Santa Monica Bay Beaches Wet-Weather Bacteria TMDL

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Santa Monica Bay Beaches Wet-weather Bacteria TMDL
Draft – 8/2/02

1 Introduction

This document covers the required elements of the wet-weather Total Maximum Daily Load (TMDL) for bacteria at Santa Monica Bay beaches (SMB beaches) as well as providing a summary of some of the supporting technical analysis used in the development of the TMDL by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board). The goal of this TMDL is to determine and set forth measures needed to prevent impairment of water quality due to bacteria during wet weather[1] for SMB beaches.[2] A TMDL to address impairment of water quality at SMB beaches due to bacteria during dry weather was adopted by the Regional Board on January 24, 2002 (see Appendix A for Regional Board Resolution No. R02-004).

To assist in the development of this TMDL, Regional Board staff convened a steering committee of key stakeholders in July 1999, and requested that Southern California Coastal Water Research Project (SCCWRP) facilitate development of a work plan in support of TMDL development and future meetings of the steering committee.[3] This TMDL is based on extensive information from other entities concerning bacteriological water quality at SMB beaches as well as an intensive wet weather sampling and modeling effort, including related studies on bacterial degradation and dilution, undertaken specifically to support the development of this and other TMDLs.

What follows is a brief overview of the benefits of this TMDL followed by an overview of the beaches included in this TMDL and the basis for their inclusion, the geographical setting, regulatory requirements for preparing this TMDL, and an introduction to the approach used in this TMDL.

1.1 Benefits of TMDL

The TMDL has been prepared pursuant to state and federal requirements to preserve and enhance water quality in Santa Monica Bay and for the benefit of the 55 million beachgoers that visit the SMB beaches on average each year (Los Angeles County Fire Department, Lifeguard Operations, 2001). At stake is the health of swimmers and surfers and associated health costs as well as sizeable revenues to the local and state economy. A joint UC-Berkeley/USC study estimates that visitors to SMB beaches spend approximately $1.7 billion annually (Hanemann *et al.*, 2001).

The California coast has sizable economic value as a resource for various tourism and recreational activities throughout the year, including winter months. According to the Los Angeles Convention and Visitors Bureau (LACVB), in 2000, a total of 19.1 million people

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[1] Wet weather is defined as days with 0.1 inch or greater of rainfall and the three days following the rain event.
[2] Bacteria can cause disease in and of itself, but is also used as an indicator of the likely presence of other disease-causing pathogens, such as viruses. Viruses are the principal agent of waterborne diseases throughout the world (National Research Council, 1999; US EPA, 2001).
[3] Agencies represented on the steering committee include the City of Los Angeles, County of Los Angeles, County Sanitation Districts of Los Angeles County, Santa Monica Bay Restoration Project, Heal the Bay, SCCWRP and the Regional Board.

visited Los Angeles from other areas of the U.S.; approximately half of these visitors came to Los Angeles during the winter months of October through March. Of these, an estimated 1.25 million visited SMB beaches, spending an estimated $556 million. These numbers do not including beach visitation and spending by the 5.5 million international tourists that visit Los Angeles County annually (LACVB, 2000).

In a study specifically designed to elicit the value of beaches, Hanemann et al. (2001) estimated that visitors to SMB beaches spend approximately $1.7 billion annually.

The travel and tourism industry in Los Angeles also generates significant fees and taxes from travel related spending, including $751 million in state and local sales taxes and $212 million in federal taxes (LACVB, 2000). According to the Los Angeles Economic Development Corporation, spending by visitors to Los Angeles provides employment for approximately 280,000 area residents, making travel and tourism the fourth largest industry in Los Angeles County (LACVB, 2000).

Looking at the economic costs of poor bacteriological quality on the other hand, a UCI researcher, Ryan Dwight, estimated that out-of-pocket health costs such as doctor visits and lost days at work may range from $12 million to $23 million per year in a study of Newport and Huntington Beaches where annual visitation lower than at Santa Monica Bay beaches.

1.2 Overview of Beaches in TMDL

Santa Monica Bay is the major receiving water for one of the largest population centers in the United States. The principal geographic features that define its extent are Point Dume to the northwest and the Palos Verdes Peninsula to the southeast as depicted in Figure 1. For the purposes of this TMDL, the Regional Board is concerned with the beaches from the Los Angeles/Ventura county line, to the northwest, to Outer Cabrillo Beach, just south of the Palos Verdes Peninsula. This area of concern covers approximately 55 miles of shoreline.

This TMDL includes 44 beaches along Santa Monica Bay. These beaches were listed on the state's 1998 303(d) list as impaired due to bacteria for two reasons – the total and/or fecal coliform water quality standards were exceeded based on shoreline monitoring data or there were one or more beach closures during the period assessed.

Fourteen of the 44 beaches on the 1998 303(d) list were listed due to exceedances of total and/or fecal coliform water quality standards (LARWQCB, 1996). (See Table 1-1 and Figures 2-4.) The assessment of these beaches was conducted during the 1996 regional water quality assessment (WQA). In the 1996 WQA, beaches were listed as impaired due to bacteria if, for the entire data set: (1) the fecal coliform standard of 400 organisms per 100 ml was exceeded in more than 15% of samples and/or (2) the total coliform standard of 10,000 organisms per 100 ml was exceeded in more than 20% of samples.[4]

[4] It should be noted that while this was the assessment guideline used in 1996, the fecal coliform assessment guideline recommended by the U.S. EPA (1997) is that no more than 10% of samples should exceed the fecal coliform objective of 400 organisms per 100 ml. Furthermore, the Water Quality Control Plan for Ocean Waters of California (California Ocean Plan) states that not more than 20% of samples shall exceed a density of 1,000 total
Footnote continued on next page

Table 1-1. Santa Monica Bay Beaches Listed for Coliform (LARWQCB, 1996)

Beach (North to South)	Miles Affected
Leo Carrillo Beach	1.15
Trancas Beach (Broad Beach)	2.02
Paradise Cove Beach	1.33
Dan Blocker Memorial Beach (Corral Beach)	1.04
Surfrider Beach	0.66
Las Flores Beach	0.76
Big Rock Beach	1.09
Topanga Beach	1.01
Will Rogers State Beach	2.2
Santa Monica Beach	2.95
Venice Beach	1.5
Dockweiler Beach	5.4
Redondo Beach	1.37
Torrance Beach	0.58
Total miles affected	23.06

In addition to the beaches above, four storm drains that discharge to SMB beaches are listed on the 1998 303(d) list as impaired due to coliform: Santa Monica Canyon; Ashland Avenue Drain; Sepulveda Canyon[5] and Pico Kenter Drain.

In addition, 42 beaches are listed on the 1998 303(d) list as impaired due to beach closures (LARWQCB, 1996). (See Table 1-2 and Figures 5-7.) Twelve of these are listed for both beach closures and coliform as indicated by a "*" in Table 1-2.[6] Nine more of these have been identified as exceeding water quality standards based on more recent data collected or analyzed by other entities, including the City of Los Angeles, Heal the Bay, and Santa Monica BayKeeper. These nine include: Nicholas Canyon Beach, Zuma Beach, Escondido Beach, Puerco Beach, Malibu Beach, Castlerock Beach, Hermosa Beach, Malaga Cove Beach, and Long Point. (See Table 1-2.)

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coliform per 100 ml and that no single sample shall exceed a density of 10,000 total coliform per 100 ml. The 10% threshold is used in section 2.3 (below), which reviews more recent data to confirm water quality impairments due to bacteria.

[5] Sepulveda Canyon is a "tributary" to Ballona Creek, and as such will be dealt with in detail as part of the Ballona Creek Bacteria TMDL.

[6] It should be noted that some of the beaches listed as impaired for beach closures do not have shoreline monitoring stations; therefore, they should be considered unassessed in terms of actual monitoring data. These include Robert H. Meyer Beach, Sea Level Beach, Point Dume Beach, Carbon Beach, La Costa Beach, Las Tunas Beach, and many of the beaches along the Palos Verdes Peninsula.

Table 1-2. Santa Monica Bay Beaches Listed for Beach Closures (LARWQCB, 1996)

Beach (North to South)	Miles Affected
Leo Carrillo Beach[*]	1.15
Nicholas Canyon Beach	1.94
Robert H. Meyer Memorial Beach	1.23
Sea Level Beach	0.67
Trancas Beach[*]	2.02
Zuma Beach	1.65
Point Dume Beach	0.95
Paradise Cove Beach[*^]	1.33
Escondido Beach[#]	2.05
Puerco Beach	1.68
Malibu Beach[^]	0.53
Surfrider Beach[*^]	0.66
Carbon Beach	1.48
La Costa Beach	0.74
Big Rock Beach[*^]	1.09
Castlerock Beach	0.81
Las Tunas Beach	1.25
Topanga Beach[*^]	1.01
Will Rogers State Beach[*^]	2.2
Santa Monica Beach[*^]	2.95
Venice Beach[*^]	1.5
Dockweiler Beach[*^]	5.4
Manhattan Beach[^]	2.08
Hermosa Beach[^]	1.88
Redondo Beach[*^]	1.37
Torrance Beach[*]	0.58
Malaga Cove Beach[^]	1.13
Flat Rock Point Beach Area	0.3
Bluff Cove Beach	0.61
Rocky Point Beach	0.52
Lunada Bay Beach	0.35
Resort Point Beach	0.49
Point Vicente Beach	2.13

Beach (North to South)	Miles Affected
Long Point	0.45
Abalone Cove Beach	0.94
Inspiration Point Beach	0.3
Portuguese Bend Beach	2.2
Palos Verdes Shoreline Park Beach	0.12
Royal Palms Beach	1.06
Whites Point Beach	0.7
Point Fermin Park Beach	1.5
Cabrillo Beach (Outer)	0.51
Total miles affected	*53.51*

*Denotes that the beach is listed as impaired due to beach closures and coliform in the 1996 regional water quality assessment.
^Denotes that the beach was given an annual (2001-02) BRC grade of "C" or worse by Heal the Bay, Inc.
# Denotes that the beach exceeds water quality standards based on Santa Monica BayKeeper's BeachKeeper monitoring data.

The majority of beach closures are due to the release of inadequately treated sewage. Closures may also result from oil spills, vessel spills and in a few cases persistent elevated bacteria densities.[7] These beaches were originally listed in 1996 because there were one or more beach closures during the period assessed. Sewage spills are primarily addressed through enforcement actions such as Administrative Civil Liability (ACL) fines, Cease and Desist Orders (CDOs), and litigation.

1.3 Geographical Setting

The Santa Monica Bay watershed is 1,072 km^2 (414 mi^2) as shown in Figure 1 and has an estimated population of 1,950,265 based on the 2000 U.S. Census. Open space represents the primary land use in the watershed (55%), while high-density residential areas represent the largest developed area (25% of the total watershed). Low-density residential constitutes 5% of the land area. Commercial, industrial and mixed urban areas cover 10%. The remaining 5% of land area is covered by transportation (1.7%), educational institutions (1.6%), agriculture (0.8%), recreational uses (0.8%), public facilities and military installations (0.2%), and water (0.4%).

While this provides an overview of the watershed as a whole, land use is in fact highly differentiated within the watershed. For the purposes of this TMDL, the Regional Board has divided the watershed into 28 subwatersheds. The two largest of these, the Malibu Creek and Ballona Creek subwatersheds, are further divided into 6 and 7 subdrainages, respectively. (Figure 1) Subwatersheds in the northern part of the Bay (northwest of Santa Monica subwatershed) have on average 85% of their land area in open space. Subwatersheds in the central and southern portion of the Bay (southeast of Santa Monica Canyon subwatershed) have on average 16% of their area in open space. (See Table 1-3 and Figures 8-10 for land use breakdowns by subwatershed.)

[7] Beach postings on the other hand may result from routine monitoring that shows elevated bacteria densities at a particular sampling location.

Table 1-3. Land Use as a Percent of Total Subwatershed Area

Subwatershed	Agriculture	Commercial	Education	High Density Residential	Industrial	Low Density Residential	Military	Mixed Urban	Open	Public Facilities	Recreation	Transportation	Water	Total Land Area (acres)
Las Virgenes	1.2%	0.8%	0.5%	4.2%	0.3%	1.1%	0.0%	0.2%	90.9%	0.0%	0.0%	0.9%	0.1%	15,554
Lidero Canyon	0.1%	2.0%	0.6%	11.2%	1.6%	7.7%	0.0%	0.4%	74.4%	0.7%	0.0%	1.1%	0.1%	11,455
Monte Nido	0.3%	0.4%	0.0%	0.1%	0.3%	5.5%	0.0%	0.1%	93.4%	0.0%	0.0%	0.0%	0.0%	13,432
Russell Valley	0.1%	5.9%	0.2%	11.6%	2.0%	15.7%	0.0%	0.1%	60.5%	1.0%	1.1%	1.7%	0.1%	9,165
Sherwood	12.9%	0.0%	0.0%	0.0%	0.1%	3.5%	0.0%	0.0%	82.1%	0.0%	0.0%	0.0%	1.2%	10,739
Triunfo Canyon	0.7%	0.1%	0.0%	1.3%	0.0%	6.4%	0.0%	0.2%	89.2%	0.0%	0.0%	0.0%	2.0%	10,064
Malibu Creek Total	**2.4%**	**1.4%**	**0.2%**	**4.5%**	**0.7%**	**6.0%**	**0.0%**	**0.2%**	**83.1%**	**0.2%**	**0.1%**	**0.6%**	**0.5%**	**70,410**
Arroyo Sequit	0.3%	0.1%	0.0%	0.0%	0.1%	1.5%	0.0%	0.0%	98.0%	0.0%	0.0%	0.0%	0.0%	7,549
Carbon Canyon	0.0%	1.2%	0.0%	5.6%	0.0%	8.5%	0.0%	0.0%	84.7%	0.0%	0.0%	0.0%	0.0%	2,320
Castlerock	0.0%	0.7%	0.2%	12.5%	0.1%	1.3%	0.0%	0.0%	85.0%	0.0%	0.0%	0.0%	0.3%	4,976
Corral Canyon	0.1%	0.8%	4.1%	3.4%	0.2%	1.7%	0.0%	0.0%	89.6%	0.0%	0.2%	0.0%	0.0%	4,280
Encinal Canyon	0.8%	0.0%	0.0%	3.9%	0.0%	4.7%	0.0%	0.0%	90.5%	0.0%	0.0%	0.0%	0.0%	1,794
Escondido Canyon	0.0%	0.0%	0.0%	1.1%	0.0%	10.3%	0.0%	0.0%	88.6%	0.0%	0.0%	0.0%	0.0%	2,295
Las Flores Canyon	0.5%	0.5%	0.0%	1.9%	0.1%	6.5%	0.0%	0.0%	90.4%	0.0%	0.0%	0.0%	0.0%	2,897
Latigo Canyon	0.0%	0.1%	0.0%	2.0%	0.0%	6.9%	0.0%	0.0%	91.0%	0.0%	0.0%	0.0%	0.0%	813
Los Alisos Canyon	1.0%	0.1%	0.0%	0.9%	0.0%	7.8%	0.0%	0.0%	90.3%	0.0%	0.0%	0.0%	0.0%	2,396
Nicholas Canyon	0.0%	0.4%	0.0%	1.8%	0.0%	4.5%	0.0%	1.6%	91.6%	0.0%	0.0%	0.0%	0.0%	1,235
Pena Canyon	0.0%	0.0%	0.0%	2.9%	0.0%	0.0%	0.0%	0.0%	97.1%	0.0%	0.0%	0.0%	0.0%	608
Piedra Gorda Canyon	0.0%	0.0%	0.0%	18.1%	0.0%	0.0%	0.0%	0.0%	81.9%	0.0%	0.0%	0.0%	0.0%	644
Pulga Canyon	0.0%	3.0%	2.0%	17.8%	0.3%	0.2%	0.0%	0.0%	76.6%	0.0%	0.0%	0.0%	0.1%	1,955
Ramirez Canyon	0.3%	0.5%	0.1%	2.3%	0.0%	18.5%	0.0%	0.1%	78.3%	0.0%	0.0%	0.0%	0.0%	3,334

Subwatershed	Agriculture	Commercial	Education	High Density Residential	Industrial	Low Density Residential	Military	Mixed Urban	Open	Public Facilities	Recreation	Transportation	Water	Total Land Area (acres)
Santa Monica Canyon	0.0%	0.4%	0.3%	11.6%	0.0%	8.5%	0.0%	0.0%	77.6%	0.0%	1.6%	0.0%	0.0%	10,088
Solstice Canyon	0.0%	0.1%	0.0%	0.0%	0.0%	2.7%	0.0%	0.0%	97.2%	0.0%	0.0%	0.0%	0.0%	2,841
Topanga Canyon	0.3%	0.2%	0.1%	0.8%	0.0%	8.7%	0.0%	0.2%	89.8%	0.0%	0.0%	0.0%	0.0%	12,575
Trancas Canyon	0.3%	0.3%	0.4%	1.8%	0.0%	6.7%	0.0%	0.1%	88.4%	0.0%	1.8%	0.0%	0.1%	6,514
Tuna Canyon	0.0%	0.0%	0.0%	1.3%	0.0%	2.3%	0.0%	0.0%	96.4%	0.0%	0.0%	0.0%	0.0%	1,013
Santa Ynez	0.0%	1.5%	0.6%	49.4%	0.0%	2.5%	0.0%	0.0%	46.1%	0.0%	0.0%	0.0%	0.0%	1,203
Zuma Canyon	1.7%	0.7%	0.0%	1.1%	0.0%	10.5%	0.0%	0.0%	85.8%	0.0%	0.0%	0.0%	0.1%	6,339
Other Northern Bay Total	**0.3%**	**0.5%**	**0.4%**	**4.8%**	**0.0%**	**6.5%**	**0.0%**	**0.1%**	**87.0%**	**0.0%**	**0.4%**	**0.0%**	**0.0%**	**77,671**
Northern Bay Total	**1.3%**	**0.9%**	**0.3%**	**4.6%**	**0.3%**	**6.3%**	**0.0%**	**0.1%**	**85.2%**	**0.1%**	**0.3%**	**0.3%**	**0.3%**	**148,081**
Cienega	0.1%	13.8%	4.2%	59.2%	8.3%	0.1%	0.0%	6.8%	4.5%	0.0%	0.0%	2.9%	0.1%	16,624
Culver City	0.0%	4.0%	1.2%	32.8%	5.9%	15.3%	0.0%	0.4%	34.1%	0.0%	4.6%	0.8%	0.9%	8,011
Hollywood	0.0%	16.1%	2.0%	52.7%	2.1%	3.0%	0.0%	9.1%	13.1%	0.0%	0.6%	0.9%	0.4%	29,602
Marina Del Rey	0.0%	10.5%	4.2%	44.0%	9.5%	0.0%	0.0%	1.0%	24.5%	0.0%	0.0%	0.2%	6.1%	5,241
West Los Angeles	0.0%	10.7%	5.3%	40.9%	2.9%	2.5%	0.0%	0.1%	29.7%	0.0%	2.7%	4.6%	0.4%	10,127
Westwood Village	0.0%	8.4%	5.1%	59.9%	5.6%	7.5%	0.0%	0.6%	6.8%	0.0%	4.4%	0.9%	0.8%	6,086
Windsow Hills	0.0%	13.3%	1.4%	55.9%	13.4%	0.3%	0.1%	2.4%	9.1%	0.0%	0.0%	4.1%	0.1%	6,288
Ballona Creek Total	**0.0%**	**12.7%**	**3.1%**	**50.8%**	**5.4%**	**3.5%**	**0.0%**	**5.0%**	**15.4%**	**0.0%**	**1.3%**	**2.0%**	**0.7%**	**81,980**
Dockweiler	0.0%	4.8%	2.8%	27.0%	19.9%	0.0%	0.0%	0.3%	12.8%	0.0%	1.1%	31.1%	0.2%	6,573
Hermosa	0.0%	10.8%	5.5%	71.5%	3.7%	0.0%	0.2%	5.2%	2.9%	0.0%	0.0%	0.0%	0.4%	2,624
Palos Verdes	0.5%	1.6%	2.0%	51.1%	0.9%	4.5%	1.5%	0.1%	33.6%	0.0%	2.9%	1.2%	0.1%	10,023
Redondo	1.7%	11.6%	8.0%	57.5%	4.1%	0.0%	0.0%	11.2%	5.5%	0.0%	0.1%	0.0%	0.2%	3,544
Santa Monica	0.0%	11.9%	3.0%	54.3%	3.7%	4.6%	0.0%	4.6%	13.0%	0.0%	2.3%	2.6%	0.0%	8,850

Subwatershed	Agriculture	Commercial	Education	High Density Residential	Industrial	Low Density Residential	Military	Mixed Urban	Open	Public Facilities	Recreation	Transportation	Water	Total Land Area (acres)
Other Southern Bay Total	0.3%	7.1%	3.4%	49.4%	6.2%	2.7%	0.5%	3.1%	17.8%	0.0%	1.8%	7.6%	0.1%	31,614
Southern Bay Total	0.1%	11.1%	3.2%	50.4%	5.6%	3.3%	0.1%	4.5%	16.1%	0.0%	1.4%	3.5%	0.6%	113,594
Grand Total	0.8%	5.3%	1.6%	24.5%	2.6%	5.0%	0.1%	2.0%	55.2%	0.1%	0.8%	1.7%	0.4%	261,675

1.4 Regulatory Background

The California Water Quality Control Plan, Los Angeles Region (Basin Plan) sets water quality standards for the Los Angeles Region, which include beneficial uses for surface and ground water, numeric and narrative objectives necessary to support beneficial uses, and the state's antidegradation policy, and describes implementation programs to protect all waters in the region. The Basin Plan establishes water quality control plans and policies for the implementation of the Porter-Cologne Water Quality Act within the Los Angeles Region and, along with the Water Quality Control Plan for Ocean Waters of California (California Ocean Plan), serves as the State Water Quality Control Plan applicable to regulating bacteria in Santa Monica Bay, as required pursuant to the federal Clean Water Act (CWA).

Section 303(d)(1)(A) of the CWA requires each state to conduct a biennial assessment of its waters, and identify those waters that are not achieving water quality standards. The resulting list is referred to as the 303(d) list. The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and to develop and implement TMDLs for these waters.

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocates the acceptable pollutant load to point and nonpoint sources. The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and section 303(d) of the CWA, as well as in U.S. Environmental Protection Agency guidance (U.S. EPA, 1991). By law, a TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loads (the Loading Capacity) is not exceeded. The Regional Board is also required to develop a TMDL taking into account seasonal variations and including a margin of safety to address uncertainty in the analysis (40 CFR 130.7(c)(1)). Finally, states must develop water quality management plans to implement the TMDL (40 CFR 130.6).

The U.S. EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the state's 303(d) list and each TMDL developed by the state. If the state fails to develop a TMDL in a timely manner or if the U.S. EPA disapproves a TMDL submitted by a state, EPA is required to establish a TMDL for that waterbody (40 CFR 130.7(d)(2)).

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

For the purpose of scheduling TMDL development, the decree combined the over 700 waterbody-pollutant combinations into 92 TMDL analytical units. Analytical unit 48 consists of beaches and key storm drains/channels to Santa Monica Bay with impairments related to pathogens. (The beaches included in TMDL analytical unit 48 are listed in Tables 1-1 and 1-2.)

The consent decree also prescribed schedules for certain TMDLs, and according to this schedule, a bacteria TMDL for SMB beaches was to be adopted by March 2002.

1.5 Overview of TMDL Approach

Staff proposes a 'reference system/anti-degradation approach' as the implementation procedure for the recently-adopted bacteria objectives for REC-1 waters (described in section 2.2) as outlined in this TMDL and the Dry-Weather Bacteria TMDL for Santa Monica Bay Beaches. As required by the CWA and Porter-Cologne Water Quality Control Act, Basin Plans include beneficial uses of waters, water quality objectives to protect those uses, an anti-degradation policy, collectively referred to as water quality standards, and other plans and policies necessary to implement water quality standards. TMDLs are incorporated into the Basin Plan as implementation plans for the Region's water quality standards.

The preferred 'reference system/anti-degradation approach' means that on the basis of historical exceedance levels at existing shoreline monitoring locations, including a local reference beach within Santa Monica Bay, staff is proposing to permit a certain number of daily exceedances of the single sample bacteria objectives. This approach is proposed in recognition of the fact that there are natural sources of bacteria that may cause or contribute to exceedances of the single sample objectives and that it is not the intent of the Regional Board to require treatment or diversion of natural coastal creeks or to require treatment of natural sources of bacteria from undeveloped areas. Staff was concerned that such an approach, while addressing the impairment of the REC-1 beneficial use, would adversely affect important aquatic life and wildlife beneficial uses in the coastal creeks and lagoons draining to SMB beaches. Such an approach means that this TMDL is only designed to insure that human-generated sources of bacteria and natural bacteria sources concentrated by human activities (e.g., storm water conveyances), collectively referred to herein as "human-generated bacteria sources," do not cause or contribute to an exceedance of water quality standards. After additional data are gathered to refine reference locations and to enhance the Regional Board's understanding of naturally occurring bacteria exceedances, the Regional Board may need to pursue a subsequent Basin Plan amendment either (1) to refine the numeric target to address natural sources or (2) to adjust the objectives to recognize naturally occurring exceedances.

As described later, staff proposes to use Leo Carrillo Beach and its associated drainage area, Arroyo Sequit Canyon, as the local reference system until other reference approaches are evaluated and the necessary data collected to support the use of alternative reference locations when the TMDL is revised in five years.. Arroyo Sequit Canyon is the most undeveloped subwatershed in the Santa Monica Bay watershed with 98% open space and little evidence of human impact. In essence, the reference approach recognizes natural sources and focuses this wet-weather TMDL to set waste load allocations such that human-generated bacteria sources do not cause or contribute to exceedances of bacteria water quality standards.

The reference beach approach, as set forth below, ensures that water quality is at least as good as that of the reference beach. In addition, this approach recognizes and is consistent with state and federal anti-degradation policies, such that where existing water quality is better than that of the reference beach, no degradation of existing water quality is permitted. This approach is necessary because the land use in many of the subwatersheds in northern Santa Monica Bay is predominately open space or undeveloped land. Some of these subwatersheds do not appear to have significant anthropogenic sources of bacteria; however, the beaches to which they drain still occasionally exceed the single sample bacteria objectives. This is likely the result of non-human sources of bacteria. Again, it is not the intent of this TMDL to require treatment or diversion of natural coastal creeks or to require treatment of natural sources of bacteria from undeveloped areas. Staff was concerned that such an approach, while addressing the impairment of the REC-1 beneficial use, would adversely affect important aquatic life and wildlife beneficial uses in the coastal creeks and lagoons draining to SMB beaches.

2 Problem Identification

This section briefly discusses the health risks associated with swimming in ocean water contaminated with human sewage and other sources of pathogens. It is these risks to public health that the Regional Board intends to reduce through the development and implementation of the TMDL. Second, the section describes the applicable water quality standards and provides background on their development. Finally, the section presents more recent data to support the original 303(d) listings made in 1996.

2.1 Health Risks of Swimming in Water Contaminated with Bacteria

Swimming in marine waters contaminated with human sewage has long been associated with adverse health effects (Favero, 1985). The most commonly observed health effect associated with recreational water use is gastroenteritis with symptoms including vomiting, fever, stomach pain and diarrhea. Other commonly reported health effects include eye, ear, and skin infections, and respiratory disease.

Since the 1950s, numerous epidemiological studies have been conducted around the world to investigate the possible links between swimming in fecal-contaminated waters and health risks. Recently, the World Health Organization completed a comprehensive review of 22 published epidemiological studies, 16 of which were conducted in marine waters (Pruss, 1998). Fourteen of the 16 marine water studies found a significant association between bacteria indicator densities and the rate of certain symptoms or groups of symptoms. Most significant associations were found for gastrointestinal illnesses. However, as shown in several large-scale epidemiological studies of recreational waters, other health outcomes such as skin rashes, respiratory ailments, and eye and ear infections are associated with swimming in fecal-contaminated water. The Santa Monica Bay study, discussed below, found swimming in urban runoff-contaminated waters resulted in an increased risk of chills, ear discharge, vomiting, coughing with phlegm and significant respiratory diseases (fever and nasal congestion, fever and sore throat, or coughing with phlegm).

In fact, significant respiratory disease was the most common outcome to swimmers exposed to runoff polluted water in Santa Monica Bay (Haile, *et al*., 1996, 1999). Cheung, *et al*. (1990a) found an increased risk of respiratory, skin rash and total illness associated with increased levels of bacteria indicator densities. Von Schirnding *et al*.(1993) found increases in the risks of respiratory and skin symptoms with increasing bacteria indicator densities. Fattal, *et al*. (1986) found skin rash symptoms and "total sickness" (at least one health effect) outcomes increased with bacteria indicator densities. Corbett, *et al*. (1993) found a positive linear relationship between several symptoms including respiratory, ear, and eye symptoms and water pollution levels. These studies compel the conclusion that there is a causal relationship between health outcomes and recreational water quality, as measured by bacteria indicator densities.

2.1.1 Santa Monica Bay Epidemiological Study

One of the studies reviewed in Pruss (1998) was the Santa Monica Bay Restoration Project epidemiological study conducted in 1995. This was the first epidemiological study to specifically evaluate the increased health risks to people who swam in marine waters contaminated by *urban runoff* (Haile, *et al.*, 1996, 1999). The results of the Santa Monica Bay study provided much of the basis for the current recreational water quality standards for marine waters in California (e.g., standards developed by the California Department of Health Services in response to Assembly Bill 411 (1997 Stats. 765)). The study collected health effects data from 11,793 individuals visiting three SMB beaches, including Santa Monica Beach, Will Rogers State Beach, and Surfrider Beach. Bacteria indicators measured in the study included total coliform, fecal coliform, *E. coli*, and enterococcus.

The epidemiological study was unique in two ways. First, the source of bacteria was not effluent from a sewage treatment plant, but instead urban runoff discharged from storm drains. Second, the study compared people swimming near a flowing storm drain to other people swimming 400 meters away from the drain. Positive associations were observed between adverse health effects and the distance an individual swam from the drain. The study found that 1 in 25 people swimming in front of a storm drain will get sick and that the likelihood of getting sick is twice as high for individuals swimming in front of a storm drain. The number of excess cases of illness attributable to swimming at the drain reached into the hundreds per 10,000 exposed participants, suggesting that significant numbers of swimmers in the water near flowing storm drains are subject to increased health risks. In addition, an increased health risk was associated with increasing densities of bacteria. Table 2-1 summarizes some of the health outcomes that were significantly associated with the four bacterial indicators at the proposed numeric targets in the TMDL.

Table 2-1. Health Risks at Proposed Numeric Targets (Haile et al., 1996, 1999; Haile and Witte, 1997)

Bacterial Indicator	Health Outcome	Attr. # (per 10,000)*
Enterococcus	Diarrhea with blood Gastroenteritis I**	27 130
Total coliform	Skin rash	165
Fecal/total ratio	Nausea Diarrhea Gastroenteritis II*** Chills	230 281 98 117
Fecal coliform	Skin rash	74

Notes: *Attributable number. **Highly credible gastrointestinal illness I with vomiting, diarrhea and fever, or stomach pain and fever. ***Highly credible gastrointestinal illness II with vomiting and fever.

2.2 Water Quality Standards

The Basin Plan designates beneficial uses for waterbodies in the Los Angeles Region. These uses are recognized as existing (E), potential (P), or intermittent (I) uses. All beneficial uses must be protected. SMB beaches have a variety of beneficial use designations including Navigation, Contact and Non-contact Recreation, Commercial and Sport Fishing, Marine Habitat, Wildlife Habitat, Spawning, Reproduction and/or Early Development, and Shellfish Harvesting. However, the focus of this TMDL is on the Water Contact Recreation (REC-1) beneficial use, which is designated as an existing use for all SMB beaches.[8]

[8] Protection of REC-1 (the water contact recreation use) will result in protection of REC-2 (the non-contact recreation use) as the water quality objective for fecal coliform to protect REC-2 is set at 10 times the REC-1 fecal coliform objective.

The REC-1 beneficial use is defined in the Basin Plan as "[U]ses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs" (Basin Plan, p. 2-2). The Basin Plan and the California Ocean Plan, the provisions of which are included in the Basin Plan by reference, contain bacteria water quality objectives to protect the REC-1 use. In the current plans, total and fecal coliform bacteria are used as indicators of the likely presence of disease-causing pathogens in surface waters.

On October 25, 2001, the Regional Board adopted a Basin Plan amendment updating the bacteria objectives for waters designated as REC-1 (Regional Board Resolution R01-018, see Appendix B). On July 18, 2002, the State Board approved the Regional Board's Basin Plan amendment (State Board Resolution 2002-0142, see Appendix B). The revised objectives include geometric mean limits and single sample limits for four bacterial indicators, including total coliform, fecal coliform, the fecal-to-total coliform ratio, and enterococcus.

The revised Basin Plan objectives for marine waters designated for Water Contact Recreation (REC-1) are as follows:

1. *Geometric Mean Limits*
   1. *Total coliform density shall not exceed 1,000/100 ml.*
   2. *Fecal coliform density shall not exceed 200/100 ml.*
   3. *Enterococcus density shall not exceed 35/100 ml.*

2. *Single Sample Limits*
   1. *Total coliform density shall not exceed 10,000/100 ml.*
   2. *Fecal coliform density shall not exceed 400/100 ml.*
   3. *Enterococcus density shall not exceed 104/100 ml.*
   4. *Total coliform density shall not exceed 1,000/100 ml, if the ratio of fecal-to-total coliform exceeds 0.1.*

The revised objectives are the same as those contained in state law (California Code of Regulations, title 17, section 7958, which implements Assembly Bill 411 (1997 Stats. 765)), which was passed in large part due to the Santa Monica Bay epidemiological study described above. Assembly Bill 411 resulted in changes to California Department of Health Services' regulations for public beaches and public water contact sports areas. These changes included (1) setting minimum protective bacteriological standards for waters adjacent to public beaches and public water contact sports areas based on four indicators (total coliform, fecal coliform, enterococcus, and the fecal-to-total coliform ratio) and (2) altering the requirements for monitoring, posting, and closing certain coastal beaches based on these four bacterial indicators. The revised objectives are also consistent with, but augment on the basis of the local SMB epidemiological study, current U.S. EPA guidance (1986), which recommends the use of enterococcus in marine water based on more recent national epidemiological studies (LARWQCB, 2001; Cabelli, 1983). Finally, the changes are consistent with those being drafted for the California Ocean Plan (Linda O'Connell, State Water Resources Control Board, personal communication). See Table 2-2 for the revised water quality objectives for protection of marine waters designated as REC-1 adopted by the Regional Board on October 25, 2001 and approved by the State Board on July 18, 2002.

Table 2-2. Proposed Bacteria Objectives for REC-1 Marine Waters (LARWQCB, 2001)

Parameter	Geometric Mean	Single Sample
Total Coliform	1,000	10,000
		1,000 if FC/TC > 0.1
Fecal Coliform	200	400
Enterococcus	35	104

As discussed earlier, staff proposes to use the reference system/anti-degradation approach (described in section 1.5, Overview of TMDL Approach) as the implementation procedure for the recently-adopted bacteria objectives. TMDLs and associated waste load allocations incorporated into permits are the vehicles for implementation of our standards. Therefore, the reference system/anti-degradation approach is the approach proposed in this TMDL as well as other bacteria TMDLs being developed in the LA Region (e.g. Santa Monica Bay Beaches Dry-Weather TMDL, Malibu Creek Bacteria TMDL).

2.3 Data Review

Santa Monica Bay beaches are some of the most comprehensively and intensively monitored in the nation. Four agencies contribute to this wealth of data. The City of Los Angeles Environmental Monitoring Division at the Hyperion Wastewater Treatment Plant (Hyperion) monitors 17 locations on a daily basis; the Los Angeles County Department of Health Services monitors 30 locations on a weekly basis; and the County Sanitation Districts of Los Angeles County (CSDLAC) monitors eight locations, six daily and two weekly. Many of these locations are adjacent to the mouth of a storm drain or creek.

Analysis of these data has consistently shown that bacteria densities at many SMB beaches exceed REC-1 bacteria objectives during both dry and wet weather. In the 1996 WQA, the Regional Board evaluated total and fecal coliform monitoring data collected between 1988 and 1994 by the agencies listed above to determine whether a beach was impaired due to exceedances of the existing water quality objectives. The 1996 WQA supported the conclusion that many SMB beaches exceed the REC-1 bacteria objectives.

More recent shoreline monitoring data (1995-2000) collected by the City of Los Angeles, Environmental Monitoring Division, County Sanitation Districts of Los Angeles County, and the Los Angeles County Department of Health Services, and analyzed by Heal the Bay, is summarized in Table 2-2. During wet weather, 38 of the 56 shoreline locations monitored (or 70%) had a higher probability of exceedance than the beach adjacent to the most undeveloped subwatershed in the Santa Monica Bay watershed (Leo Carrillo Beach).[9]

[9] In this analysis, wet weather was defined as rainfall of 0.1 inch or more plus the 3 days following the rain event following the protocol used by the Los Angeles County Department of Health Services to post beaches during and after a rain event.

Table 2-2. Five-Year Summary of Number of Wet Weather Samples Exceeding Single Sample Targets

WET WEATHER EXCEEDANCES		Five-Year Total (November 1995 - October 2000)		
LOC_ID	Beach Monitoring Location	Total number of wet weather samples	Number of wet weather samples with an exceedance	Wet weather exceedance probability
DHS (010)	Leo Carrillo Beach, at 35000 PCH	48	9	0.19
DHS (009)	Nicholas Beach- 100 feet west of lifeguard tower	10	2	0.20
DHS (010a)	Broad Beach	43	9	0.21
DHS (008)	Trancas Beach entrance, 50 yards east of Trancas Bridge	19	5	0.26
DHS (007)	Westward Beach, east of Zuma Creek	48	10	0.21
DHS (006)	Paradise Cove, adjacent to west side of Pier	48	13	0.27
DHS (005)	Latigo Canyon Creek entrance	48	18	0.38
DHS (005a)	Corral State Beach	47	10	0.21
DHS (003)	Malibu Point	48	10	0.21
DHS (003a)	Surfrider Beach (second point)- weekly	47	27	0.57
S1	Surfrider Beach (breach point)- daily	365	208	0.57
DHS (002)	Malibu Pier- 50 yards east	48	27	0.56
DHS (001a)	Las Flores Beach	37	13	0.35
DHS (001)	Big Rock Beach, at 19900 PCH	45	15	0.33
S2	Topanga State Beach	367	114	0.31
DHS (101)	PCH and Sunset Bl.- 400 yards east	42	12	0.29
DHS (102)	16801 Pacific Coast Highway, Bel Air Bay Club (chain fence)	46	15	0.33
S3	Pulga Canyon storm drain- 50 yards east	371	107	0.29
DHS (103)	Will Rogers State Beach- Temescal Canyon (25 yrds. so. Of drain)	49	16	0.33
S4	Santa Monica Canyon, Will Rogers State Beach	372	109	0.29
DHS (104a)	Santa Monica Beach at San Vicente Bl.	45	20	0.44
DHS (104)	Santa Monica at Montana Av. (25 yrds. so. of drain)	46	18	0.39
DHS (105)	Santa Monica at Arizona (in front of the drain)	46	19	0.41
S5	Santa Monica Municipal Pier- 50 yards southeast	334	153	0.46
S6	Santa Monica Beach at Pico/Kenter storm drain	334	181	0.54
DHS (106)	Santa Monica Beach at Strand St. (in front of the restrooms)	46	22	0.48
DHS (106a)	Ashland Av. storm drain- 50 yards north	45	23	0.51
S7	Ashland Av. storm drain- 50 yards south	334	94	0.28
DHS (107)	Venice City Beach at Brooks Av. (in front of the drain)	19	10	0.53

WET WEATHER EXCEEDANCES		Five-Year Total (November 1995 - October 2000)		
LOC_ID	Beach Monitoring Location	Total number of wet weather samples	Number of wet weather samples with an exceedance	Wet weather exceedance probability
S8	Venice City Beach at Windward Av.- 50 yards north	334	55	0.16
DHS (108)	Venice Fishing Pier- 50 yards south	46	10	0.22
DHS (109)	Venice City Beach at Topsail St.	46	23	0.50
S10	Ballona Creek entrance- 50 yards south	334	125	0.37
S11	Dockweiler State Beach at Culver Bl.	334	97	0.29
DHS (110)	Dockweiler State Beach- south of D&W jetty	46	18	0.39
S12	Imperial HWY storm drain- 50 yards north	334	74	0.22
DHS (111)	Hyperion Treatment Plant One Mile Outfall	46	11	0.24
DHS (112)	Dockweiler State Beach at Grand Av. (in front of the drain)	46	15	0.33
S13	Manhattan State Beach at 40th Street	334	14	0.04
S14	Manhattan Beach Pier- 50 yards south	334	20	0.06
DHS (114)	Hermosa City Beach at 26th St.	46	7	0.15
S15	Hermosa Beach Pier- 50 yards south	334	33	0.10
DHS (115)	Herondo Street storm drain- (in front of the drain)	45	11	0.24
S16	Redondo Municipal Pier- 50 yards south	334	59	0.18
DHS (116)	Redondo State Beach at Topaz St. - north of jetty	41	10	0.24
S17	Redondo State Beach at Avenue I	334	25	0.07
S18	Malaga Cove, Palos Verdes Estates-daily	334	12	0.04
LACSDM	Malaga Cove, Palos Verdes Estates-weekly	39	7	0.18
LACSDB	Palos Verdes (Bluff) Cove, Palos Verdes Estates	23	0	0.00
LACSD1	Long Point, Rancho Palos Verdes	241	13	0.05
LACSD2	Abalone Cove Shoreline Park	248	3	0.01
LACSD3	Portuguese Bend Cove, Rancho Palos Verdes	248	6	0.02
LACSD5	Royal Palms State Beach	248	19	0.08
LACSD6	Wilder Annex, San Pedro	195	4	0.02
LACSD7	Cabrillo Beach, oceanside	248	7	0.03

In addition to the above analysis, several other entities have collected and analyzed shoreline bacteriological monitoring data for SMB beaches. First, Heal the Bay compiles and analyzes data collected by local health agencies throughout Southern California. It publishes its results monthly on the Internet and in an annual Beach Report Card (BRC). The BRC assigns each beach a grade from A to F, taking into consideration the frequency and magnitude of indicator threshold exceedances over a 28-day period.[10] Table 2-3 summarizes the annual BRC grades for SMB beaches for the period April 2001 through March 2002. Sixty percent of beach locations (31 of 51) received a wet-weather grade of C or lower. The 2001-02 BRC also confirms the findings of the Regional Board's 1996 WQA.

Table 2-3. Heal the Bay's Annual BRC Grades for SMB Beaches (2001-02)

Beach/Monitoring Location	Dry Weather	Wet Weather
Leo Carrillo Beach	A	A
Nicholas Canyon Beach (33 yds. West of lifeguard tower)	A	A+
Trancas Beach entrance (Broad Beach)	A	A
Westward Beach (Zuma Beach)	A	B
Paradise Cove	C	F
Latigo Canyon Creek entrance (Corral Beach)	A	D
Puerco Beach	A	B
Surfrider Beach (near Malibu Colony)	A	F
Surfrider Beach (daily @ breach location)	F	F
Malibu Pier	B	F
Big Rock Beach	B	F
Topanga State Beach	A	F
Will Rogers Beach (@ PCH & Sunset Blvd.)	A	D
Will Rogers Beach (near Bel Air Bay Club)	A	C
Will Rogers Beach (Pulga Canyon storm drain, 50 yards east)	A	A
Will Rogers Beach (Temescal Canyon)	B	F
Will Rogers Beach (Santa Monica Canyon)	C	F
Santa Monica Beach (Montana Ave.)	A	F
Santa Monica Beach (Arizona Ave.)	A	F
Santa Monica Pier (50 yards downcoast)	C	F
Santa Monica Beach (Pico-Kenter storm drain)	A	F
Santa Monica Beach (Strand St.)	A	F
Ocean Park Beach (Ashland Ave. storm drain, 50 yards south)	A	C
Venice Beach (Brooks Ave.)	A	F

[10] The indicator thresholds used in the BRC are the same as those recently adopted by the Regional Board for marine waters designated as REC-1 and those proposed as targets in the TMDL, which include total coliform, fecal coliform, enterococcus, and a fecal-to-total coliform ratio.

Beach/Monitoring Location	Dry Weather	Wet Weather
Venice Beach (Windward Ave., 50 yards north)	A	B
Venice Pier (50 yards south)	A	B
Venice Beach (Topsail St.)	C	F
Dockweiler Beach (50 yards south of Ballona Cr.)	A	F
Dockweiler Beach (Culver Blvd.)	A	D
Dockweiler Beach (D&W jetty)	B	D
Dockweiler Beach (Imperial Hwy. Storm drain, 50 yards north)	A	C
Dockweiler Beach (opposite Hyperion)	A	F
Dockweiler Beach (Grand Ave.)	A	F
Manhattan Beach (40th St.)	A+	A
Manhattan Beach (27th St.)	A	D
Manhattan Pier (50 yards south)	A	A
Hermosa Beach (26th St.)	A	F
Hermosa Pier (50 yards south)	A	A
Herondo St. storm drain (50 yards north)	C	F
Redondo Pier (50 yards south)	B	D
Redondo Beach (Topaz St.)	A	F
Redondo Beach (Ave. I)	A	B
Malaga Cove – daily	A+	A+
Malaga Cove – weekly	A+	C
Bluff Cove	A+	A+
Long Point	A+	A+
Abalone Cove	A	A+
Portuguese Bend	A	A+
Royal Palms Beach	A	B
Wilder Annex	A+	B
Cabrillo Beach (Outer)	A	B

Finally, in support of the TMDL, the Southern California Coastal Water Research Project (SCCWRP) conducted a 5-year (1995-99) retrospective evaluation of shoreline bacteria data (Schiff *et al.*, 2001). Rather than examining the percentage of samples that exceeded the water quality objectives for a particular monitoring location, SCCWRP analyzed the percentage of shoreline mile-days that exceeded water quality objectives.[11] It should be noted that while

[11] Shoreline mile-days are calculated as follows:
Footnote continued on next page

examining exceedances in terms of shoreline mile-days provides insight into the frequency of exceedances, it does not shed light on the magnitude of exceedances.

SCCWRP's evaluation reached several conclusions about the nature of bacteria contamination along beaches. First, SCCWRP found that only 13% of shoreline mile-days exceeded bacteria objectives during the 5-year period. This result highlights the fact that during dry weather, the prevailing condition in Southern California, most beaches do not exceed water quality standards. Second, SCCWRP found that although rainstorms are relatively infrequent in Southern California and only one-quarter of the samples were collected during wet weather, approximately 40% of all fecal coliform exceedances, 50% of all enterococcus exceedances, and 65% of all total coliform exceedances occurred during wet weather, indicating that the percentage of shoreline mile-days exceeding the objectives during wet weather is significantly higher than the percentage exceeding during dry weather.

SCCWRP's analysis also enables the Regional Board to rank sites, and groups of sites, in terms of their relative contribution to the total number of shoreline mile-days that exceed the bacteria objectives. For both wet and dry weather, 53% of exceedances occurred near storm drains, while 40% occurred on sandy beaches. (It should be noted that the influence of storm drains may have been underestimated in the analysis, since sampling sites are located 50 meters north or south of storm drains and water quality impairments may have occurred at less than 50 meters.[12])

While five freshwater outlets/storm drains (Malibu Creek, Santa Monica Pier, Santa Monica Canyon, Pico-Kenter, and Topanga Point) accounted for over half of the drain-related exceedances during dry weather, exceedances were more evenly spread across storm drain-impacted beaches during wet weather. For open beach sites, the top five most contaminated sites (Surfrider, Malibu Pier, Big Rock Beach, Las Flores Beach, and Paradise Cove) accounted for 37% of exceedances during dry weather, but only 27% of exceedances in wet weather. See Appendix C for the complete retrospective evaluation published in SCCWRP's 2000-01 Annual Report.

$$SMD = \frac{\sum_{i=1}^{n} s_i \times d_i \times 200}{\sum_{i=1}^{n} d_i \times 200}$$

Where:
SMD = proportion of shoreline mile-days that exceed a water quality threshold for a stratum (i.e., storm drain, open beach)
s_i = samples that exceed water quality threshold for indicator *y* (i.e., fecal coliform) for strata *i*
d_i = temporal weighting equivalent to the number of days until the next sampling event in strata *i*
200 = shoreline distance weighting (in meters)
The water quality objectives used in the evaluation are the single sample objectives recently adopted by the Regional Board and proposed as the numeric targets in the TMDL.
[12] A recent Southern California Bight-wide summer shoreline bacteriological survey showed that 90% of all exceedances of health standards observed during the 5-week study occurred near a flowing storm drain (Noble *et al.* 1999).

In summary, most of the monitored beaches in Santa Monica Bay have been identified by the Regional Board in its 1996 WQA or more recently by other entities as impaired due to exceedances of bacteriological water quality standards.

3 Numeric Target

The TMDL will have a multi-part numeric target based on the bacteria objectives for marine waters designated for contact recreation (REC-1), specified in the Basin Plan amendment adopted by the Regional Board on October 25, 2001 and approved by the State Board on July 18, 2002. As stated earlier, these objectives are the same as those specified in the California Code of Regulations, title 17, section 7958 "Bacteriological Standards" and consistent with those recommended in "Ambient Water Quality for Bacteria – 1986" (U.S. EPA, 1986). The objectives include four bacterial indicators: total coliform, fecal coliform, enterococcus, and the fecal-to-total coliform ratio. (See Table 2-2.)

For the TMDL, the numeric targets will be the same as the recently adopted Basin Plan objectives, as measured at point zero (also referred to as the "mixing zone" or "wave wash"). Point zero is the point at which water from the storm drain or creek initially mixes with ocean water, and is consistent with the 'point of initial dilution' as defined in the California Ocean Plan (2001). Point zero has been selected as the compliance point for the numeric target for two reasons. First, public access to these drains is not restricted (see Figure 11); people are often observed swimming near storm drains. Furthermore, all near-shore coastal waters in the Los Angeles Region are designated with the water contact recreation (REC1) beneficial use. Second, in a special study conducted in support of this TMDL, researchers found that the dilution zone is drain-specific and highly dependent on prevailing oceanographic and climatic conditions (e.g., tide height, wave height, longshore velocity, wind speed) (see Appendix G). For example, exceedances of the bacterial indicators were observed at 100 yards at Santa Monica Canyon (Will Rogers Beach), while exceedances were observed as far away as 400 yards at Malibu Creek (Surfrider Beach) (Taggart, unpublished data). There is inadequate data to accurately define dilution zones, other than point zero, for every freshwater outlet under all possible oceanographic and climatic conditions in the bay to be protective of public health.

For beaches without freshwater outlets (i.e., storm drains or coastal creeks), the targets will apply at existing or new monitoring sites, with samples taken at ankle depth. These targets apply during both dry and wet weather, since there is water contact recreation throughout the year, including during wet weather, at the beaches. The geometric mean targets are based on a rolling 30-day period, and may not be exceeded at any time.

To implement the recently-adopted single sample bacteria objectives for waters designated REC-1 and to set waste load allocations based on the single sample targets, the Regional Board has chosen to set an allowable number of exceedance days for each shoreline monitoring site. Staff proposes expressing the waste load allocations in the TMDL as 'allowable exceedance days' because bacterial density and the frequency of single sample exceedances are most relevant to public health. The US EPA allows states to select the most appropriate measure to express the TMDL; allowable exceedance days are considered an 'appropriate measure' consistent with the definition in 40 CFR 130.2(i). The number of allowable exceedance days is based on one of two criteria: (1) bacteriological water quality at any site is *at least* as good as at a designated reference site and (2) there is no degradation of existing shoreline bacteriological water quality if historical water quality at a particular site is *better than* the designated reference site. Applying these two criteria allows the Regional Board to avoid imposing requirements to divert natural coastal creeks or treat natural sources of bacteria from undeveloped areas. This approach, including the allowable exceedance levels during wet weather, is further explained in section 8, Waste Load Allocations.

Moreover, as discussed in section 1.5 (Overview of TMDL Approach), the Regional Board recognizes that as proposed this TMDL will only insure that 'human-generated sources of bacteria' do not cause or contribute to exceedances of bacteriological water quality standards. When the TMDL is revised in five years to adjust reference site data, the Regional Board will need to consider whether a refinement of the numeric targets is necessary to account for natural sources of bacteria exceedances. Alternatively, during the fifth-year TMDL revision, the Regional Board may determine that the more appropriate mechanism is to adjust bacteria water quality standards to account for naturally occurring exceedances of bacteria objectives. Regardless of the future action, the TMDL as proposed establishes waste load allocations tailored to eliminate exceedance days attributable to human-generated bacteria sources.

4 Assessing Sources

The TMDL requires an estimate of loadings from point sources and nonpoint sources. In the TMDL process waste load allocations are given for point sources and load allocations for nonpoint sources. Point sources typically include discharges from a discrete human-engineered point (e.g., a pipe from a wastewater treatment plant or industrial facility). These types of discharges are regulated through a National Pollutant Discharge Elimination System (NPDES) permit, typically issued in the form of Waste Discharge Requirements (WDRs) issued by the Regional Board.

In Los Angeles County, runoff to Santa Monica Bay is regulated under two storm water NPDES permits and, therefore, is also considered a point source from a regulatory perspective. The first is the County of Los Angeles Municipal Storm Water NPDES Permit (MS4 Permit), which was renewed in December 2001 (Regional Board Order No. 01-182). There are 85 co-permittees covered under this permit including 84 cities and the County of Los Angeles. The second is a separate storm water permit specifically for the California Department of Transportation (Caltrans).

Runoff from the storm drain system may have elevated levels of bacterial indicators due to sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, pet waste, illegal discharges from recreational vehicle holding tanks, and malfunctioning septic tanks among others. Sources of elevated bacteria to marine waters may also include direct illegal discharges from boats, malfunctioning septic tanks, illicit discharges from private drains, and swimmer "wash-off." The bacteria indicators used to assess water quality are not specific to human sewage; therefore, fecal matter from animals and birds can also be a source of elevated levels of bacteria, and vegetation and food waste can be a source of elevated levels of total coliform bacteria, specifically.

4.1 Point Sources

There are seven major NPDES permit discharges in the Santa Monica Bay Watershed. Three are Publicly Owned Treatment Works (POTWs) (two with direct ocean discharges), one is a refinery, and three are electricity generating stations. The three POTWs are Hyperion Treatment Plant, Joint Water Pollution Control Plant, and Tapia Wastewater Reclamation Plant. The refinery is the Chevron Refinery and the three generating stations are Scattergood, El Segundo, and Redondo. In light of their operations, the refinery and the three generating stations are not considered probable sources of bacteria.

Hyperion is a full secondary treatment plant with a dry weather design capacity of 450 MGD and wet weather peak hydraulic capacity of 850 MGD. The treated wastewater from Hyperion discharges through a 5-mile outfall pipe into Santa Monica Bay. Hyperion discharges approximately 360 MGD to the Bay during dry weather. As part of its permitted operations, Hyperion measures physical, chemical and microbiological parameters at an array of 11 inshore locations five times per month to determine whether the effluent plume reaches the shore. In its 1997-98 Santa Monica Bay Biennial Assessment Report, the City concludes that bacteria loads from Hyperion are not impacting the shoreline. Inshore stations showed 100% compliance with bacteriological receiving water limits with the exception of a few stations in the vicinity of

Ballona Creek and Marina del Rey and King Harbor, which may be impacted by boat activity, birds, harbor runoff, and flow from Ballona Creek. (CLA-EMD, 1999).

The Joint Water Pollution Control Plant (Joint Plant) is a partial secondary treatment plant with a design capacity of 385 MGD. Treated wastewater from the Joint Plant discharges through an approximately two-mile-long outfall network onto the Palos Verdes Shelf. The Joint Plant discharges 334 MGD to the Bay, and continuously disinfects its discharge. The Joint Plant measures total coliform, fecal coliform, and enterococcus at its two main outfalls as well as at six inshore stations located near the 9-meter isobath. In 2000, the inshore stations monitored by the Joint Plant consistently met REC-1 bacteriological water quality objectives. In addition, the Joint Plant Annual Monitoring Report for 2000 shows that the monthly geometric mean densities of total coliform, fecal coliform and enterococcus from the two outfalls are consistently low (CSDLAC, 2001).

The Tapia Wastewater Reclamation Plant is a tertiary treatment plant with a design capacity of 16.1 MGD. It discharges approximately 8-10 MGD to Malibu Creek during the winter season only (November 16 to April 16).[13] Tapia also disinfects before discharging to Malibu Creek. Tapia's 1999 Annual Report indicates that total coliform is less than 1.1 MPN/100 ml based on monthly monitoring of the effluent discharged to Malibu Creek (LVMWD, 1999).

There are 21 minor NPDES permitted discharges in the Santa Monica Bay watershed. In addition, there are numerous discharges covered under general permits or industrial and construction storm water permits. The bacteria loads associated with these dischargers are largely unknown. Most do not monitor for bacteria. The discharge flows associated with these permits are generally low. In addition, many of these permits are for episodic discharges rather than continuous flows. Rather than attempt to compile the data from all the minor NPDES permits, general permits, and industrial and construction storm water permits in the Santa Monica Bay Watershed, the Regional Board assumes that bacteria loadings from these point source discharges will be accounted for in the watershed-wide assessment of loadings from runoff, discussed below.

4.2 Storm Water Runoff

As mentioned above, all runoff to Santa Monica Bay is regulated as a point source under the Los Angeles County MS4 Permit and the Caltrans Storm Water Permit.

4.2.1 Existing Data Characterizing Sources

The following section summarizes existing data on bacteria densities for a variety of land uses and receiving water sites for wet weather. Despite an intensive shoreline bacteriological monitoring program, there is little routine monitoring *in the subwatersheds* draining to the impaired beaches. Los Angeles County, the lead permittee for the existing municipal storm water permit,[14] conducts a storm water monitoring program, which is the principal source of data on water quality during wet weather. Summaries of data on wet weather sources of bacteria are presented below.

[13] Based on data from 1996-2000.
[14] In the current permit, the Los Angeles County Flood Control District is specifically named the principal permittee.

4.2.2 Wet Weather Source Characterization

Data to characterize wet weather sources of bacteria to beaches is available from the monitoring program conducted as a requirement of the Los Angeles County MS4 Permit as well as other storm water NPDES permits throughout Southern California. The Los Angeles County permit requires monitoring of both instream water quality (to calculate mass emissions for various pollutants) as well as land use monitoring to attempt to quantify pollutant loads from specific land uses.

Table 4-1 summarizes the wet weather data for specific land uses collected by Los Angeles County under the Municipal Storm Water Permit for the period 1994-2000, as well as similar land use specific data from all storm water monitoring programs in Southern California for the period 1990-1999. All land use sites in both data sets exceeded the objectives for total coliform, fecal coliform and enterococcus. The Los Angeles County data set indicated that the high-density/single-family residential category had the highest densities of all three bacterial indicators, followed by the commercial land use for total coliform and fecal coliform, and the light-industrial land use for enterococcus. SCCWRP's aggregated data set from all of the storm water monitoring programs in Southern California indicated that the industrial land use category had the highest densities of all three indicators (SCCWRP, 2001).

Table 4-1. Summary of Bacteria Densities from Various Land Uses during Wet Weather

Data Source	Land Use	Total Coliform		Fecal Coliform		Enterococcus	
		N	Arithmetic Mean	N	Arithmetic Mean	N	Arithmetic Mean
SCCWRP (2001)	Agriculture	15	399,333	15	89,133	NS	NS
	Commercial	75	353,767	85	130,690	35	92,163
	Industrial	68	665,218	85	268,899	17	1,081,368
	Open	48	209,435	48	101,505	40	98,606
	Residential	98	401,424	113	185,254	47	305,536
LA County (1994-2000)	Commercial	8	1,140,000	8	528,740	8	86,250
	Light Industrial	5	454,000	5	338,220	5	98,200
	Vacant	21	9,187	21	1,397	21	679
	HD/SF Residential	3	1,366,667	3	933,333	3	610,000
	Transportation	4	692,500	4	328,750	4	32,000

Table 4-2 summarizes the wet weather data collected under the Los Angeles County Storm Water Monitoring Program for Ballona Creek (between Sawtelle and Sepulveda Boulevards) and Malibu Creek (south of Piuma Road). As expected, the yearly geometric mean bacteria densities for all three indicators far exceeded the thresholds for all six years in both creeks.

Table 4-2. Yearly Geometric Mean Stormwater Bacteria Densities (MPN/100 ml), 1994-2000 (LACDPW 2000)

Site Name	Year	Total Coliform	Fecal Coliform	Enterococcus
Ballona Creek				
	94-95	518,004	198,738	151,008
	95-96	2,623,967	684,899	1,001,181
	96-97	667,467	67,466	90,000
	97-98	1,120,085	522,415	no data
	98-99	326,580	30,930	137,594
	99-00	280,332	87,737	43,877
Malibu Creek				
	94-95	160,000	22,000	2,400
	95-96	120,240	13,221	6,996
	96-97	58,285	8,794	30,000
	97-98	239,022	53,312	no data
	98-99	35,502	3,866	4,538
	99-00	34,594	10,792	5,386

While the storm water monitoring program collects valuable data to help characterize wet weather bacteria densities, there remain significant data gaps. For example, the samples collected under the storm water monitoring program are grab samples, which do not allow an evaluation of changes in bacteria density during the course of a storm event. In addition, the storm water monitoring program is limited in terms of the types of "critical sources" of bacteria that are sampled. Both of these types of data are valuable when exploring management scenarios.

4.2.2.1 Wet Weather Source Characterization Study – Phase I

In response to the data gaps mentioned above, the Regional Board in partnership with other entities[15] undertook a study to characterize wet-weather bacteria densities from various land uses and in major watercourses (SCCWRP, 2000).

The sample design entailed sampling eight key land uses during multiple storms. In addition, the sample design entailed sampling multiple sites within a general land use to characterize the range of bacteria densities that might be found within each land use category. The study also included sampling at two instream stations – one in Ballona Creek and one in Santa Monica Canyon channel. See Table 4-3 for a list of the eight general land uses, 19 land use sites and two instream stations, and the targeted number of samples and number of samples collected at each location during Phase I. Two-thirds of the targeted site-events were sampled between January and April,

[15] The other entities included: Southern California Coastal Water Research Project, City of Los Angeles, County of Los Angeles, County Sanitation Districts of Los Angeles County, Heal the Bay, Santa Monica Bay Restoration Project, and others.

2001. The remaining sites, as well as additional open space and instream sites, will be sampled during the 2001-02 and 2002-03 wet seasons.

Table 4-3. Wet-weather Source Characterization Sites

Land Use Category	Critical Sources within Land Use	Target Number of Samples	Number Collected
High Density Residential	Mixed	2	2
	High pet density	1	0
Low Density Residential	Sewered	2	2
	Unsewered	1	0
Commercial	Mixed	2	2
	Mixed, with homeless population	1	0
	Restaurant	1	0
	Shopping mall	1	0
Industrial	Mixed	2	2
	Food industry	1	0
	Auto salvage	1	1
	Oil extraction	1	0
Agriculture	Mixed	2	2
	Nursery	1	1
Recreation	Golf course	1	0
	Horse stable	2	2
Transportation	Rail yard	1	1
	Gas station	1	0
Open Space	Open	2	1
Instream	Ballona Creek	2	2
	Santa Monica Canyon	2	2
Total		**30**	**20**

Table 4-4 summarizes the initial results from the land use and instream sites sampled under Phase I of the wet weather characterization study.[16] All land use sites except for open space exceeded REC-1 single sample bacteria objectives for total coliform, fecal coliform and/or enterococcus by at least an order of magnitude. The horse stable and nursery sites had the highest values for all three bacterial indicators. Overall, total coliform was exceeded by a factor of 3 (low-density residential) to 230 (agriculture-nursery). Fecal coliform was exceeded by a factor of 3 (industrial) to 660 (recreation-horse stable). Enterococcus was exceeded by a factor of 4 (open

[16] Note that the bacteria densities presented in this table cannot be directly compared to those presented in Tables 4-1 and 4-2 as the values are flow-weighted geometric means, rather than arithmetic means.

space) to 2,900 (agriculture-nursery). Ballona Creek and Santa Monica Canyon channel instream sites exceeded water quality standards for all indicators. In general, total coliform was exceeded by a factor of 32, fecal coliform by a factor of 28, and enterococcus by a factor of 330 at the two instream sites.

Table 4-4. Wet Weather Source Characterization Study: First-Year Data Summary (Flow-weighted Geometric Means)

Sampling Sites			Total Coliform (#/100 ml)		Fecal Coliform (#/100 ml)		Enterococcus (#/100 ml)	
		N	Mean	S.D.	Mean	S.D.	Mean	S.D.
Land Use Sites	Open Space	10	6,453	.	59	.	382	.
	Transportation (Railyard)	12	6,557	.	130	.	3,591	.
	Recreation (Horse Stable)	24	1,031,356	729,189	265,481	205,721	82,856	21,980
	Agriculture (Nursery)	13	2,347,197	.	56,223	.	302,199	.
	Agriculture	36	202,079	75,518	22,898	21,176	26,186	8,521
	Industrial	18	31,630	18,468	1,071	651	2,445	1,591
	Industrial (Auto Salvage)	12	160,185	.	13,673	.	65,931	.
	Commercial	22	284,558	266,134	3,198	2,949	20,020	19,452
	High Density Residential	22	75,557	24,679	14,620	8,700	8,260	3,734
	Low Density Residential	23	52,643	28,484	4,898	1,615	8,706	2,038
Instream Sites	Santa Monica Canyon	21	352,610	268,670	10,805	5,160	28,162	19,417
	Ballona Creek	21	288,291	182,230	11,480	5,602	40,292	24,129

5 Critical Condition

The critical condition in a TMDL defines an extreme condition for the purpose of setting allocations to meet the TMDL numeric target. While a separate element of the TMDL, it may be thought of as an additional margin of safety such that the allocations are set to meet the numeric target during an extreme (or above average) condition.[17] Unlike many TMDLs, the critical condition for bacteria loading is not during low flow conditions or summer months, but rather during wet weather. This is because intermittent or episodic loading sources such as surface runoff can have maximal impacts at high (i.e. storm) flows (US EPA, 2001). Local and bight-wide shoreline monitoring data show a higher percentage of daily exceedance of the single sample targets during wet weather, as well as more severe bacteriological impairments indicated by higher magnitude exceedances and exceedances of multiple indicators (Noble *et al*., 2000a, Schiff *et al*., 2001).

To more specifically identify a critical condition within wet weather in order to set the allowable number of exceedance days (described in section 7, Waste Load Allocations), staff propose using the 90th percentile 'storm year' in terms of wet days as the reference year.[18] Staff selected the 90th percentile year for several reasons. First, selecting the 90th percentile year avoids an untenable situation where the reference system is frequently out of compliance. Second, selecting the 90th percentile year allows responsible jurisdictions and agencies to plan for a 'worst-case scenario', as a critical condition is intended to do. Finally, the Regional Board expects that there will be fewer exceedance days in drier years, since structural controls will be designed for the 90th percentile year.

The 90th percentile storm year in terms of wet days was identified by constructing a cumulative frequency distribution of annual wet weather days using historical rainfall data from LAX from 1947-2000 (see Appendix D). This means that only 10% of years should have more wet days than the 90th percentile year. The 90th percentile year in terms of wet days was 1979, which had 74 wet days. The number of wet days was selected instead of total rainfall because a retrospective evaluation of shoreline data showed that the number of sampling events during which greater than 10% of samples exceeded the fecal coliform objective on the day after a rain was nearly equivalent for rainstorms less than 0.5 inch and those greater than 0.5 inch, concluding that even small storms represent a critical condition (Noble *et al*., 2000a). This is particularly true since the TMDL's numeric target is based on number of days of exceedance, not on the magnitude of the exceedance.

[17] Critical conditions are often defined in terms of flow, such as the seven-day-ten-year low flow (7Q10), but may also be defined in terms of rainfall amount, days of measurable rain, etc.
[18] The 'storm year' is defined as November 1 to October 31 to be consistent with the periods specified in AB411.

6 Linkage Analysis

The linkage analysis for this TMDL was performed using the BASINS/HSPF model (Better Assessment Science Integrating Point and Nonpoint Sources/Hydrologic Simulation Program-FORTRAN, hereafter HSPF). HSPF is a dynamic watershed and receiving water quality-modeling program, meaning that it provides continuous simulation of bacteria build-up and wash-off, bacteria loading and delivery, point source discharges and instream water quality response.

The HSPF model is one of the most complete watershed models available that deals with both urban and non-urban watersheds, and has undergone extensive development and application since the mid-1970s. It is currently supported by both the U.S. EPA and the United States Geological Survey (USGS), and is included as a component in U.S. EPA's BASINS program. Finally, HSPF is endorsed by the U.S. EPA specifically for use in developing TMDLs.

The focus of modeling was on wet weather. The reason for this was three-fold. First, wet weather represents the critical condition in the TMDL (as discussed below). Second, dry weather bacteria loads tend to be less predictable and therefore more difficult to model. Third, the Regional Board expects that, in most cases, dry weather bacteria loads to Santa Monica Bay beaches from storm drains will be addressed through diversion of dry weather flows from these systems to wastewater treatment plants. (See section 9, Implementation.)

The results of the modeling effort are described below. However, the results were not used in setting the number of allowable exceedance days due to the limited amount of wet-weather sampling data that has been collected thus far (described in section 4.2.2). Staff expects to re-evaluate the model results when the TMDL is revised in five years, after additional wet-weather data has been collected and used to calibrate and validate the model.

6.1 Model Development and Results

Water quality modeling is used to: (1) determine the contributions of different sources to bacteria loads (source characterization), (2) relate these loadings to water quality responses in the receiving water, (3) estimate the necessary load reductions necessary to meet the numeric targets, and (4) simulate potential management scenarios. The analysis described below focuses on (2) and (3).[19]

The objective of the modeling exercise was to develop time variable subwatershed models to estimate bacterial loadings to SMB beaches during wet weather, and ultimately the number of days of exceedance during wet weather for each subwatershed system. Detailed technical reports (prepared by SCCWRP) on the development of the hydrologic and water quality models and model results have been included in Appendix E.

It must be emphasized that the model as developed in this context only estimates bacteria loadings from storm water runoff. At this stage, the Regional Board lacks the necessary data on

[19] The first and fourth uses of the model will be discussed once additional wet weather sampling data is collected and incorporated into the model.

bacteria levels in dry-weather runoff and groundwater to calibrate and validate bacteria loads during dry weather or from groundwater contributions. Therefore, a key model assumption for most subwatersheds was that bacteria loads during dry weather or from groundwater equaled zero. As a result, where there are groundwater or dry-weather urban runoff sources of bacteria to the surf zone, the model has most likely *underestimated* bacteria densities as well as the number of exceedance days of bacteria objectives for the design year.

The Santa Monica Bay watershed was divided into 28 subwatersheds based on CALWATER 2.0 watersheds and the storm drain network mapped by the Los Angeles County Department of Public Works. The model was run for each of the 28 subwatersheds.[20] The Malibu Creek and Ballona Creek subwatersheds were further divided into 6 and 7 sub-drainage areas, respectively. (Figure 1) Stream geometry was described using simplified storm drain maps based on a detailed GIS coverage from the Los Angeles County Department of Public Works.

The model was set-up using a variety of local data on meteorology (e.g., rainfall, temperature, etc.), hydrology (e.g., stream geometry), topography, land use, stream flow (for Ballona and Malibu Creeks), point source discharges (for Tapia WRP), and water quality (for Ballona Creek and Santa Monica Canyon Channel).

To determine the necessary reduction in "exceedance days" to meet the numeric target, a design year was selected for modeling purposes based on the number of rain days. It was decided that the 90th percentile year in terms of the number of rain days would be used as the design year (i.e., critical condition) for running the model. To identify the 90th percentile year in terms of rain days, staff examined a cumulative frequency distribution of rainfall at LAX from 1947-2000. The 90th percentile year in terms of number of rain days was 1993.[21] In 1993, there were 33 days with measurable rainfall (0.05 inch or more), 29 days with 0.1 inch or more of rain, and 68 wet days.[22] The rainfall pattern throughout the Santa Monica Bay watershed is variable, therefore, data from nearby gages, including the LAX gage, were used to model the subwatersheds. Rainfall for each subwatershed was scaled using the PRISM model, which was used to create an isohyetal map of rainfall for the state of California using all rain gages in the state that had historical data as well as elevation. Other meteorological conditions used in the model development were based on data from the LAX meteorological station.

Land use data from the Southern California Association of Governments (SCAG, 1993) was aggregated into 13 land uses, corresponding to the categories used in previous TMDLs (LARWQCB, 2000). (See Table 6-1.) The percent imperviousness values used were the same as those specified in the Los Angeles County's storm water model (LAC-DPW, 1999).

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[20] The TMDL is in fact 28 "mini" TMDLs, one for each subwatershed.

[21] Selection of the design year was done early in the development of the TMDL. Since that time, Regional Board staff have received comments that it is more appropriate to look at wet days, rather than only rain days. Furthermore, it was suggested that rather than using the calendar year, a storm year be used to determine the 90th percentile year in terms of wet days. It was not possible to re-run the model with these changes; however, 1993 represented the 92nd percentile storm year in terms of wet days, with only one more 'wet day' than 1979.

[22] It turned out that 1993 was also the 90th percentile year in terms of annual rainfall amount.

Table 6-1. Land Use Categories used in Wet-weather Model

Agriculture
Commercial
Education
High Density Residential
Industrial
Low Density Residential
Military Installations
Mixed Urban
Open
Public Facilities & Institutions
Recreation
Transportation
Water

6.1.1 Hydrologic Model

For the hydrologic model, the Malibu watershed and Ballona watershed were selected as the calibration and validation watersheds, respectively, because of the availability of historical flow data and because they represent two extremes in terms of land use, with Malibu 83% open space and Ballona 15% open space. Ten years of historical stream flow data (1988-98) for Malibu Creek and Ballona Creek were used to calibrate and validate the model. The hydrologic model performed well in these watersheds of comparable size, but with very different land use patterns; therefore, the application of the model to unmonitored watersheds was assumed appropriate. Thus, the derived hydrology parameters were applied to the 26 unmonitored subwatersheds.

6.1.1.1 Hydrology Model Results

For Malibu Creek watershed, the calibration watershed, the measured and modeled annual volumes match well. Storm hydrographs also simulated well – both storm volume and peak flows were modeled well. A linear regression of modeled and measured daily flows for 9 years shows that modeled flows explain 88% of measured flows during that time period (Figure 12). Finally, a comparison of the Malibu modeled error to USGS criteria illustrates that the model is within the acceptable error range for all parameters except low flows. Similar results were achieved in Ballona Creek watershed, the validation watershed. (Figure 13.) The model was again within the acceptable error range for all parameters except low flows. Finally, for specific storm events, the hydrologic model predicted peaks in the hydrograph fairly well for both land use sites and receiving water sites.

6.1.2 Water Quality Model

Preliminary estimates of wet-weather bacteria loads were made by calibrating the model to small single land use sites based on the wet-weather source characterization data.[23] The model was validated for short and long time scales using (1) data on instream water quality for Santa Monica Canyon Channel and Ballona Creek collected under the wet-weather source characterization study; (2) historical water quality data for Ballona and Malibu Creeks; and (3) data on bacteria build-up, wash-off and degradation.[24]

Several assumptions were made in the water quality model. First, it was assumed that the bacteria degradation rate for all indicators was 0.8 d^{-1} (or approximately 0.45 per day). (See Appendix F for a description and discussion of the bacterial degradation experiments conducted in support of the TMDL.) Second, it was assumed that because the water quality data for the various land use types was collected from storm water runoff only, that bacteria loads were from the monitored surface flows only, not from groundwater contributions or dry-weather runoff. Finally, because the model was successfully applied to Malibu and Santa Monica canyons (largely undeveloped) and the Ballona subwatershed (largely urbanized), it was assumed that the model could be applied in unmonitored subwatersheds.

6.1.2.1 Water Quality Model Results

Measured bacteria densities are highly variable. Likewise, there is high variability in modeled bacteria densities. However, a comparison of modeled versus measured bacteria densities for dry days and wet days in Ballona Creek and Malibu Creek shows that the geometric mean densities estimated for the design year are close to the measured geometric mean densities and the confidence intervals overlap for all indicators. As one might expect, the model underestimates bacteria densities as compared to measured values, with the exception of Malibu Creek during wet days.[25] (Figures 14 and 15.) As for individual storm events, the model is able to generally predict peaks in bacteria densities for both land use sites and receiving water sites.

Once a comparison of modeled and measured values was completed, the model was run to determine the number of days of exceedance that would occur at the base of each subwatershed during wet weather. Two additional key assumptions were made at this stage. First, it was assumed that there was no dilution between the drain (or freshwater outlet/creek) and the wave wash (compliance point). Second, it was decided that the 90th percentile hourly bacteria density for each day would be used to compare with the water quality objective. This translates to approximately the third highest modeled value in a day.[26] This was done for each of the four single sample bacteria objectives. If any one of the four modeled values exceeded the associated water quality objective, the subwatershed was identified as exceeding for the day. (See section 6

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[23] Due to the fact that only one sample was obtained for the open space land use category, additional local data were used to derive the model input values for this land use category. See Appendix E for a more detailed description of how the model was calibrated for open space.

[24] Data for Ballona Creek were submitted by the City of Los Angeles, Environmental Monitoring Division, and for Malibu Creek by LVMWD.

[25] This may be because staff was able to account for some groundwater contributions of bacteria in the Malibu watershed by using data collected to develop the Malibu Creek watershed bacteria TMDL.

[26] In other words, the 24 modeled hourly bacteria values for a day were rank-ordered and the 90th percentile value (i.e., the 22nd value when ranked from low to high) was selected as the value for comparison with the numeric target.

for further discussion of these assumptions as they relate to the Margin of Safety.) The model results are presented by subwatershed in Table 6-2 and Figure 16.

Table 6-2. Number of Days of Exceedance for Design Year based on Daily 90th Percentile Modeled Values

Subwatershed	Modeled Number of Days of Exceedance for Design Year				
	Total Coliform	Fecal Coliform	TC/FC ratio	Enterococcus	Total Exceedances
Arroyo Sequit	26	26	28	28	28
Nicholas Canyon	22	24	15	26	26
Los Alisos Canyon	23	24	17	26	26
Encinal Canyon	23	24	15	26	26
Trancas Canyon	27	28	16	29	29
Zuma Canyon	28	29	17	31	31
Ramirez Canyon	23	25	13	27	27
Escondido Canyon	26	27	18	29	29
Latigo Canyon	24	25	18	28	28
Solstice Canyon	26	27	28	28	28
Corral Canyon	25	26	13	28	28
Malibu	33	46	35	62	62
Carbon Canyon	23	23	15	26	26
Las Flores Canyon	22	23	17	24	24
Piedra Gorda Canyon	23	23	11	25	25
Pena Canyon	24	25	18	28	28
Tuna Canyon	24	25	20	27	27
Topanga Canyon	26	28	19	29	29
Castlerock	26	28	17	29	29
Santa Ynez Canyon	24	27	8	27	27
Pulga Canyon	27	30	15	33	33
Santa Monica Canyon	53	59	21	64	64
Santa Monica	73	73	1	75	75
Ballona - 15 cfs*	99	101	2	100	101
Dockweiler	29	30	3	33	33
Hermosa	30	31	0	31	31
Redondo	34	34	1	35	35
Palos Verdes	30	32	4	32	32

7 Margin of Safety

A margin of safety has been implicitly included through several conservative model assumptions and the selection of model output values, as described below. In addition, an explicit margin of safety has been incorporated, as the load allocations will allow exceedances of the single sample targets no more than 5% of the time on an annual basis (based on the cumulative allocations adopted in the dry weather TMDL, and those proposed for wet weather in section 8 below). Currently, the Regional Board concludes that there is water quality impairment if more than 10% of samples at a site exceed the single sample bacteria objectives annually.[27]

7.1 Dilution between Drain and Wave Wash

First, the model assumes no dilution between the storm drain and the wave wash. Two local studies have examined dilution between the storm drain and wave wash during dry weather, though no similar studies have been conducted during wet weather (Taggart, 2001; City of Los Angeles, 2001). In the two studies conducted at storm drains discharging to Santa Monica Bay, researchers have observed a high degree of variability in the amount of dilution temporally, spatially, and among bacterial indicators – with dilution between the storm drain and wave wash spanning the gamut from 100% to negative values. The negative dilution values observed, indicating a higher indicator density in the wave wash as compared to the storm drain, may have several explanations. First, in the study conducted by Taggart, initial analysis suggests that measurement error, as estimated from duplicate samples, is able to account for almost all of the negative dilution values. Second, there may be a source of bacteria in the surf zone, but not in the storm drain (e.g., birds, bathers). Third, samples from the storm drain and wave wash were not collected at the same time and therefore do not represent the same parcel of water; as a result, natural variability may account for the apparent "negative dilution."

The study conducted by Taggart shows that dilution is site-specific and dependent on oceanographic and climatic parameters including tide height, longshore velocity in the surf zone, wave height, and wind speed (see Appendix G for further discussion).

Because of the high variability in the amount of dilution temporally, spatially, and among bacterial indicators, staff decided to select a conservative dilution factor based on approximately the 10th percentile dilution factor from the two studies mentioned above. The 10th percentile ranged from -10% for total coliform, -19% for fecal coliform, and -40% for enterococcus (see Appendix G). Instead of specifying a negative dilution ratio, we chose on the basis of the data to specify 0% dilution between the drain and the wave wash. Zero percent dilution corresponded to the 11th percentile for total coliform and 12th percentile for fecal coliform and enterococcus.

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[27] We are hesitant to base an impairment decision on one sample, knowing that bacteria densities can be highly variable (Noble *et al.* 1999, 2000a, 2000b; Taggart, 2001). Some researchers contend one sample is of limited value because of the high variability in bacteria densities, and central tendencies and variability are needed to define water quality at a particular site (Pike, 1992; Cheung, *et al.*, 1990b). Therefore, we conclude that while single sample results may be appropriate for public notification purposes, they are not appropriate for evaluating water quality to determine impairment.

7.2 Bacterial Degradation

Based on three experiments, two in fresh water and one in marine water, bacterial degradation was shown to range from hours to days. Transport time from most subwatersheds during wet weather is short. Therefore, the conclusion is that bacteria degradation is not fast enough to greatly affect bacteria densities in the wave wash. Based on the results of the fresh water experiments, the model assumes a first-order decay rate for bacteria of 0.8 d^{-1} (or 0.45 per day). (Degradation rates were shown to be as high as 1.0 d^{-1}.) (See Appendix F for a discussion of the experimental design and results of the bacteria degradation study.)

7.3 Selection of Modeled Bacteria Values

Staff chose to model the bacteria loads and days of exceedance based on the 90th percentile hourly density for each of the bacterial indicators, as modeled on a daily basis. Hourly values for each indicator are determined by calculating the geometric mean of the 15-minute values generated by the model. The hourly values for each indicator are then ranked on a daily basis and the 90th percentile value for each indicator is chosen to determine whether the day exceeds any of the bacteria objectives. The 90th percentile hourly bacteria density works out to be approximately the third highest modeled hourly value for each indicator in a day.

8 Waste Load Allocations

Waste load allocations (WLAs) in this TMDL are expressed in a unique way. WLAs are expressed as the number of daily or weekly sample days that may exceed the single sample targets identified in section 3 at a beach (shoreline monitoring site). WLAs are expressed as allowable exceedance days because the bacterial density and frequency of single sample exceedances are the most relevant to public health protection. Allowable exceedance days are ‘appropriate measures’ consistent with the definition in 40 CFR 130.2(i).

For each beach (shoreline monitoring site) and corresponding subwatershed, allowable exceedance days are set on an annual basis as well as for three other time periods. These three periods are (1) summer dry weather (April 1 to October 31), (2) winter dry weather (November 1 to March 31), and (3) wet weather (defined as days of 0.1 inch of rain or more plus three days following the rain event).[28] The dry-weather bacteria TMDL adopted by the Regional Board on January 24, 2002 (Resolution No. R02-004) addresses the first two periods, while this TMDL addresses the third period. All responsible jurisdictions and agencies within a sub-watershed are jointly responsible for complying with the waste load allocation at the receiving shoreline monitoring location. Because all storm water runoff to SMB beaches is regulated as a point source, load allocations (LAs) of zero days of exceedance for nonpoint sources are proposed in this TMDL.

The following section is comprised of three parts. In the first, we further discuss why WLAs are defined as allowable exceedance days. In the second, we introduce the criteria for determining allowable exceedance days. Finally, we describe the decision-making process used to set allowable exceedance days for each shoreline monitoring site.

8.1 Why waste load allocations are defined as allowable exceedance days: The role of natural subwatersheds

The bacteria indicators used to assess water quality are not specific to human sewage. Fecal matter from wildlife and birds can be a source of elevated levels of bacteria, and vegetation can be a source of elevated levels of total coliform bacteria, specifically.

As discussed in section 1.1, subwatersheds in the northern part of the Bay have on average 85% of their land area in open space. (See Figures 8 and 9.) Based on historical data, even the most undeveloped subwatersheds occasionally exceed the single sample targets outlined in section 3. For example, at Leo Carrillo Beach (LCB) with an associated subwatershed that is 98% open space, 9 out of 48 wet-weather samples exceeded one or more single sample targets over the 5-year period from November 1995 to October 2000. The water quality model described in section 5 generates similar results.[29]

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[28] These time periods are consistent with the AB-411 implementing regulations (CCR, title 17) as well as with protocols used by the Los Angeles County Department of Health Services to post beaches during wet weather.
[29] For the two most undeveloped subwatersheds, Arroyo Sequit Canyon and Solstice Canyon, the model estimates 28 wet-weather exceedance days at the base of each subwatershed during the simulation year (see Table 6-2). Arroyo Sequit Canyon is approximately 12 square miles in size and is 98% open space, while Solstice Canyon is approximately 4.5 square miles and is 97.2% open space.

In light of these findings, strictly applying the single sample targets identified in section 3 would likely require implementing agencies to capture or treat wet-weather runoff from natural areas. It is not the intent of this TMDL to require diversion of natural coastal creeks or to require treatment of natural sources of bacteria from undeveloped areas. Therefore, the implementation procedure for the recently-adopted bacteria objectives for REC-1 waters and the WLA approach proposed herein set allowable exceedance days based on bacteriological water quality conditions that are achievable at reference beach(es) associated with largely undeveloped subwatershed(s) within Santa Monica Bay or based on antidegradation principles.

As stated in sections 1.5 (Overview of TMDL Approach) and 3 (Numeric Target), notwithstanding the policy considerations warranting use of a reference beach approach, staff recognizes that as proposed this TMDL will only insure that 'human-generated sources of bacteria' do not cause or contribute to exceedances of bacteriological water quality standards. When the TMDL is revised in five years to adjust reference site data, the Regional Board may need to consider whether a refinement of the numeric targets is necessary to account for natural sources of bacteria exceedances. Alternatively, during the fifth-year TMDL revision, the Regional Board may determine that the more appropriate mechanism is to adjust bacteria water quality standards to account for naturally occurring exceedances of bacteria objectives. Regardless of the future action, the TMDL as proposed establishes waste load allocations tailored to eliminate exceedance days attributable to human-generated bacteria sources.

8.2 Criteria for determining allowable exceedance days: The role of the reference system and antidegradation

As previously described in section 3, staff proposes to set the number of allowable exceedance days for each beach to ensure that two criteria are met (1) shoreline bacteriological water quality is at least as good as that of a largely undeveloped system and (2) there is no degradation of existing shoreline bacteriological water quality.

8.3 Determining allowable wet-weather exceedance days

Staff ensures that the two criteria above are met by using the smaller of two exceedance probabilities for any one shoreline monitoring site multiplied by region-specific rainfall data for the critical condition (discussed in section 5).[30] An exceedance probability, P(E), is simply the probability that one or more single sample targets described in section 3 will be exceeded at a particular shoreline monitoring site, based on historical data. The flow diagram below illustrates the decision-making process for determining allowable exceedance days at a beach (shoreline monitoring site).

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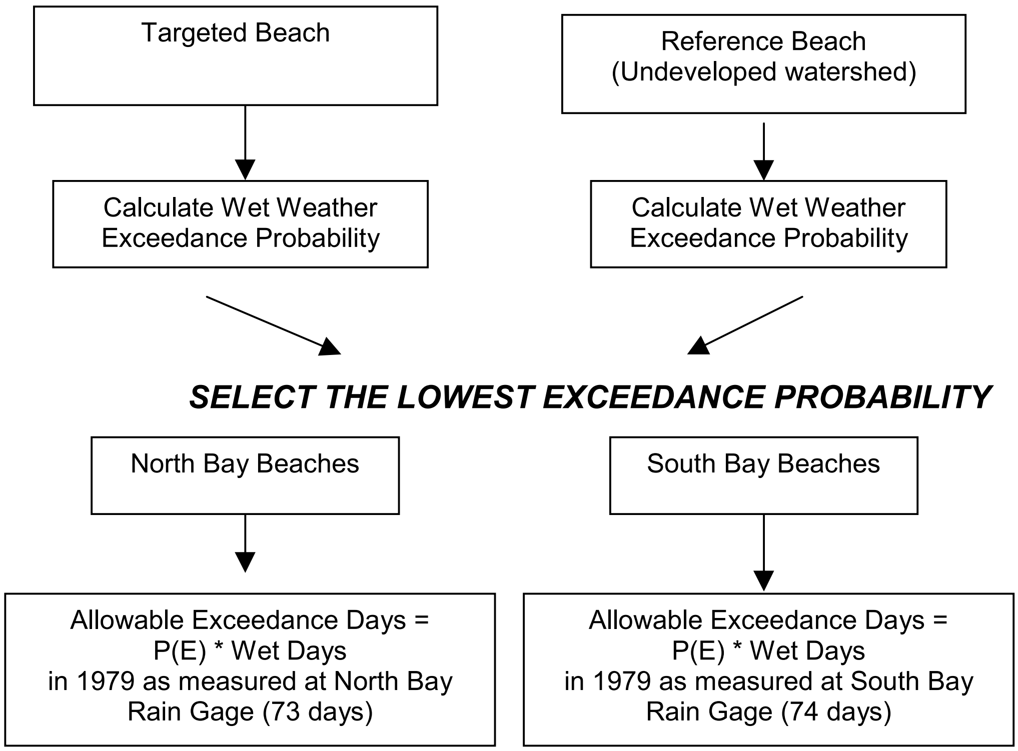
[30] As a reminder, the critical condition proposed is the 90th percentile storm year in terms of wet days. The storm year is defined as November 1-October 31, and wet days are defined as days with ≥0.1 inch of rain plus the three days following. The 90th percentile year based on historical data from the LAX meteorological station is 1979. In 1979 there were 74 wet days as measured at LAX.

Figure 17. Decision-making process for determining waste load allocations (expressed as allowable exceedance days)



For any one monitoring site, two exceedance probabilities are compared and the lowest one is selected (1) the wet-weather exceedance probability in the reference system, $P(E_w)_R$ and (2) the wet-weather exceedance probability based on historical bacteriological data at that particular site, $P(E_w)_i$. (In other words, if $P(E_w)_R$ is greater than $P(E_w)_i$, then $P(E_w)_i$ will apply to that particular site (i.e., the site-specific exceedance probability would override the "default" exceedance probability of the reference system).) Next the monitoring sites (target beaches) are grouped as either South Bay beaches (Santa Monica Beach and south) or North Bay beaches (Will Rogers Beach and north). For the North Bay beaches, the chosen exceedance probability is multiplied by the wet days in the reference year as measured at the North Bay (Monte Nido) rain gage, while for the South Bay beaches, the exceedance probability is multiplied by the number of wet days as measured at the South Bay (LAX) rain gage.

Below we provide background information and justification for the two steps in the process described above. First, we describe how the wet-weather exceedance probabilities for the shoreline monitoring sites were calculated. Then we discuss how these exceedance probabilities are translated into allowable exceedance days for each targeted shoreline monitoring site, including justifications for the proposed reference beach and reference year.

8.3.1 Step 1: Calculating Wet-Weather Exceedance Probabilities

The wet-weather exceedance probability is simply the probability that one or more single sample targets will be exceeded on a wet day at a particular site. The most recent five years of shoreline monitoring data (November 1995-October 2000) were used to determine the wet-weather exceedance probability for each shoreline monitoring site.[31,32,33]

Samples were identified as wet-weather samples using region-specific rainfall data. For sites north of and including Santa Monica Canyon, the Monte Nido rain gage in the Malibu subwatershed was used. For sites south of Santa Monica Canyon, the Los Angeles Civic Center rain gage was used. See Table 8-1 for the wet-weather exceedance probabilities for each shoreline monitoring site, based on historical data.

Table 8-1. Summary of historical data and calculated exceedance probabilities

WET WEATHER EXCEEDANCES		Five-year Total (November 1995 - October 2000)		
LOC_ID	LOC_Name	Total number of wet weather samples	Number of wet weather samples with an exceedance	Wet weather exceedance probability
DHS (010)	Leo Carrillo Beach, at 35000 PCH	48	9	0.19
DHS (009)	Nicholas Beach- 100 feet west of lifeguard tower	10	2	0.20
DHS (010a)	Broad Beach	43	9	0.21
DHS (008)	Trancas Beach entrance, 50 yds east of Trancas Bridge	19	5	0.26
DHS (007)	Westward Beach, east of Zuma Creek	48	10	0.21
DHS (006)	Paradise Cove, adjacent to west side of Pier	48	13	0.27
DHS (005)	Latigo Canyon Creek entrance	48	18	0.38
DHS (005a)	Corral State Beach	47	10	0.21
DHS (003)	Malibu Point	48	10	0.21
DHS (003a)	Surfrider Beach (second point)- weekly	47	27	0.57
S1	Surfrider Beach (breach point)- daily	365	208	0.57
DHS (002)	Malibu Pier- 50 yards east	48	27	0.56
DHS (001a)	Las Flores Beach	37	13	0.35
DHS (001)	Big Rock Beach, at 19900 PCH	45	15	0.33
S2	Topanga State Beach	367	114	0.31
DHS (101)	PCH and Sunset Bl.- 400 yards east	42	12	0.29
DHS (102)	16801 PCH, Bel Air Bay Club (chain fence)	46	15	0.33

[31] Only four years of data (1997-2000) were available for the County Sanitation Districts' sites on the Palos Verdes Peninsula.

[32] As a reminder, wet weather was defined as those days with 0.1 inch of rain or more, and the three days following the rain event. This definition is the same as that used by the Los Angeles County Department of Health Services for rain-related beach postings.

[33] The storm years of 1996-2000 represented a wide range of rainfall conditions in terms of wet days for the historical record at LAX (1947-2000): 1996 (44th percentile), 1997 (30th percentile), 1998 (98th percentile), 1999 (80th percentile), 2000 (54th percentile).

WET WEATHER EXCEEDANCES		Five-year Total (November 1995 - October 2000)		
LOC_ID	LOC_Name	Total number of wet weather samples	Number of wet weather samples with an exceedance	Wet weather exceedance probability
S3	Pulga Canyon storm drain- 50 yards east	371	107	0.29
DHS (103)	Will Rogers State Beach - Temescal Canyon (25 yds. so. Of drain)	49	16	0.33
S4	Santa Monica Canyon, Will Rogers State Beach	372	109	0.29
DHS (104a)	Santa Monica Beach at San Vicente Bl.	45	20	0.44
DHS (104)	Santa Monica at Montana Av. (25 yds. so. of drain)	46	18	0.39
DHS (105)	Santa Monica at Arizona (in front of the drain)	46	19	0.41
S5	Santa Monica Municipal Pier- 50 yards southeast	334	153	0.46
S6	Santa Monica Beach at Pico/Kenter storm drain	334	181	0.54
DHS (106)	Santa Monica Beach at Strand St. (in front of the restrooms)	46	22	0.48
DHS (106a)	Ashland Av. storm drain- 50 yards north	45	23	0.51
S7	Ashland Av. storm drain- 50 yards south	334	94	0.28
DHS (107)	Venice City Beach at Brooks Av. (in front of the drain)	19	10	0.53
S8	Venice City Beach at Windward Av.- 50 yards north	334	55	0.16
DHS (108)	Venice Fishing Pier- 50 yards south	46	10	0.22
DHS (109)	Venice City Beach at Topsail St.	46	23	0.50
S10	Ballona Creek entrance- 50 yards south	334	125	0.37
S11	Dockweiler State Beach at Culver Bl.	334	97	0.29
DHS (110)	Dockweiler State Beach- south of D&W jetty	46	18	0.39
S12	Imperial HWY storm drain- 50 yards north	334	74	0.22
DHS (111)	Hyperion Treatment Plant One Mile Outfall	46	11	0.24
DHS (112)	Dockweiler State Beach at Grand Av. (in front of the drain)	46	15	0.33
S13	Manhattan State Beach at 40th Street	334	14	0.04
S14	Manhattan Beach Pier- 50 yards south	334	20	0.06
DHS (114)	Hermosa City Beach at 26th St.	46	7	0.15
S15	Hermosa Beach Pier- 50 yards south	334	33	0.10
DHS (115)	Herondo Street storm drain- (in front of the drain)	45	11	0.24
S16	Redondo Municipal Pier- 50 yards south	334	59	0.18
DHS (116)	Redondo State Beach at Topaz St. - north of jetty	41	10	0.24
S17	Redondo State Beach at Avenue I	334	25	0.07
S18	Malaga Cove, Palos Verdes Estates-daily	334	12	0.04
LACSDM	Malaga Cove, Palos Verdes Estates-weekly	39	7	0.18

WET WEATHER EXCEEDANCES		Five-year Total (November 1995 - October 2000)		
LOC_ID	LOC_Name	Total number of wet weather samples	Number of wet weather samples with an exceedance	Wet weather exceedance probability
LACSDB	Palos Verdes (Bluff) Cove, Palos Verdes Estates	23	0	0.00
LACSD1	Long Point, Rancho Palos Verdes	241	13	0.05
LACSD2	Abalone Cove Shoreline Park	248	3	0.01
LACSD3	Portuguese Bend Cove, Rancho Palos Verdes	248	6	0.02
LACSD5	Royal Palms State Beach	248	19	0.08
LACSD6	Wilder Annex, San Pedro	195	4	0.02
LACSD7	Cabrillo Beach, oceanside	248	7	0.03

8.3.2 Step 2: Calculating Allowable Exceedance Days at a Targeted Beach

To determine allowable wet-weather exceedance days, the smaller of the two wet-weather exceedance probabilities – that of the targeted beach or that of the reference beach – is selected to use in subsequent calculations.

Staff proposes to use Leo Carrillo Beach (LCB) as the reference beach. To translate the exceedance probabilities into allowable exceedance days and exceedance-day reductions, staff proposes to use the number of wet weather days in the 90th percentile storm year, based on rainfall data from the Los Angeles International Airport (LAX) meteorological station and the Monte Nido rain gage. Justification for these two decisions is provided below.

8.3.2.1 Justification for reference beach

The steering committee selected Leo Carrillo Beach (LCB) as the reference beach because (1) its drainage area, Arroyo Sequit Canyon, has the largest percentage of land area in open space (98%) relative to all other Santa Monica Bay subwatersheds, (2) it has a freshwater outlet (Arroyo Sequit) to the beach, and (3) there is an existing shoreline monitoring site at the beach. Furthermore, field surveys by Regional Board staff have confirmed that there is very little evidence of anthropogenic impact in most of this relatively large subwatershed. See Table 8-2.

Table 8-2. Comparison of Subwatershed Size and Percent Open Space

Subwatershed	Open	Total Land Area (acres)	Size Rank	Open Space Rank
Arroyo Sequit	98.0%	7,549	5	1
Solstice Canyon	97.2%	2,841	14	2
Pena Canyon	97.1%	608	26	3
Tuna Canyon	96.4%	1,013	23	4
Nicholas Canyon	91.6%	1,235	21	5
Latigo Canyon	91.0%	813	24	6
Encinal Canyon	90.5%	1,794	20	7
Las Flores Canyon	90.4%	2,897	13	8
Los Alisos Canyon	90.3%	2,396	16	9
Topanga Canyon	89.8%	12,575	1	10
Corral Canyon	89.6%	4,280	10	11
Escondido Canyon	88.6%	2,295	18	12
Trancas Canyon	88.4%	6,514	7	13
Zuma Canyon	85.8%	6,339	8	14
Castlerock	85.0%	4,976	9	15
Carbon Canyon	84.7%	2,320	17	16
Piedra Gorda Canyon	81.9%	644	25	17
Ramirez Canyon	78.3%	3,334	12	18
Santa Monica Canyon	77.6%	10,088	2	19
Pulga Canyon	76.6%	1,955	19	20
Santa Ynez	46.1%	1,203	22	21
Palos Verdes	33.6%	10,023	3	22
Santa Monica	13.0%	8,850	4	23
Dockweiler	12.8%	6,573	6	24
Redondo	5.5%	3,544	11	25
Hermosa	2.9%	2,624	15	26

8.3.2.2 Justification for critical condition (reference year)

Based on an examination of historical rainfall data from the Los Angeles International Airport (LAX) meteorological station, staff proposes using the 90th percentile storm year[34] in terms of wet-weather days as the critical condition for determining the allowable exceedance days.[35] The reference year of 1979 was chosen because it is the 90th percentile year in terms of wet-weather days, based on 50+ years (1947-2000) of rainfall data from LAX. In the 1979 storm year, there were 74 wet-weather days.[36] See Table 8-3.

Table 8-3. Cumulative Frequency Table of Annual Wet Weather Days as Measured at LAX, 1947-2000

Water Year	Wet Days	Percentile
1983	115	100.0%
1998	110	98.0%
1978	80	96.1%
1995	78	94.2%
1993	75	92.3%
1979	74	90.3%
1952	73	84.6%
1969	73	84.6%
1982	73	84.6%
1958	71	82.6%
1999	66	80.7%
1985	65	76.9%
1992	65	76.9%
1973	64	75.0%
1986	62	73.0%
1980	61	69.2%
1989	61	69.2%
1949	60	67.3%
1957	59	65.3%
1975	56	63.4%
1953	55	53.8%
1965	55	53.8%
1971	55	53.8%

[34] The "storm year" is defined as November 1 to October 31, in order to be consistent with AB-411 implementing regulations.
[35] Staff used data from the LAX meteorological station, since it has the longest historical rainfall record.
[36] For comparison, in the 1979 storm year, there were 34 *days of rain*, which represented the 94th percentile, and 14.91 *inches of rain*, representing the 75th percentile, for the historical rainfall record at LAX.

Water Year	Wet Days	Percentile
1994	55	53.8%
2000	55	53.8%
1984	54	51.9%
1950	53	46.1%
1966	53	46.1%
1974	53	46.1%
1996	52	44.2%
1963	51	42.3%
1962	50	40.3%
1967	48	36.5%
1988	48	36.5%
1956	47	34.6%
1981	46	30.7%
1997	46	30.7%
1951	45	26.9%
1954	45	26.9%
1977	41	25.0%
1955	39	21.1%
1987	39	21.1%
1960	38	19.2%
1948	36	15.3%
1990	36	15.3%
1976	35	13.4%
1964	33	11.5%
1991	31	9.6%
1972	30	7.6%
1961	27	3.8%
1970	27	3.8%
1959	25	1.9%
1968	23	.0%

By selecting the 90th percentile year, we avoid creating a situation where the reference beach frequently exceeds its allowable exceedance days (i.e., 9 years out of 10, the number of exceedance days at the reference beach should be less than the *allowable* exceedance days at the reference beach).[37]

8.3.3 Translating exceedance probabilities into estimated exceedance days during the critical condition

The estimated number of wet-weather exceedance days during the critical condition (reference year) was calculated for each site by multiplying the site-specific exceedance probability, given a wet day, by the estimated number of wet days in a 90th percentile storm year. The site-specific exceedance probability is taken directly from the historical data analysis. Based on rainfall data from 1979, the estimated number of wet days in a 90th percentile storm year is 74 for sites south of Santa Monica Canyon, and 73 for sites north of and including Santa Monica Canyon.

$$E_{W,CC} = (P(E)|wet\_day) * wet\_days_{90th\%} \qquad \text{(Equation 8.1)}$$

Where $E_{W,CC}$ is the estimated number of wet-weather exceedance days under the critical condition and P(E) is the average probability of exceedance over the wet weather event for any site(based on data for the period November 1995-October 2000). The average exceedance probability is appropriate since the weekly sampling is systematic and the rain events are randomly distributed; therefore, sampling will be evenly spread over the wet-weather event (i.e., the rain day, day after, 2nd day after, 3rd day after).[38]

To estimate the number of exceedance days during the reference year *given a weekly sampling regime*, the number of wet-weather days was adjusted by solving for *x* in the following equations:

$$North\_Bay\_sites: \frac{73}{365\_days} = \frac{x}{52\_weeks} \qquad \text{(Equation 8.2)}$$

$$South\_Bay\_sites: \frac{74}{365\_days} = \frac{x}{52\_weeks} \qquad \text{(Equation 8.3)}$$

Using these equations, the exceedance probability of the reference beach is translated to exceedance days as follows. An analysis of historical shoreline monitoring data for Leo Carrillo Beach, the reference beach, shows that the wet-weather exceedance probability is 0.19. This exceedance probability is multiplied by 73 wet days, the number of wet-weather days in the 90th percentile storm year at the Monte Nido rain gage, per Equation 8.1 resulting in 14 exceedance days. Staff recognizes that the number of wet-weather days will change from year-to-year and, therefore, the 0.19 wet-weather exceedance probability will not always equate to 14 days. However, staff proposes setting the allowable number of exceedance days based on the 90th

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[37] Conversely, if we were to select the 10th percentile year in terms of wet days to set the allowable exceedance days, the reference beach could foreseeably exceed the allowable exceedance days 9 years out of 10.

[38] Also note that SCCWRP found no correlation between the day of the week and the percentage of samples exceeding the single sample objectives (Schiff *et al*., 2002, p. 40).

percentile year, rather than having the allowable number of exceedance days “float” based on the number of wet days in a particular year. This is because it would be difficult to design diversion or treatment facilities to address such variability from year to year. Staff expects that by designing facilities for the 90th percentile year, during drier years there will most likely be fewer exceedance days than the maximum allowable.

Estimating the number of exceedance days at Leo Carrillo Beach in the reference year under a weekly sampling regime is accomplished by multiplying 0.19 by 10.4 (derived from equation 8.2), resulting in 2 exceedance days when weekly sampling is conducted.

The estimated exceedance days for all the other northern Bay sites (north of and including Santa Monica Canyon) are calculated in the same way, using the site-specific exceedance probabilities. The estimated exceedance days for the southern Bay sites (south of Santa Monica Canyon) are calculated using 74 wet days (for daily exceedance days) and 10.54 wet days (for weekly exceedance days) based on Equation 8.3.

In Table 8-4, for each shoreline monitoring site (and assuming a daily sampling regime), staff present the estimated number of wet-weather exceedance days under the critical condition, the allowable number of wet-weather exceedance days calculated as described above, and the necessary exceedance-day reduction.

Table 8-4. Estimated wet-weather exceedance days in critical year, allowable exceedance days, and exceedance-day reductions, by site

Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90th percentile)	Allowable no. of wet weather exceedance days (daily sampling)	Estimated final wet-weather exceedance-day reduction
Leo Carrillo Beach, at 35000 PCH	14	14	0
Nicholas Beach- 100 feet west of lifeguard tower	15	14	1
Broad Beach	16	14	2
Trancas Beach entrance, 50 yards east of Trancas Bridge	20	14	6
Westward Beach, east of Zuma Creek	16	14	2
Paradise Cove, adjacent to west side of Pier	20	14	6
Latigo Canyon Creek entrance	28	14	14
Corral State Beach	16	14	2
Malibu Point	16	14	2
Surfrider Beach (second point)- weekly	42	14	28
Surfrider Beach (breach point)- daily	42	14	28
Malibu Pier- 50 yards east	42	14	28
Las Flores Beach	26	14	12
Big Rock Beach, at 19900 PCH	25	14	11
Topanga State Beach	23	14	9

Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90th percentile)	Allowable no. of wet weather exceedance days (daily sampling)	Estimated final wet-weather exceedance-day reduction
PCH and Sunset Bl.- 400 yards east	21	14	7
16801 PCH, Bel Air Bay Club (chain fence)	24	14	10
Pulga Canyon storm drain- 50 yards east	22	14	8
Will Rogers State Beach- Temescal Canyon (25 yrds. so. of drain)	24	14	10
Santa Monica Canyon, Will Rogers State Beach	22	14	8
Santa Monica Beach at San Vicente Bl.	33	15	18
Santa Monica at Montana Av. (25 yrds. so. of drain)	29	15	14
Santa Monica at Arizona (in front of the drain)	31	15	16
Santa Monica Municipal Pier- 50 yards southeast	34	15	19
Santa Monica Beach at Pico/Kenter storm drain	41	15	26
Santa Monica Beach at Strand St. (in front of the restrooms)	36	15	21
Ashland Av. storm drain- 50 yards north	38	15	23
Ashland Av. storm drain- 50 yards south	21	15	6
Venice City Beach at Brooks Av. (in front of the drain)	39	15	24
Venice City Beach at Windward Av.- 50 yards north	13	13	0
Venice Fishing Pier- 50 yards south	17	15	2
Venice City Beach at Topsail St.	37	15	22
Ballona Creek entrance- 50 yards south	28	15	13
Dockweiler State Beach at Culver Bl.	22	15	7
Dockweiler State Beach- south of D&W jetty	29	15	14
Imperial HWY storm drain- 50 yards north	17	15	2
Hyperion Treatment Plant One Mile Outfall	18	15	3
Dockweiler State Beach at Grand Av. (in front of the drain)	25	15	10
Manhattan State Beach at 40th Street	4	4	0
Manhattan Beach Pier- 50 yards south	5	5	0
Hermosa City Beach at 26th St.	12	12	0
Hermosa Beach Pier- 50 yards south	8	8	0
Herondo Street storm drain- (in front of the drain)	19	15	4
Redondo Municipal Pier- 50 yards south	14	14	0
Redondo State Beach at Topaz St. - north of jetty	19	15	4
Redondo State Beach at Avenue I	6	6	0
Malaga Cove, Palos Verdes Estates-daily	3	3	0

Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90th percentile)	Allowable no. of wet weather exceedance days (daily sampling)	Estimated final wet-weather exceedance-day reduction
Malaga Cove, Palos Verdes Estates-weekly	14	14	0
Palos Verdes (Bluff) Cove, Palos Verdes Estates	0	0	0
Long Point, Rancho Palos Verdes	4	4	0
Abalone Cove Shoreline Park	1	1	0
Portuguese Bend Cove, Rancho Palos Verdes	2	2	0
Royal Palms State Beach	6	6	0
Wilder Annex, San Pedro	2	2	0
Cabrillo Beach, oceanside	3	3	0

To summarize, bay-wide the estimated exceedance-day reductions represent a 40% reduction in the expected number of exceedance days that would occur under the defined critical condition. For individual beaches, the exceedance-day reductions range from a maximum of 28 days to 0 days (where the antidegradation standard is applied). The range of allowable wet-weather exceedance days is zero to a maximum of 14 days at northern Bay sites, and 15 days at central and southern Bay sites.[39]

[39] The one-day difference between the northern Bay sites and central and southern Bay sites is due to a one-day difference in the number of wet days in the critical year (1979) between the LAX rain gage and the Monte Nido rain gage.

9 IMPLEMENTATION STRATEGIES

9.1 Introduction

As required by the federal Clean Water Act, discharges of pollutants to Santa Monica Bay from municipal storm water conveyances are prohibited, unless the discharges are in compliance with a NPDES permit. In December 2001, the Los Angeles County Municipal NPDES Storm Water Permit was re-issued jointly to Los Angeles County and 84 cities as co-permittees. The Los Angeles County Municipal Storm Water NPDES Permit and the Caltrans Storm Water Permit will be key implementation tools for this TMDL. Future storm water permits will be modified in order to address implementation and monitoring of this TMDL and to be consistent with the waste load allocations of this TMDL.

Each permittee or group of permittees along with other responsible agencies[40] within a subwatershed may decide how to achieve the necessary reductions in exceedance days at each beach location by employing one or more of the implementation strategies discussed below or any other viable strategy. The Porter Cologne Water Quality Control Act prohibits the Regional Board from prescribing the method of achieving compliance with water quality standards, and likewise TMDLs. Below staff have identified some potential implementation strategies; however, there is no requirement to follow the particular strategies proposed herein as long as the required reductions in exceedance days (and associated allowable exceedance days) are achieved.

In many cases there are multiple incorporated and unincorporated areas within a subwatershed; therefore, all jurisdictions within a subwatershed are jointly responsible for meeting the TMDL requirements. See Appendix H for responsible jurisdictions by subwatershed. Staff expects that after an additional year or two of sampling, the source characterization study and model results will assist municipalities in focusing their implementation efforts on key land uses, critical sources and storm periods.

As mentioned earlier, the necessary reductions in the number of exceedance days must be achieved in the wave wash or at ankle depth for "open beach" monitoring stations (i.e., monitoring stations located away from any storm drain or coastal creek). This means that jurisdictions, or groups of cities/permittees, will be required to meet the total reduction in the subwatershed associated with the shoreline monitoring station, not necessarily an allocation for their jurisdiction or for specific land uses. Clearly the focus should be on developed areas or areas with significant human use (i.e., open space heavily used for recreation). Flexibility will be allowed in determining how to reduce bacteria densities as long as the required allocations are achieved in the wave wash or at ankle depth.

[40] For the purposes of this TMDL, "responsible jurisdictions and responsible agencies" includes a local or state agency that (1) is responsible for discharges from a publicly owned treatment works into the Santa Monica Bay watershed or directly into the Bay, (2) is a permittee or a co-permittee on a municipal storm water permit, or (3) has jurisdiction over a beach adjacent to Santa Monica Bay.

To achieve the necessary exceedance-day reductions to meet the allowable exceedance days presented in section 8, Regional Board staff recognizes the need to balance short-term capital investments directed to addressing this and other TMDLs in the Santa Monica Bay watershed with current long-term planning activities for storm water management in the region as a whole. It should be emphasized that the potential implementation strategies discussed below may significantly contribute to the implementation of other TMDLs for Santa Monica Bay and its watershed. To accomplish this, staff proposes an 18-year implementation schedule with interim implementation targets.

9.1.1 Summary of Potential Implementation Strategies

Staff convened a TMDL Steering Committee meeting on April 10, 2002 to solicit ideas for potential implementation strategies and information on associated implementation costs. At the April 10 meeting, the City of Los Angeles (City), County of Los Angeles Department of Public Works (County), and County Sanitation Districts of Los Angeles County (Districts) agreed to work together to develop an implementation strategy proposal with associated implementation cost estimates.[41] On May 20, 2002, the City provided in writing an implementation strategy proposal and associated cost estimates for the entire watershed, to which the County and Districts provided input.[42]

Three potential implementation strategies are presented below 1) an integrated resources strategy, 2) a targeted upstream structural and non-structural control strategy, and 3) an interim diversion strategy. The strategy suggested in the original draft TMDL (dated November 8, 2001) employed large-scale dedicated runoff treatment facilities. At the public workshop held on June 27, 2002, it became clear that this strategy was unlikely to be pursued and, therefore, it is not presented as a potential strategy in this draft.

The integrated resources strategy to meeting the wet-weather TMDL requirements follows the principles and goals of the City's Integrated Plan for the Wastewater Program (IPWP).[43] An integrated resources approach takes a holistic view of regional water resources management by integrating planning for future wastewater, storm water, recycled water, and potable water needs and systems, and focusing on beneficial re-use of storm water to reduce the need for imported water where feasible.

The upstream structural and non-structural control strategy is based on the premise that specific land uses, critical sources, or periods of a storm event can be targeted to achieve the TMDL waste load allocations. It is this strategy that the wet-weather study described in sections 4 and 6 was designed to evaluate. For example, non-structural controls may include better enforcement of pet waste disposal ordinances and food waste disposal ordinances for restaurants and food industries. Structural controls may include placement of storm water treatment devices

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[41] The City of Los Angeles and the County of Los Angeles together comprise 76% of the land area in the Santa Monica Bay Watershed Management Area.

[42] At a meeting on April 16, 2002, the County requested that the City extrapolate its cost estimates to include the entire watershed.

[43] Regional Board Assistant Executive Officer, Deborah Smith, was an active participant in the stakeholder process used to develop the IPWP.

specifically designed to reduce bacteria densities (e.g. Purizer© or Clear Creek Systems©)[44] at critical upstream points in the storm water conveyance system.

The interim diversion strategy includes the installation of facilities to provide capture and storage of wet-weather runoff and diversion of the stored runoff to the wastewater collection system for treatment at the City's Hyperion Treatment Plant (HTP) or the Districts' Joint Water Pollution Control Plant (JWPCP) during low flow conditions at the plants (typically during the early morning hours of 12-6 a.m.). If diversion to the JWPCP is not an option, other strategies such as dedicated runoff treatment plants such as the Santa Monica Urban Runoff Recycling Facility (SMURRF) or alternative BMPs would need to be implemented to meet the TMDL requirements in the South Bay.

Below each of these strategies is discussed in more detail. The integrated resources strategy and interim diversion strategy are the approaches proposed by the City with input from the County and the Sanitation Districts. The discussion of these two inter-related strategies reflects the proposal submitted to the Regional Board by the City on May 20, 2002. The upstream structural and non-structural control strategy is an approach that is currently being explored by the steering committee through the intensive wet-weather sampling and modeling effort described in sections 4 and 6.

9.2 Three Potential Implementation Strategies

9.2.1 Integrated Resources Strategy for Beneficial Re-Use

In the long-term, Regional Board staff supports in concept an integrated resources approach to improving water quality during wet weather, such as the City's Integrated Plan for the Wastewater Program (IPWP). In outlining a reasonably foreseeable means of implementing the wet-weather TMDL, under this strategy staff has applied the details of the City's long-term facilities planning under the Integrated Resources Plan (IRP), which is phase 2 of the IPWP, to the Santa Monica Bay watershed management area as a whole. The IRP is a comprehensive, planning program for the City, including a facilities plan, environmental documentation, and financial plan, and as such it will take several years to complete. Therefore, a companion, interim implementation strategy is presented below that will align with the City's IRP and have the goal of meeting the TMDL requirements for bacteria as well as other upcoming TMDLs. The City's IRP is intended to meet wastewater and water resource management needs for year 2020, which is consistent with the 18-year implementation schedule proposed for this TMDL.

Implementation of the TMDL may be accomplished through both the interim implementation strategy to initially capture, store, and treat wet-weather runoff from the Santa Monica Bay Watershed Management Area (described below) and the longer term integrated resources strategy such as that developed in the City's IRP Runoff Management Plan. The IRP is a City-wide strategy developed by the City of Los Angeles and does not specifically focus on the Santa Monica Bay Watershed, although the principles and goals could be applied in other jurisdictions

[44] Reference to commercial systems such as Purizer© and Clear Creek Systems© does not indicate endorsement of these products by the Los Angeles Regional Water Quality Control Board, rather they are merely cited as examples of commercially-available storm water treatment devices designed to reduce bacteria densities in storm water.

within the watershed. The goal of the plan is to capture and beneficially use 50% of the annual average wet-weather urban runoff; however, it is not known what portion of this runoff will be in the Santa Monica Bay Watershed. Furthermore, capture and beneficial use of 50% of the annual average wet-weather urban runoff may not achieve implementation with this TMDL during very wet years. The implementation strategy proposed here could be designed to achieve the TMDL requirements, while remaining consistent with the goals of the City's IPWP and addressing any shortfall of the IRP in achieving implementation with this TMDL specifically for the Santa Monica Bay Watershed. The Regional Board encourages siting and construction of the storage facilities consistent with an approach such as the City's IPWP to facilitate their eventual conversion into integrated resources plan as stormwater treatment facilities. Because the ultimate goal may be to use the storage sites as stormwater treatment facility sites, the Regional Board acknowledges that additional time may be required to site locations that also will work for an integrated resources strategy. The additional benefits gained from resource capture for beneficial use warrants the additional time; therefore, staff has proposed that this TMDL implementation schedule be consistent with the City's IPWP schedule of 2020.

One component of the IRP is a Runoff Management Plan, which could provide a framework for implementing runoff management practices to meet the IRP goals and address protection of public health and the environment. The Runoff Management Plan as described in the IRP will include consideration of structural Best Management Practices (BMPs) to achieve reduction of pollutant loadings to receiving waters. Urban runoff can be treated at strategic locations throughout the watershed or subwatersheds. (This is also similar to the upstream structural and non-structural control strategy described below.)

Runoff mitigation efforts (capture and treatment) may include an element of groundwater recharge and percolation of storm water runoff, in accordance with the IRP guiding principles[45] to capture and use wet-weather runoff. It is important that the recharge program be planned and operated to prevent contamination of the groundwater by poor quality runoff. To the extent that runoff can be captured and recharged, total runoff volume and the potential to cause exceedances of bacteria objectives at Santa Monica Bay beaches would be reduced. Other pollutants of concern that will be addressed by future TMDLs may also be reduced by these activities.

Runoff that cannot be used for recharge either due to location within the watershed or poor water quality could be treated using other BMPs to remove pollutants and provide the option of diverting this flow for other types of reuse, or for downstream discharge. Reuse of storm water requires storage facilities, strategically placed to optimize the use of the captured flow. This storage could range from on-lot cisterns to larger regional above- or below-ground facilities.

9.2.2 Upstream Structural and Non-Structural Control Strategy

To assist responsible jurisdictions and agencies in identifying the most cost-effective means of implementing this TMDL, the steering committee designed and undertook a wet weather study to (1) collect additional data on wet weather sources of bacteria and (2) model the fate and transport

[45] The IRP guiding principles were established during the Integrated Plan for the Wastewater Program (IPWP) which was the initial policy-setting phase of the IRP.

of bacteria during wet weather from the watershed to the beaches. This study was specifically designed to enable an evaluation of various implementation scenarios.

The study was designed to answer several questions including:

- Do certain land uses contribute higher densities of bacteria than others?
- Are there critical sources of bacteria within land uses that contribute higher densities of bacteria than the land use in general (e.g. high density residential with a high density of pets; unsewered, low density residential; commercial areas dominated by restaurants; industrial areas dominated by food industries; etc.)?
- Is bacteria subject to a "first flush" effect like other storm water pollutants? If so, can we identify a critical rainfall volume to capture to achieve the waste load allocations (e.g. first 0.1 inch, first 0.5 inch)?

While these questions have been examined for other storm water pollutants (e.g. metals), there has been little research of this type for bacteria. Though, in a study of bacteria loading in urban streams cited in "Protocol for Developing Pathogen TMDLs" (US EPA, 2001), Young and Thackston (1999) found that bacteria densities were directly related to the density of housing, population, development, percent impervious area, and domestic animal density.

To answer these questions, the study design entailed sampling eight key land uses during multiple storms. Within these eight key land uses, multiple sites were sampled (some identified as potential critical bacteria sources) to characterize the range of bacteria densities that might be found within each land use category. See Table 4-3 for a list of the eight general land uses and 19 land use sites identified in the wet-weather sampling plan. Finally, during each storm event, samples were collected at regular intervals throughout the storm hydrograph to evaluate the wash-off pattern for bacteria. Two seasons of wet weather sampling have been conducted thus far, with plans for at least one additional wet weather season. Additional details of this strategy including cost estimates will be available when the TMDL is revised.

The Regional Board encourages responsible agencies to utilize the results of the wet weather sampling to identify potential upstream non-structural or structural controls for targeted land uses, critical sources, or specific periods of a storm event. For example, non-structural controls may include better enforcement of pet waste disposal ordinances and food waste disposal ordinances for restaurants and food industries. Structural controls may include placement of storm water treatment devices specifically designed to reduce bacteria densities (e.g. Purizer© or Clear Creek Systems©)[46] at targeted upstream points in the storm water conveyance system. These structural solutions may be further targeted to a specific storm period such as the first 0.1 inch or 0.5 inch if the bacteria wash-off pattern mimics a 'first-flush' effect.

9.2.3 Interim Diversion Strategy

The proposed interim implementation strategy would include the installation of facilities to provide capture and storage of wet-weather runoff and diversion of the stored runoff to the

[46] Reference to commercial systems such as Purizer© and Clear Creek Systems© does not indicate endorsement of these products by the Los Angeles Regional Water Quality Control Board, rather they are merely cited as examples of storm water treatment devices designed to reduce bacteria densities in storm water.

wastewater collection system for treatment at the City's Hyperion Treatment Plant (HTP) in Playa del Rey during low flow conditions at the plant (typically during the early morning hours of 12-6 a.m.) This can most readily be applied to subwatersheds that drain from the North and Central Bay areas, upstream of HTP (northwest of and including Dockweiler subwatershed).

For the watersheds downgradient of HTP (Hermosa, Redondo and Palos Verdes subwatersheds), other approaches may need to be considered. Sewage from cities in these South Bay and Palos Verdes areas is treated by the Sanitation Districts at the JWPCP and the possibility of diversion of wet-weather runoff to that facility would need to be further discussed with the Districts. If diversion to the JWPCP is not an option, other strategies such as dedicated runoff treatment plants or alternative BMPs would need to be implemented to achieve TMDL implementation in the South Bay area. These watersheds are significantly smaller than those upstream of HTP, and at this time the estimated exceedance-day reductions are relatively small (8 days for Hermosa and Redondo subwatersheds; 0 days for Palos Verdes subwatershed). Therefore, it is expected that storage and treatment of runoff from these subwatersheds could be accomplished with relatively small dedicated runoff treatment facilities such as the SMURRF constructed by Santa Monica.

While the impact to water quality of such storage and diversion practices is uncertain at this time, it is reasonable to expect that this approach will be effective at reducing SMB beaches bacterial levels to meet the requirements of the TMDL. The effectiveness of this approach is primarily related to the ability to store and treat sufficient wet-weather runoff to adequately reduce exceedance days in the downstream receiving water (i.e., the target beach(es)).

The Regional Board encourages responsible agencies to test the effectiveness of this strategy for improving water quality prior to the TMDL being revised in five years. To meet the SMB Beaches Dry Weather Bacteria TMDL requirements, staff proposed continuing and expanding efforts to design and install structures to divert dry weather runoff to the wastewater collection system for treatment at HTP and JWPCP. If one of these planned diversions were to include the siting of a storage tank, both wet-weather and dry-weather runoff could be diverted prior to the TMDL being revised. For example, the Castlerock or Pulga Canyon subwatersheds could be candidates for wet-weather diversion if a site for wet-weather runoff storage can be identified. If this strategy is pursued, a schedule for diversion of wet-weather flow along the SMB coast can be developed in future negotiations with responsible agencies. The Regional Board acknowledges that additional time will need to be allotted earlier in the schedule to allow for siting of storage facilities and obtaining easements for conveyance facilities.

The collection, storage, transmission and diversion facilities could be strategically located to allow connection to the City's major trunk line along the coast (the Coastal Interceptor Sewer), at locations with adequate sewer capacity to accommodate diversion of the stored runoff for downstream treatment. Subsidence of wet-weather wastewater flows from further upstream in the collection system also would have to be considered in the planning for these diversions.

The volume of flow required for storage and treatment would have to be estimated to size the storage facilities and estimate diversion flow rates, and the affected collection system and treatment capacities to accommodate these diverted flows. For this draft, the volume of wet-weather runoff required to be treated to meet the TMDL requirements was estimated based on the original draft SMB Bacteria TMDL (original draft TMDL)[47]. The estimates of the total daily volume requiring treatment for each subwatershed were determined relative to the reference system. In other words, the model estimates of the number of days of exceedance for each subwatershed were compared with the number of exceedance days in the reference system in order to identify those subwatersheds that would likely require some kind of treatment. In this draft, staff estimated that a treatment flow of approximately 96 MGD would be required to be treated from the entire SMB Watershed Management Area (WMA) to meet the proposed TMDL waste load allocations, as expressed as allowable exceedance days by beach monitoring site (see Table 9-1).

Table 9-1

Model Estimates of Total Daily Volume Requiring Treatment by Subwatershed

Subwatershed	Total Daily Volume	Subtotal
Trancas Canyon	10,000 gal/d	
Zuma Canyon	10,000 gal/d	
Escondido Canyon	10,000 gal/d	
Topanga Canyon	10,000 gal/d	
Castlerock	10,000 gal/d	
Pulga Canyon	40,000 gal/d	
Santa Monica Canyon	32 MGD	
Santa Monica	26 MGD	
Dockweiler	12 MGD	
Northern and Central Bay		**70 MGD**
Hermosa	4.5 MGD	
Redondo	7 MGD	
Palos Verdes	14.5 MGD	
South Bay		**26 MGD**

Notes: The model estimates are based on treating the 29th rain event in the critical year for each subwatershed, since the model predicted that the reference system would exceed 28 days in the critical year.

The portion of these flows from subwatersheds north of HTP was approximately 70 MGD. These are estimates of the daily volumes that would need to be treated; corresponding peak flows would likely be much higher than the equivalent of 1/24th of these daily volumes. The water quality model being developed by the Southern California Coastal Water Research Project

[47] California Regional Water Quality Control Board, Los Angeles Region, *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches*, November 8, 2001.

(SCCWRP) was used to estimate these preliminary daily runoff volumes. This was accomplished by rank-ordering the total daily volumes in the design year for each subwatershed, and then determining the maximum daily volume that would need to be treated to result in the same number of exceedance days as modeled in the reference system. Further calibration and validation of the model is planned before the TMDL is revised, which will allow for refinement of these daily runoff volumes and an assessment of peak flows prior to the TMDL being revised.

These storage and diversion facilities will be sized to accommodate the requisite storage volumes and appropriate rates of diversion to the collection system to avoid overflows. Wet-weather flows beyond the capacities of these facilities will bypass, but it is expected that the "first flush" of these larger storm events will still be captured and treated, thereby reducing the water quality impacts of these larger storms.

The value of the facilities installed for this interim strategy can be realized as part of a long-term integrated resources strategy by planning for the future use of the collection, storage and transmission facilities to provide storm water for potential reuse opportunities.

Based on steering committee discussions and current diversion construction plans, the most likely option for diversion would be to construct smaller storage and diversion facilities at those subwatersheds where exceedance-day reductions are needed. It is assumed that a single storage and diversion facility would be installed at each of the subwatersheds requiring exceedance-day reductions, thereby reducing conveyance requirements. The original draft TMDL identified 12 subwatersheds that would require flow capture and diversion or treatment to meet the allowable exceedance day allocations. These subwatersheds are Trancas Canyon, Zuma Canyon, Escondido Canyon, Topanga Canyon, Castlerock, Pulga Canyon, Santa Monica Canyon, Santa Monica, Dockweiler, Hermosa, Redondo, and Palos Verdes. (The Malibu and Ballona subwatersheds were excluded from this list since they will be addressed by separate TMDLs.) The sizes of the storage and diversion facilities correspond to the daily volumes needing capture during wet weather as identified in the original draft TMDL and previously listed in Table 9-1.

9.3 Implementation Schedule

Staff proposes an 18-year implementation schedule, with final implementation deadline of the year 2020. This may be accomplished through the implementation of any combination of the strategies described above or by any other feasible method identified by the responsible agencies.

The specific requirements of the SMB wet-weather bacterial TMDL will be further when the TMDL is revised in five years, after additional shoreline monitoring data and the calibrated water quality model are available. However, to prevent a delay in addressing wet-weather exceedances, some reduction targets need to be established at this time, with some flexibility to accommodate uncertainties.

To allow immediate planning to begin in order to achieve some exceedance-day reductions early in the implementation schedule, estimates of exceedance-day reductions are based on the existing shoreline monitoring locations, as discussed in section 8. Because existing shoreline monitoring locations are typically 25-50 yards downcurrent of freshwater outlets, the interim compliance points are the existing shoreline monitoring locations. Once shoreline monitoring data have been collected from the wave wash, allowable exceedance days will be reassessed during the TMDL revision and the final compliance point of the wave wash will apply from that time forward.

Percentage reductions leading to full implementation is the method used to establish the interim goals. Three interim milestones are proposed at 6 years, 10 years and 15 years after the effective date. These interim milestones are based on 10% (year 6), 25% (year 10) and 50% (year 15) cumulative percentage reductions from the total exceedance-day reductions required for each beach region (discussed below). These reduction goals are translated into the number of exceedance days to be reduced (or, conversely, the number of annual allowable wet-weather exceedance days) for each milestone (6-year, 10-year, and 15-year) to provide a defined target. To further accommodate this need for a defined planning target, the reduction goals for early in the implementation period (e.g., <10 years after effective date) are based on the estimated final exceedance-day reductions in section 8 (Table 8-2); these targets will not be changed when the TMDL is revised. When the TMDL is revised in five years, subsequent reductions (e.g., ≥10 years after effective date) shall be re-calculated, if needed, based on any additional data gathered, to target full implementation by 2020. Staff recognizes that the schedule is “back-loaded” (i.e., small reductions in the early years and large reductions in the later years). This was done due to the large amount of planning that will be needed to develop an integrated resources approach to address storm water. Back-loading the reduction will also allow sufficient time for capital improvements which, as they come on-line late in the TMDL process, will address a greater range of the bacteria exceedances.

Because exceedance-day reductions are needed at many beaches, responsible agencies will most likely need to work cooperatively to prioritize and target implementation activities throughout the 18-year schedule, rather than addressing all beach locations simultaneously. To allow for targeted implementation scheduling (i.e., focus on a subwatershed), staff proposes establishing interim implementation targets as a set number of allowable exceedance days *by beach region*. Progress towards implementation will be measured against the total allowable exceedance days for each beach region at each milestone. Six regions and corresponding groups of responsible agencies are defined for this purpose (see Table 9-2 below). *Note that while the interim implementation targets are set based on beach region to provide flexibility in scheduling implementation activities, the final implementation targets in terms of allowable exceedance days must be met by year 2020 at each individual beach location (see Table 9-3).*

Interim targets are not proposed at this time for the ‘Ballona Creek outlet’ beach region or the ‘Malibu Beach’ beach region. These two regions are being addressed through two subsequent bacteria TMDLs that are specifically focused on these individual watersheds. These subsequent TMDLs will be developed to achieve the final allowable wet-weather exceedance days at these beach locations as specified in this TMDL. However, an implementation schedule and interim milestones will be set in the individual TMDLs, rather than in this TMDL.

Table 9-2. Implementation Groups by Beach Region and Interim Compliance Targets

Beach Region	Watersheds	Responsible Agencies	Interim Compliance Targets (Cumulative Allowable Wet-Weather Exceedance Days for *all* Beaches in a Region)		
			Year 6	Year 10	Year 15
North Bay Beaches	Arroyo Sequit	Malibu	190	182	168
	Nicholas Canyon	Unincorporated			
	Los Alisos Canyon	Caltrans			
	Encinal Canyon				
	Trancas Canyon				
	Zuma Canyon				
	Ramirez Canyon				
	Escondido Canyon				
	Latigo Canyon				
	Solstice Canyon				
	Corral Canyon				
	Carbon Canyon				
	Las Flores Canyon				
	Piedra Gorda Canyon				
	Pena Canyon				
	Tuna Canyon				
Malibu Beaches	Malibu Canyon	Agoura Hills	*	*	*
		Calabasas			
		Malibu			
		Thousand Oaks			
		Unincorporated			
		Westlake Village			
		Hidden Hills			
		Simi Valley			
		Caltrans			

Beach Region	Watersheds	Responsible Agencies	Interim Compliance Targets (Cumulative Allowable Wet-Weather Exceedance Days for *all* Beaches in a Region)		
			Year 6	Year 10	Year 15
Central Bay Beaches	Topanga Canyon Castlerock Santa Ynez Canyon Pulga Canyon Santa Monica Canyon Santa Monica Marina del Rey Dockweiler	El Segundo Los Angeles Santa Monica Unincorporated Calabasas Culver City Manhattan Beach Caltrans	588	546	476
Ballona Cr Outlet	West Los Angeles Westwood Village Culver City Hollywood Cienega Windsow Hills	Beverly Hills Culver City Inglewood Los Angeles Unincorporated West Hollywood Caltrans	*	*	*
South Bay Beaches	Hermosa Redondo	Hermosa Beach Manhattan Beach Redondo Beach Torrance El Segundo Unincorporated Caltrans	80	79	77
Palos Verdes Beaches	Palos Verdes	Palos Verdes Estates Rancho Palos Verdes Rolling Hills Torrance Los Angeles Redondo Beach Rolling Hills Estates Unincorporated Caltrans	41	41	41

Notes: *Interim milestones for these beach regions will be identified in the individual bacteria TMDLs for these two watersheds.

By grouping beaches to assess interim compliance, defined exceedance reduction targets are provided, but with flexibility that will accommodate implementation scenarios that focus on individual watersheds or more holistic, multipurpose BMPs. This approach removes the challenge of targeting an unknown number of exceedance day reductions, and allows for the development and selection of appropriate technologies at appropriate locations throughout the SMB WMA.

During the implementation period, a translator will be employed to evaluate implementation. The Regional Board will use a value of 85% to evaluate whether adequate progress was made toward meeting the interim implementation targets in situations where the target was not fully met. For example, as in the case above, responsible agencies would be considered in compliance so long as the reduction was at least 85% of the targeted reduction from a prior baseline or milestone. For the year-6 milestone of a 10% reduction (or 28 days) at Central Bay beaches, this would mean that a minimum reduction of 24 days would need to be achieved to demonstrate compliance.

Table 9-3. Summary of Proposed Interim Compliance Targets by Beach Region and Final Allowable Exceedance Days by Beach Location

			Interim Compliance Targets** (Allowable Exceedance Days during Wet Weather)			
Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90th percentile)*	Estimated final wet-weather exceedance-day reduction*	Based on 10% reduction from critical year (6 years after effective date)	Based on 25% cumulative reduction from critical year (10 years after effective date)*	Based on 50% cumulative reduction from critical year (15 years after effective date)*	Final allowable no. of wet weather exceedance days (daily sampling)*
Leo Carrillo Beach, at 35000 PCH	14	0	n/a	n/a	n/a	14
Nicholas Beach- 100 feet west of lifeguard tower	15	1	n/a	n/a	n/a	14
Broad Beach	16	2	n/a	n/a	n/a	14
Trancas Beach entrance, 50 yards east of Trancas Bridge	20	6	n/a	n/a	n/a	14
Westward Beach, east of Zuma Creek	16	2	n/a	n/a	n/a	14
Paradise Cove, adjacent to west side of Pier	20	6	n/a	n/a	n/a	14
Latigo Canyon Creek entrance	28	14	n/a	n/a	n/a	14
Corral State Beach	16	2	n/a	n/a	n/a	14
Las Flores Beach	26	12	n/a	n/a	n/a	14
Big Rock Beach, at 19900 PCH	25	11	n/a	n/a	n/a	14
NORTH BAY BEACHES SUBTOTAL	**196**	**56**	**190**	**182**	**168**	**n/a**
Malibu Point	16	2	N/a	n/a	n/a	14
Surfrider Beach (second point)- weekly	42	28	N/a	n/a	n/a	14
Surfrider Beach (breach point)- daily	42	28	N/a	n/a	n/a	14
Malibu Pier- 50 yards east	42	28	N/a	n/a	n/a	14
MALIBU BEACHES SUBTOTAL	**142**	**86**	*******	*******	*******	**n/a**
Topanga State Beach	23	9	n/a	n/a	n/a	14
PCH and Sunset Bl.- 400 yards east	21	7	n/a	n/a	n/a	14

Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90th percentile)*	Estimated final wet-weather exceedance-day reduction*	Interim Compliance Targets** (Allowable Exceedance Days during Wet Weather)			Final allowable no. of wet weather exceedance days (daily sampling)*
			Based on 10% reduction from critical year (6 years after effective date)	Based on 25% cumulative reduction from critical year (10 years after effective date)*	Based on 50% cumulative reduction from critical year (15 years after effective date)*	
16801 Pacific Coast Highway, Bel Air Bay Club (chain fence)	24	10	n/a	n/a	n/a	14
Pulga Canyon storm drain- 50 yards east	22	8	n/a	n/a	n/a	14
Will Rogers State Beach- Temescal Canyon (25 yrds. so. of drain)	24	10	n/a	n/a	n/a	14
Santa Monica Canyon, Will Rogers State Beach	22	8	n/a	n/a	n/a	14
Santa Monica Beach at San Vicente Bl.	33	18	n/a	n/a	n/a	15
Santa Monica at Montana Av. (25 yrds. so. of drain)	29	14	n/a	n/a	n/a	15
Santa Monica at Arizona (in front of the drain)	31	16	n/a	n/a	n/a	15
Santa Monica Municipal Pier- 50 yards southeast	34	19	n/a	n/a	n/a	15
Santa Monica Beach at Pico/Kenter storm drain	41	26	n/a	n/a	n/a	15
Santa Monica Beach at Strand St. (in front of the restrooms)	36	21	n/a	n/a	n/a	15
Ashland Av. storm drain- 50 yards north	38	23	n/a	n/a	n/a	15
Ashland Av. storm drain- 50 yards south	21	6	n/a	n/a	n/a	15
Venice City Beach at Brooks Av. (in front of the drain)	39	24	n/a	n/a	n/a	15
Venice City Beach at Windward Av.- 50 yards north	13	0	n/a	n/a	n/a	13
Venice Fishing Pier- 50 yards south	17	2	n/a	n/a	n/a	15
Venice City Beach at Topsail St.	37	22	n/a	n/a	n/a	15
Dockweiler State Beach at Culver Bl.	22	7	n/a	n/a	n/a	15
Dockweiler State Beach- south of D&W jetty	29	14	n/a	n/a	n/a	15
Imperial HWY storm drain- 50 yards north	17	2	n/a	n/a	n/a	15
Hyperion Treatment Plant One Mile Outfall	18	3	n/a	n/a	n/a	15

Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90^{th} percentile)*	Estimated final wet-weather exceedance-day reduction*	Interim Compliance Targets** (Allowable Exceedance Days during Wet Weather)			Final allowable no. of wet weather exceedance days (daily sampling)*
			Based on 10% reduction from critical year (6 years after effective date)	Based on 25% cumulative reduction from critical year (10 years after effective date)*	Based on 50% cumulative reduction from critical year (15 years after effective date)*	
Dockweiler State Beach at Grand Av. (in front of the drain)	25	10	n/a	n/a	n/a	15
CENTRAL BAY BEACHES SUBTOTAL	**616**	**279**	**588**	**546**	**476**	**n/a**
Ballona Creek entrance- 50 yards south	28	13	n/a	n/a	n/a	15
BALLONA CREEK OUTLET SUBTOTAL	**28**	**13**	***	***	***	**n/a**
Manhattan State Beach at 40th Street	4	0	n/a	n/a	n/a	4
Manhattan Beach Pier- 50 yards south	5	0	n/a	n/a	n/a	5
Hermosa City Beach at 26th St.	12	0	n/a	n/a	n/a	12
Hermosa Beach Pier- 50 yards south	8	0	n/a	n/a	n/a	8
Herondo Street storm drain- (in front of the drain)	19	4	n/a	n/a	n/a	15
Redondo Municipal Pier- 50 yards south	14	0	n/a	n/a	n/a	14
Redondo State Beach at Topaz St. - north of jetty	19	4	n/a	n/a	n/a	15
SOUTH BAY BEACHES SUBTOTAL	**81**	**8**	**80**	**79**	**77**	**n/a**
Redondo State Beach at Avenue I	6	0	n/a	n/a	n/a	6
Malaga Cove, Palos Verdes Estates-daily	3	0	n/a	n/a	n/a	3
Malaga Cove, Palos Verdes Estates-weekly	14	0	n/a	n/a	n/a	14
Palos Verdes (Bluff) Cove, Palos Verdes Estates	0	0	n/a	n/a	n/a	0
Long Point, Rancho Palos Verdes	4	0	n/a	n/a	n/a	4
Abalone Cove Shoreline Park	1	0	n/a	n/a	n/a	1
Portuguese Bend Cove, Rancho Palos Verdes	2	0	n/a	n/a	n/a	2
Royal Palms State Beach	6	0	n/a	n/a	n/a	6

Beach Monitoring Location	Estimated no. of wet weather exceedance days in critical year (90^{th} percentile)*	Estimated final wet-weather exceedance-day reduction*	Interim Compliance Targets** (Allowable Exceedance Days during Wet Weather)			Final allowable no. of wet weather exceedance days (daily sampling)*
			Based on 10% reduction from critical year (6 years after effective date)	Based on 25% cumulative reduction from critical year (10 years after effective date)*	Based on 50% cumulative reduction from critical year (15 years after effective date)*	
Wilder Annex, San Pedro	2	0	n/a	n/a	n/a	2
Cabrillo Beach, oceanside	3	0	n/a	n/a	n/a	3
PALOS VERDES BEACHES SUBTOTAL	**41**	**0**	**41**	**41**	**41**	**n/a**

Notes: * The compliance targets are based on existing shoreline monitoring data. These are the compliance targets until additional shoreline monitoring data are collected prior to revision of the TMDL. Once additional shoreline monitoring data are available, the following will be re-evaluated when the TMDL is revised 1) estimated number of wet-weather exceedance days in the critical year at all beach locations, 2) final wet-weather exceedance day reduction at all beach locations, 3) year 10 and year 15 interim compliance targets for each beach region, and 4) final allowable wet-weather exceedance days for each beach location. ** During the implementation period, the Regional Board will evaluate whether adequate progress was made toward meeting the interim compliance targets by recognizing adequate progress as being at least 85% of the targeted reduction. The 85% value will be applied to the targeted reduction from a prior baseline or milestone (e.g., Central Beaches have a year-6 milestone of a 10% reduction (or 28 days), which would mean that a minimum reduction of 24 days would need to be achieved to demonstrate compliance). *** Interim milestones for the Malibu and Ballona beach regions will be identified in the individual bacteria TMDLs for these two watersheds.

Table 9-4 summarizes the major implementation milestones proposed in the TMDL.

Table 9-4. Summary of Implementation Schedule

Years after effective date	Implementation Activity/Compliance Target
1-4	• Collect shoreline bacteriological data from wave wash on a daily basis at reference beaches and other representative beaches • Conduct additional wet-weather sampling to characterize bacteria loading from land uses, critical sources and reference mass emission sites • Further calibrate and validate model based on wet-weather sampling • Re-evaluate possible reference system approaches and select final reference approach • Explore potential implementation scenarios using the calibrated and validated water quality model
5	Revise TMDL to re-evaluate allowable exceedance days based on final reference approach. If necessary, numeric targets will be adjusted to account for naturally occurring exceedances or an additional Basin Plan amendment will be proposed to adjust objectives for naturally occurring exceedances.
6	Achieve 10% reduction from the total exceedance-day reduction required for each beach region
10	Achieve 25% reduction from the total exceedance-day reduction required for each beach region
15	Achieve 50% reduction from the total exceedance-day reduction required for each beach region
18	Achieve full implementation of TMDL requirements at all beach locations

9.4 Implementation Cost Estimates

As stated earlier, Regional Board staff met with the steering committee in April 2002 to discuss various aspects of the wet-weather TMDL including potential implementation strategies and associated costs. On the basis of this meeting, subsequent discussions with stakeholders and input received at the public workshop, the most likely implementation scenario was identified as the interim diversion strategy assuming a single storage and diversion facility for each subwatershed requiring reductions to achieve the TMDL. The following cost estimates for the interim diversion strategy were provided by the City as part of its implementation strategy proposal.

9.4.1 Interim Strategy: Conveyance, Storage and Diversion

The interim implementation strategy, as outlined above, is envisioned to eventually contribute to a long-term integrated resources strategy for a holistic approach to wastewater and water resource management such as the City's IRP. Cost estimates for conveying, storing, and diverting flows per the interim implementation strategy were developed assuming conveyance, storage, and diversion from 12 locations along the coast. It is expected that the siting of the storage facilities and conveyance of the flows will be the most challenging aspects to this strategy.

Table 9-5 summarizes the capital and O&M costs for the diversion strategy.

Table 9-5. Diversion Present Worth Cost Comparisons

Number of Diversions	Present Worth Costs[1, 2] ($, millions)			
	Capital	O&M[3]		TOTAL
		Annual	Present Worth	Present Worth
12	379	0.35	3.7	383

Notes:

[1] *These concept-level costs are order-of-magnitude estimates which have a range of accuracy between –30 and +50 percent. All costs are in year 2001 dollars.*

[2] *Present worth costs based on 7 percent interest over 20-year return period. Uniform series discount factor 10.5940 applied to O&M annual costs.*

[3] *O&M cost primarily associated with power requirements for pumping from storage tank to diversion structure.*

9.4.2 Integrated Resource Strategy

It is not possible to estimate the cost of the long-term integrated resource strategy because it is still in the planning stage. It may well cost more than the interim diversion strategy; however, it is intended to address multiple pollutants, not just bacteria, and would reduce the Region's need for imported water through re-use of storm water.

9.4.3 Upstream Structural and Non-Structural Controls Strategy

It is not possible to reliably estimate the cost of the upstream structural and non-structural controls strategy at this time because there is insufficient data to accurately model various implementation scenarios. Additional details of this strategy including various implementation scenarios and cost estimates will be available when the TMDL is revised. The Regional Board expects that such targeted upstream structural and non-structural controls will be much less costly than the 'wholesale' end-of-pipe diversion strategy for which costs are provided in this document.

10 Monitoring Program

There are four objectives of the monitoring program. The first is to collect additional data (land use, in-stream and wave wash) to re-evaluate possible reference system approaches. The second is to collect shoreline monitoring data from the wave wash at targeted beaches to re-evaluate allowable exceedance days based on the antidegradation criterion. The third is to collect additional wet-weather data to evaluate potential management scenarios. The fourth is to collect shoreline data from the wave wash to assess compliance with interim allowable exceedance days by beach region and final allowable exceedance days by beach location.[48] To achieve these objectives, the monitoring program for the TMDL consists of three key components 1) a reference characterization component, 2) a source characterization component and 3) a shoreline compliance monitoring component.

10.1 Reference Characterization

The reference system characterization will allow the Regional Board to refine estimates of the "reference" level of exceedance, which is used to set allowable exceedance days at target beaches where the antidegradation criterion does not apply. As discussed in section 8, the TMDL waste load allocations are set such that the number of exceedance days at a target beach should be the lesser of that observed in the reference system or the historical level of exceedance for the target beach. The Steering Committee selected Arroyo Sequit Canyon and Leo Carrillo Beach as the best candidate "reference" system for the purpose of setting the "reference" allowable exceedance days at this stage. However, currently, shoreline bacteriological monitoring is not conducted in the wave wash (where Arroyo Sequit initially mixes with the ocean water). Over the next few years, the Regional Board intends work with the Steering Committee and other agencies to re-evaluate the details of using a reference system approach. This evaluation will include assessing alternative reference systems and collecting data from these systems to better define the "reference" level(s) of exceedance observed in local natural systems during both wet and dry weather.[49]

10.2 Source Characterization

The purpose of the source characterization component is to allow the Regional Board to better calibrate and validate the model and refine estimates of the necessary exceedance day reductions for each subwatershed and by municipality. Over the next two years, the Steering Committee will collect water quality data under wet weather conditions to refine estimates of bacteria densities from particular land uses and critical sources and at various instream locations. This will be a continuation of the wet weather sampling program described in section 4.

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[48] Compliance during the period prior to the re-opener is at existing shoreline monitoring locations, not the wave wash.

[49] Possible alternatives may include selecting a large subwatershed (such as Arroyo Sequit) and a small subwatershed (such as Tuna Canyon) to control for differences in exceedance levels due to drainage area and flow or using a modeling approach where each subwatershed is assumed to be 100% open space and the number of exceedance days in the critical year is then derived for these "model" subwatersheds.

The source characterization component will also assist responsible agencies to implement the TMDL. The data collected on average bacteria densities from different land uses, and the range of bacteria densities within a land use, during different storm events, and within storm events will be used in the model to evaluate different management scenarios (such as capturing and treating the first flush from certain land uses) and prioritize areas for implementation of storm water best management practices.

10.3 Compliance Determination

Daily or weekly sampling in the wave wash at all major drains and creeks or at existing monitoring stations at beaches without storm drains or freshwater outlets will determine compliance.[50] At all locations, samples must be taken at ankle depth and on an incoming wave. At locations where there is a freshwater outlet, during wet weather, samples should be taken as close as possible to the wave wash, and no further away than 10 meters down current of the storm drain or outlet.[51] At locations where there is a freshwater outlet, samples should be taken when the freshwater outlet is flowing into the surf zone.[52]

Interim compliance will be determined by daily or weekly sampling at existing shoreline monitoring stations until data are available from the wave wash to revise the TMDL's allowable exceedance days consistent with the final compliance point (the wave wash).

If the number of exceedance days is greater than the allowable number of exceedance days for any beach region at the interim implementation milestones taking into account the 85% translator, the responsible agencies will be considered out-of-compliance with the TMDL. If the number of exceedance days exceeds the allowable number of exceedance days for a target beach at the final implementation deadline, the subwatershed and responsible agencies will be considered out-of-compliance with the TMDL.

10.3.1 Follow-up Monitoring

If a single sample shows the discharge or contributing area to be out of compliance, daily sampling in the wave wash or at the existing open shoreline monitoring location shall be conducted (if it is not already) until all single sample objectives are below the thresholds. Furthermore, if a beach location is out-of-compliance, responsible municipalities will be required to initiate an investigation, which may lead to a sanitary survey of the subwatershed(s) per Assembly Bill 538 protocols where there is a persistent water quality problem (as defined in AB 538) to more specifically locate the source of the problem (see

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[50] The frequency of sampling (i.e., daily versus weekly) will be at the discretion of the implementing agencies. However, the number of sample days that may exceed the objectives will be scaled accordingly (see Table 17).

[51] Safety considerations during wet weather may preclude taking a sample in the wave wash.

[52] At some freshwater outlets and storm drains, during high tide conditions, the tide pushes the freshwater discharge back into the drain. As a result, sampling under these conditions is not representative of water quality conditions when the drain is flowing into the surf zone. The tide height at which this situation occurs will vary with the size, slope and configuration of the drain and the beach. Responsible agencies must ensure that samples are collected only when drains are flowing into the surf zone, not when the discharge is pushed back into the drain. Responsible agencies must submit a coordinated shoreline monitoring plan within 120 days of the effective date of the TMDL, in which this assurance should be included.

Appendix I for these protocols). Responsible jurisdictions may wish to conduct compliance monitoring at key jurisdictional boundaries as part of this effort.

If a beach location without a freshwater outlet is out-of-compliance or if the outlet (i.e., publicly-owned storm drain or natural creek) is diverted or being treated, the adjacent municipality, County agency(s), or State or federal agency(s) will be responsible for conducting the investigation.

The County of Los Angeles and municipalities within the Santa Monica Bay watershed are strongly encouraged to pool efforts and coordinate with other appropriate monitoring agencies in order to meet the challenges posed by this TMDL by developing cooperative compliance monitoring programs.

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