Bacteria-Impaired Waters TMDL Project I for Beaches and Creeks in the San Diego Region

TECHNICAL DRAFT

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1 Executive Summary

Section 303(d) of the Clean Water Act (CWA) requires that each State identify waterbodies within its boundaries for which the effluent limitations are not stringent enough to meet applicable water quality standards (i.e., water quality objectives and beneficial uses). The CWA also requires states to establish a priority ranking for these impaired waters, known as the Section 303(d) List of Water Quality Limited Segments, and to establish Total Maximum Daily Loads (TMDLs) for such waters. The purpose of a TMDL is to restore the beneficial uses and to attain the water quality objectives in the waterbody. A TMDL represents the maximum amount of the pollutant of concern that the waterbody can receive and still attain water quality standards. Once this maximum pollutant amount has been calculated, it is then divided up and allocated amongst all of the contributing sources in the watershed. In order to meet the TMDL, an Implementation Plan is also developed that describes the pollutant reduction actions that must be taken by various responsible parties to meet the allocations. The Implementation Plan includes a time schedule for meeting the required pollutant reductions and requirements for monitoring to assess the effectiveness of the load reduction activities in attaining water quality objectives and restoring beneficial uses.

The California Regional Water Quality Control Board, San Diego Region (Regional Board) is responsible under the California Water Code for protecting the beneficial uses of the waters of the State in the San Diego Region by regulating the discharge of pollutants to those waters, as required under the CWA. Due to frequent, high concentrations of bacteria, the Regional Board placed 38 waterbodies, comprising approximately 50 miles of coastal shoreline and creeks, and 2000 acres of bays and lagoons, on the 2002 CWA List of Water Quality Limited Segments. Bacteria densities have been found to frequently exceed the numeric water quality objectives (WQOs) for total, fecal, and enterococci bacteria as defined in the Regional Board’s Water Quality Control Plan for the San Diego Basin (Basin Plan). These exceedances threaten or impair the water contact, non-water contact, and shellfish harvesting beneficial uses of the listed waterbodies.

The United State Environmental Protection Agency (USEPA) used CWA Section 106 funds to contract the environmental consulting firm, Tetra Tech, to provide technical assistance to the Regional Board in calculating the TMDLs for the impaired waterbodies through the development of Region-wide watershed models. This project, known as the *Bacteria-Impaired Waters TMDL Project I for Beaches and Creeks* (Bacteria Project I), was developed to address 17 out of the 38 bacteria-impaired waterbodies on the 2002 CWA Section 303(d) List in the San Diego Region. This project includes TMDL calculations for roughly 24 miles of coastal shoreline and creeks. The remaining 20 bacteria-impaired waters will be addressed in an upcoming subsequent TMDL project known as *Bacteria Impaired Waters TMDL Project II for Bays and Lagoons* (Bacteria Project II).

TMDLs were developed to meet water quality objectives and protect beneficial uses in the bacteria-impaired waterbodies included in this project (Appendix A).

The final numeric targets for the TMDLs were set equal to the numeric water quality objectives associated with the water contact (REC-1) beneficial use for fecal coliform and enterococci bacteria as defined in the Regional Board's Basin Plan. For total coliform, the final numeric targets were set equal to the numeric water quality objectives associated with the shellfish harvesting (SHELL) beneficial use. In addition, during wet weather, an interim numeric target was established based on a "reference approach" that allows a certain number of exceedance frequencies of the water quality objectives during wet weather conditions to account for natural sources of bacteria in a watershed (e.g., bird or wildlife waste). In areas where background sources of bacteria can, by themselves, result in non-attainment of Basin Plan WQOs, it is often useful to compare the watershed to a reference watershed representative of natural conditions. The reference approach ensures that water quality objectives are at least as good as conditions observed at a reference watershed, while accounting for the impact of natural sources on water quality. Furthermore, the approach ensures no further bacteriological degradation of water quality where existing conditions are better than the reference watershed. This approach was used by the Los Angeles Regional Water Quality Control Board (LARWQCB) for developing bacteria TMDLs for Malibu Creek and the Santa Monica Bay beaches (LARWQCB, 2002, and 2003).

Bacteria generation was linked to different types of land uses, and transported to receiving waters via urban runoff, natural background, homeless encampments, and sewage spills from wastewater treatment plants. It was determined that by far, the most significant controllable source of bacteria to receiving waters is urban runoff discharges from Municipal Separate Storm Sewer Systems (MS4s) during both wet and dry weather. In wet weather, it was found that the amount of runoff and associated bacteria concentrations are highly dependent on land use and associated management practices (e.g., management of livestock in agricultural areas, pet waste in residential areas). In dry weather, the amount of runoff and associated bacteria concentrations come from various land use practices that cause water to enter storm drains and creeks, such as lawn irrigation runoff and car washing. The natural sources were largely determined to be uncontrollable and have been accounted for through the use of the reference approach discussed above.

To determine existing bacteria loads and assign TMDLs to these impaired waterbodies, a regional watershed-based approach (model study) was developed. For wet weather modeling analysis, a modeling system was used to simulate the build-up and wash-off of bacteria, and the hydrologic and hydraulic processes that affect delivery to the impaired waters. The wet weather approach was based on the application of the United States Environmental Protection Agency's (USEPA) Loading Simulation Program in C++ (LSPC) to estimate bacteria loading from streams and assimilation within the waterbody.

For dry weather, a different approach was necessary due to the variable nature of bacteria concentrations in the receiving waters. In order to represent the linkage between source contributions and in-stream response, a steady-state mass balance model was developed to simulate transport of bacteria in the impaired streams and the streams flowing to impaired shorelines. The model was created to estimate bacteria concentrations in the San Diego Region, to develop necessary load allocations for TMDL development, and to allow for readily incorporating any new data. Bacteria concentrations in each segment were calculated using water quality data, a first-order die-off rate, stream infiltration, basic channel geometry, and flow.

The TMDLs and waste load allocations were calculated for each impaired waterbody included in this report, for both wet and dry weather. These results are presented in Tables 9.1-9.6. The Regional Board will develop the Implementation Plan for these TMDLs at a future date.

2 Introduction

Section 303(d) of the Clean Water Act (CWA) requires states to conduct biennial assessments of waters not meeting water quality standards and to develop lists of water quality limited segments of waterbodies. States are further required to establish a priority ranking for waters on the Section 303(d) List of Water Quality Limited Segments and to establish Total Maximum Daily Loads (TMDLs) for these waterbodies. A TMDL establishes the allowable load of a pollutant based on the relationship between pollutant sources and attainment of water quality standards. It provides the scientific basis to establish water quality-based controls to reduce pollution from point and nonpoint sources in order to attain water quality objectives and restore and protect the beneficial uses of the impaired waterbody. The waterbodies addressed in this project were added to the List of Water Quality Limited Segments on, or before the 2002 listing cycle. No sites that are added to the list during subsequent listing cycles will be included in this project.

The TMDL process began with the development of a technical analysis which includes the following 7 components: (1) a **Problem Statement** describing which water quality objectives are not being attained and which beneficial uses are impaired; (2) identification of **Numeric Targets** which will result in attainment of the water quality objectives and protection of beneficial uses; (3) a **Source Analysis** to identify all of the point and nonpoint sources of the impairing pollutant in the watershed and to estimate the current pollutant loading for each source; (4) a **Linkage Analysis** to calculate the **Loading Capacity** of the waterbody for the pollutant; i.e., the maximum amount of the pollutant that may be discharged to the waterbody without causing exceedances of water quality objectives and impairment of beneficial uses; (5) a **Margin of Safety** (MOS) to account for uncertainties in the analysis; (6) the division and **Allocation** of the TMDL among each of the contributing sources in the watershed, waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint and background sources; (7) a description of how **Seasonal Variation and Critical Conditions** are accounted for in the TMDL determination. The document containing the above components is generally referred to as the technical TMDL analysis.

The Regional Board is currently developing the **Implementation Plan** for this project. The Implementation Plan describes the pollutant reduction actions that must be taken by various responsible parties to meet the allocations. Specifically, the Regional Board can issue or amend existing Waste Discharge Requirements, including those that implement National Pollutant Discharge Elimination System (NPDES) regulations, or Waivers of Waste Discharge Requirements, or adopt Basin Plan prohibitions. The implementation provisions may also require studies by the dischargers to fill data gaps, refine the TMDLs and required load reductions, or modify compliance requirements. The dischargers will also be ordered to conduct monitoring to assess the effectiveness of the implementation measures at meeting the load and waste load reductions. Public participation is a key element of the TMDL process, and stakeholder involvement is encouraged and required.

The technical portion of this project was completed primarily by the use of watershed models. Two distinct models were used for calculating bacteria loads. One model specifically quantified loading during wet weather events. The other model quantified loading during dry conditions. In addition to current loading, Total Maximum Daily Loads (TMDLs) were calculated for the two conditions for each watershed. An annual TMDL was then reported for each watershed (sum of the wet weather and dry weather TMDLs). This information is available in Tables 9.1-9.6.

Although beaches and creeks are separate systems with different associated water quality objectives, the technical approach for assessing both systems were identical. Therefore discussions regarding analyses of both systems are kept together in this document.

3 Problem Statement

The *Bacteria-Impaired Waters TMDL Project I for Beaches and Creeks* (Bacteria TMDL Project I) was developed to address 17out of the 38 bacteria-impaired waterbodies on the 2002 CWA Section 303(d) list in the San Diego Region. In order to address these impairments, the San Diego Regional Water Quality Control Board (Regional Board) and the United States Environmental Protection Agency (USEPA) coordinated a watershed assessment and modeling study to support the development of TMDLs. In order to assist the Regional Board in the development of the technical portion of the Bacteria Project I TMDLs, USEPA used CWA section 106 funds to contract the environmental consulting firm, Tetra Tech. Tetra Tech has provided the Regional Board with technical assistance in calculating the TMDLs for the impaired waterbodies through the development of Region-wide watershed models.

The Bacteria TMDL Project I resulted in the development of TMDLs for 46 impaired beach segments and five creeks of the San Diego Region, amounting to roughly 24 miles of coastal shoreline and creeks, and also creek and lagoon mouths that were small enough in area to be included in this analysis. (Appendix A). Bacteria densities in these waterbodies have chronically exceeded the numeric water quality objectives for total, fecal, and/or enterococci bacteria. These exceedances threaten and impair the water contact (REC-1), non-water contact (REC-2), and shellfish harvesting (SHELL) beneficial uses. To determine existing bacteria loads and assign TMDLs to these multiple impaired waterbodies, a regional watershed-based approach was developed. This approach is consistent with the methodologies used for bacteria TMDL development for impaired coastal areas of the Los Angeles Region, specifically the Santa Monica Bay beaches (LARWQCB, 2002) and Malibu Creek (LARWQCB, 2003). This project is confined to beaches and creeks. Large lagoons and adjacent shoreline areas and embayments are not addressed in this project.

In preparing the TMDLs, a distinction was made between wet and dry weather because, although the sources of bacteria are the same, the method of delivery of bacteria to the receiving waterbodies vary between the two conditions. During wet weather, the sources of bacteria are transported by wash-off of loads accumulated on the land surface. During rain events, these bacteria loads are delivered to the waterbody via creeks and stormwater collection systems. In dry weather, bacteria loads are transported to surface waters through other mechanisms, such as runoff from lawn irrigation or pavement cleaning. Sources of bacteria during wet and dry weather vary widely and include aquatic and terrestrial wildlife and pets, and anthropogenic sources such as sewer line breaks, and illegal sewage disposal from boats along the coastline.

3.1 Project Area Description

The impaired waters addressed in this analysis are in southern California, primarily in Orange and San Diego Counties. The beaches and creeks that are threatened and impaired because of elevated bacteria levels are located within or hydraulically downstream of five watersheds in Orange County (with a small portion in Riverside County) (Figure 3-1) and eight watersheds in San Diego County (Figure 3-2). Table 3-1 lists the watersheds that affect the bacteria-impaired waterbodies in the region. Most of the waterways flow directly to the Pacific Ocean, except Chollas Creek, which flows to San Diego Bay. The combined watersheds cover roughly 1,730 square miles (4,480 square kilometers).

The climate in the region is generally mild with annual temperatures averaging around 65°F near the coastal regions. Annual average rainfall ranges from 9 to 11 inches along the coast to more than 30 inches in the eastern mountains. There are two distinct climatic periods: a dry period from late April to mid-October and a wet period from mid-October through late April. The wet period provides 85 to 90 percent of the annual rainfall (County of San Diego, 2000).

The land use of the region is highly variable. The coastline areas are highly concentrated with urban and residential land uses, and the inland areas primarily consist of open space. Most of the contributing area is open space or recreational land use (64.2 percent), followed by low-density residential (14.1 percent) and agriculture/livestock (12.4 percent) land uses. Other major land uses are commercial/institutional (3.0 percent), high-density residential (2.2 percent), industrial/transportation (1.6 percent), military (1.0 percent), transitional (0.8 percent), and water (0.7 percent) (Appendix B, No.25).

3.2 Impairment Overview

The waterbodies included in this project were listed as impaired primarily because of non-attainment of the bacteria water quality objectives associated with contact recreation. The beaches were listed as impaired because the total coliform (TC), fecal coliform (FC), and/or enterococci (ENT) bacteria water quality objectives were exceeded based on shoreline monitoring data (Appendix B). For more information regarding the methodology for listing beaches for bacteria during the 2002 update of the List of Water Quality Limited Segments, see Appendix C.

For this study, a regionalized watershed-based approach was developed to calculate bacteria loadings for the majority of the Regional Board's impaired shoreline and creek segments. Although seven coastal lagoons are also listed as impaired because of bacteria, the approach outlined in this document is not applicable for calculation of TMDLs for those waterbodies. Table 3-1 lists the impaired waterbodies addressed in this study. . The drainage areas of many of the watersheds that affect shoreline impairments are located above more than one impaired beach segment. Table 3-1 lists the watersheds (shown in Figures 3-1 and 3-2) that affect impaired waterbodies due to bacteria loadings. Appendix A provides a more detailed list of the waterbodies included in this project, including waterbody segment names and impaired miles.

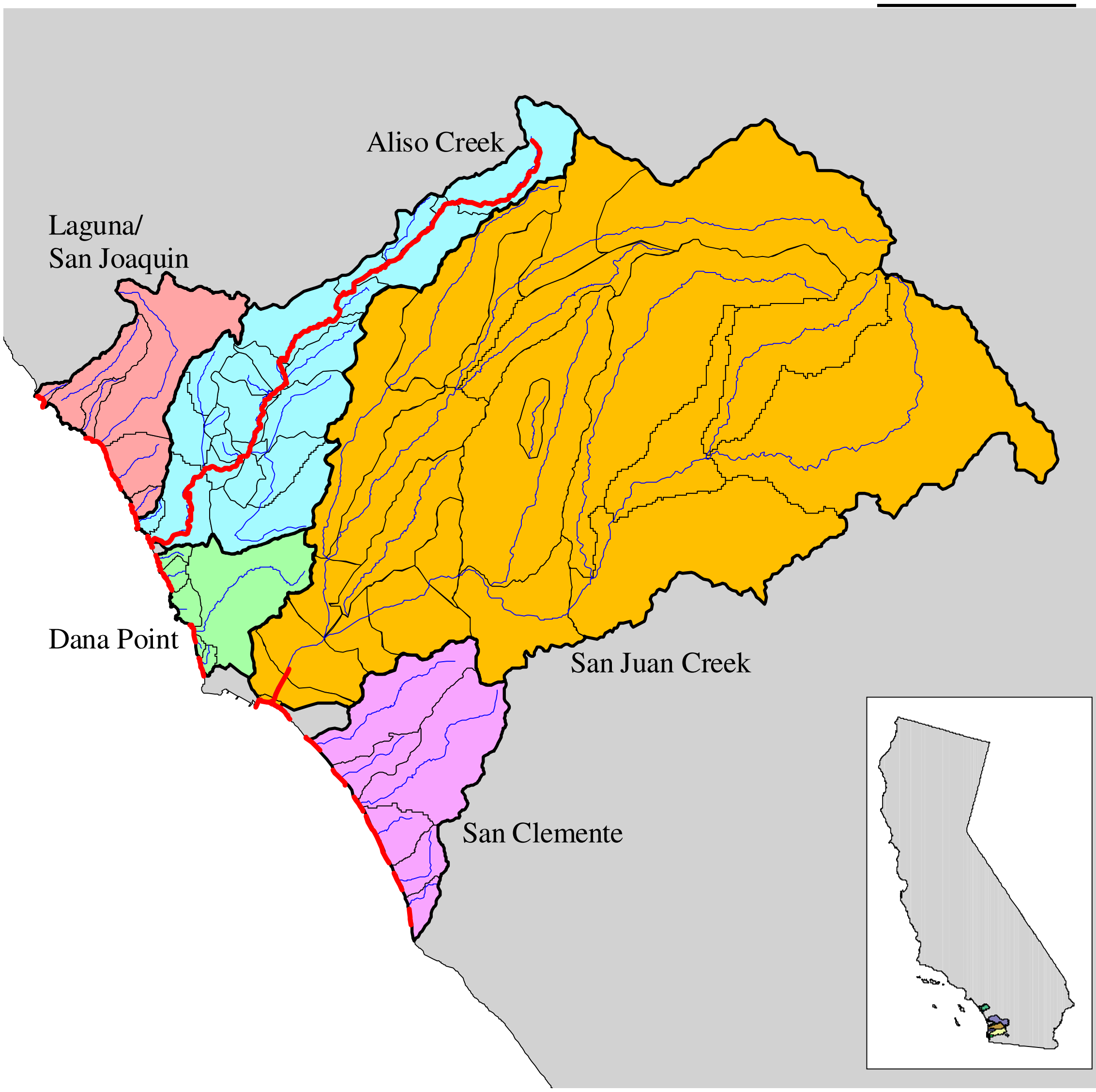

Figure 3-1. Watersheds of interest in Orange County.

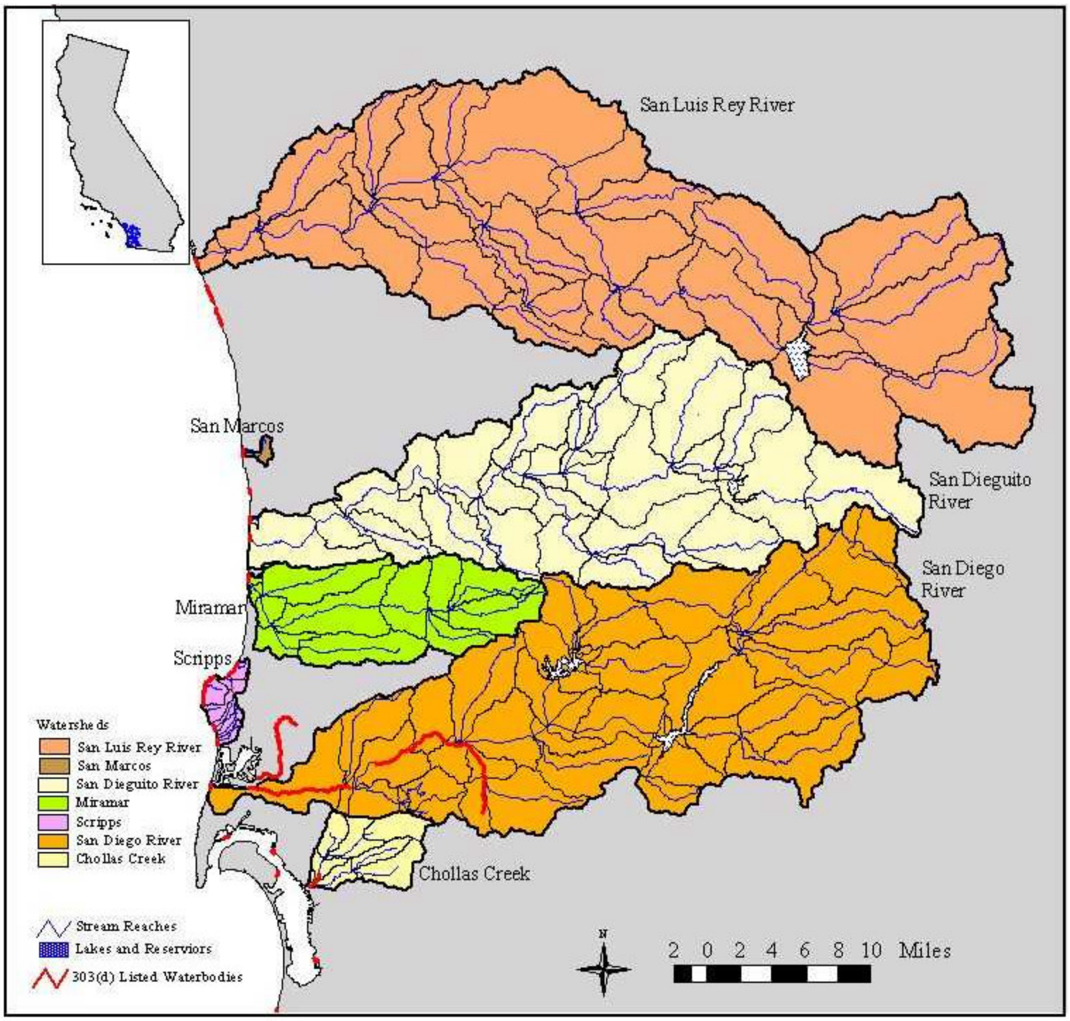

Figure 3-2. Watersheds of interest in San Diego County.

Table 3-1. Bacteria-Impaired Water Quality Limited Segments Addressed in This Analysis

Watershed	Type of Listing	Waterbody Name [a]	Drainage Area (mi^2)[b]
Laguna/San Joaquin	Shoreline	Pacific Ocean Shoreline, Laguna Beach HSA, San Joaquin Hills HSA	13.94
Aliso Creek	Creek, Shoreline	Aliso Creek, Aliso Creek (mouth), Pacific Ocean Shoreline, Aliso HSA	35.74
Dana Point	Shoreline	Pacific Ocean Shoreline, Dana Point HSA (Salt Creek)	8.89
San Juan Creek	Creek	Lower San Juan HSA	177.18
San Clemente	Shoreline	Pacific Ocean Shoreline, San Clemente HA	18.78
San Luis Rey River	Shoreline	Pacific Ocean Shoreline, San Luis Rey HU	560.42 (354.12)
San Marcos	Shoreline	Pacific Ocean Shoreline, San Marcos HA	1.43
San Dieguito River	Shoreline	Pacific Ocean Shoreline, San Diequito HU (Bell Valley)	346.22 (292.24)
Miramar	Shoreline	Pacific Ocean Shoreline, Miramar Reservoir HA	93.73
Scripps	Shoreline	Pacific Ocean Shoreline, Scripps HA	8.75
San Diego River	Creek, Shoreline	Forester Creek, San Diego River (Lower), Pacific Ocean Shoreline, San Diego HU	436.48 (173.95)
Chollas Creek	Creek	Chollas Creek	26.80

Note: HSA = hydrologic subarea; HA = hydrologic area; HU = hydrologic unit
[a] Listed as impaired for exceedances of FC, and/or TC, and/or ENT.
[b] The drainage area associated with the dry weather TMDLs are in parenthesis. The drainage areas associated with the wet weather TMDLs are without parenthesis. Some areas impound runoff during dry periods because these watersheds are above large reservoirs and lakes.

3.3 Applicable California Water Quality Standards

Water quality standards consist of water quality objectives and beneficial uses. Water quality objectives are defined under CWC Section 13050(h) as "limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water." Under Section 304(a)(1) of the CWA, the United States Environmental Protection Agency (USEPA) is required to publish water quality criteria that incorporate ecological and human health assessments based on current scientific information. Water quality objectives must be based on scientifically sound water quality criteria, and be at least as stringent as those criteria.

The *San Diego Regional Water Quality Control Plan* (Basin Plan) identifies beneficial uses and water quality objectives for each waterbody. Table 3-2 lists the beneficial uses for each of the impaired inland segments and the Pacific shoreline. The beneficial use designations are as follows:

- Municipal and domestic supply (MUN)
- Agricultural supply (AGR)
- Industrial process supply (PROC)
- Industrial water supply (IND)
- Ground water recharge (GWR)
- Freshwater replenishment (FRSH)
- Navigation (NAV)
- Hydropower generation (POW)
- Water contact recreation (REC-1)
- Non-contact recreation (REC-2)
- Commercial and sport fishing (COMM)
- Aquaculture (AQUA)
- Warm freshwater habitat (WARM)
- Cold freshwater habitat (COLD)
- Inland saline water habitat (SAL)
- Estuarine habitat (EST)
- Marine habitat (MAR)
- Wildlife habitat (WILD)
- Preservation and enhancement of "Areas of Special Biological Significance" (BIOL)
- Rare and endangered species (RARE)
- Migration of aquatic organisms (MIGR)
- Spawning, reproduction, and/or early development (SPWN)
- Shellfish harvesting (SHELL)

The REC-1 water quality objectives for bacterial indicators applicable in the San Diego Region are contained in the Ocean Plan and Basin Plan. The objectives contained in both are derived from water quality criteria promulgated by the USEPA in 1976 and 1986. Both the Ocean Plan and Basin Plan contain REC-1 objectives for TC, FC, and ENT, and SHELL objectives for TC. For a complete discussion of WQOs for each beneficial use and each type of waterbody, see Appendix D.

Although WQOs are written in terms of concentration of bacteria indicator colonies, non-attainment of beneficial uses is actually caused by the presence of disease-causing pathogens. At present, measuring pathogens directly is difficult, and for this reason high concentrations of indicator bacteria are used to indicate the presence of pathogens. For a complete discussion of the use of bacteria indicators to measure water quality and the presence of pathogens, see Appendix E.

Table 3-2. Beneficial Uses of the Impaired Waters

Waterbody Type	Waterbody	Designated Uses
Creek	Aliso Creek	MUN,[a] AGR, REC-1,[b] REC-2, WARM, WILD
Creek	San Juan Creek	MUN,[a] AGR, IND, REC-1, REC-2, WARM, COLD, WILD
Creek	Forrester Creek	MUN,[b] IND, REC-1, REC-2, WARM, WILD
Creek	San Diego River, Lower	MUN,[a] AGR, IND, REC-1, REC-2, WARM, WILD, RARE
Creek	San Diego River, Lower	MUN,[b] IND, REC-1, REC-2, WARM, WILD, RARE
Creek	Chollas Creek	MUN,[a] REC-1,[b] REC-2, WARM, WILD
Coastal water	Pacific Ocean Shoreline	IND, NAV, REC-1, REC-2, COMM, BIOL, WILD, RARE, MAR, AQUA, MIGR, SPWN, SHELL

[a] The waterbody is exempted by the Regional Board under terms and conditions of State Board Resolution 88-63, *Sources of Drinking Water* Policy.
[b] This use is listed as a potential beneficial use.

Source: SDRWQCB, 1994.

4 Numeric Target Selection

When calculating TMDLs, numeric targets are established to meet water quality objectives and ensure the protection of beneficial uses. TMDLs were calculated for each impaired waterbody, for each bacteria indicator, for wet and dry conditions, and for interim and final phases of the project. The numeric targets used in the TMDL calculations were equal to the different WQOs for the bacteria indicators (total coliform TC, fecal coliform FC, and enterococci ENT) for either REC-1 or SHELL beneficial uses depending on the indicator and/or waterbody. The numeric targets selected in the TMDL analysis depended partly on whether the impaired water body was a beach, a creek tributary to an impaired beach, or a creek not tributary to an impaired beach. The reason that somewhat different targets were needed for these three scenarios is because the Ocean Plan contains total coliform WQOs for SHELL and REC-1 beneficial uses at beaches, while the Basin Plan does not assign SHELL uses to inland surface waters, and the REC-1 beneficial use for inland surface waters does not have a total coliform WQO.

Different dry weather and wet weather numeric targets were used because the bacteria transport mechanisms are different under wet and dry conditions. Single sample maximum WQOs were used as wet weather numeric targets because wet weather, or storm flow, is episodic and short in duration, and characterized by rapid wash-off and transport of very high bacteria loads from all land use types to receiving waters. On the other hand, geometric mean WQOs were used as numeric targets for dry weather periods because dry weather runoff is generated mostly from irrigation runoff, is not uniformly linked to every land use, and is more steady state in nature, with lower flows, lower loads, and slower transport, making die-off and/or amplification processes more important.

For impaired beaches, the numeric targets were equal to the total coliform, fecal coliform and enterococci WQOs for REC-1 beneficial uses in all cases except for the final numeric targets for total coliform. In this case the SHELL WQO was used because it is lower than the REC-1 WQO for total coliform. Wet weather numeric targets were equal to the single sample maximum WQOs, while dry weather targets were equal to the geometric mean WQOs.

The same numeric targets were used for the impaired creeks tributary to impaired beaches (Aliso Creek and San Diego River). Even though these creeks are not designated with SHELL beneficial uses and there is no REC-1 objective for total coliform for inland surface waters in the Basin Plan, numeric targets for total coliform were selected for TMDL calculations for these creeks to ensure that the REC-1 and SHELL beneficial uses will be protected at the impaired downstream beach. For creeks with no immediate downstream impaired beaches (San Juan Creek,[1] Chollas Creek, and Forrester Creek), numeric targets were selected for fecal coliform and enterococci only.

4.1 Reference Watershed Approach

Another difference between the wet weather and dry weather TMDL calculations, besides the use of single sample maximum WQOs versus geometric mean WQOs, is that the wet weather

[1] San Juan Creek drains to an impaired lagoon, which drains to an impaired beach. The lagoon and adjacent beach are being addressed in a separate TMDL project. Therefore, numeric targets based on WQOs for SHELL beneficial uses are not needed for this waterbody to protect SHELL uses at the downstream beach.

interim targets are implemented in the TMDL by allowing a 22 percent exceedance frequency of the single sample WQOs for REC-1. The purpose of the exceedance frequency is to account for the natural, and largely uncontrollable sources of bacteria (e.g., bird and wildlife feces) in the wet weather loads generated in the watersheds which can, by themselves, cause exceedances of WQOs. Twenty-two percent is the frequency of exceedance of the single sample maximum WQO measured in a reference watershed in Los Angeles County. The reference watershed approach was developed by the Los Angeles Regional Board, and is included in its Basin Plan as an implementation policy for single sample bacteria WQOs.[2] A reference watershed is one that is minimally impacted by anthropogenic activities. The reference watershed approach also incorporates antidegradation principles in that, if water quality is better than that of the reference watershed in a particular location, no degradation of existing bacteriological water quality is permitted.

Although a reference watershed exceedance frequency for the San Diego Region based on a watershed in the Region has not been developed, the need to use the approach in these bacteria TMDLs was demonstrated by evaluating data from the mouth of San Mateo Creek and from San Onofre State Beach (Figure 4-1). Most of the San Mateo Creek watershed is open space (95 percent); minor areas are associated with agriculture (2 percent) and low-density residential (1 percent). The remaining land uses, which contribute less that two percent of the total area, include high-density residential, commercial/institutional, industrial/transportation, parks/recreation, open recreation, horse ranches, and transitional. The watershed behind San Onofre State Beach is likewise mostly open space.

Water quality data (Table 4-1) from San Mateo Creek and San Onofre State Beach show that single sample WQOs for FC, TC, and ENT are exceeded at a high enough frequency (from 17 to 50 percent depending on the indicator) to justify the use of the reference watershed approach to account for background bacteria loads in the TMDLs. The County of San Diego Department of Environmental Health (DEH) collected bacteria data at two stations located near the mouth of San Mateo Creek from 1999 through 2002 (Appendix B, No. 16). The monitoring data were separated based on their association with wet or dry conditions to better understand bacteria concentration variability during wet weather runoff verses dry weather runoff. The wet period was defined to be consistent with DEH's General Advisory to avoid contact with ocean and bay water within 300 feet on either side of any storm drain, river, or lagoon outlet. A wet period is specifically defined as 72 hours after 0.2 inch or more of rain. For each monitoring station, sampling dates were compared to rainfall data collected at the closest rainfall gage (ALERT21) to determine whether bacteria samples had been collected during wet or dry periods (Appendix B, No. 23). Once the data for all stations were designated as wet or dry samples, they were compared to single sample WQOs for FC, TC, and ENT at each station (Tables 4-1).

[2] The Los Angeles Regional Board used the Arroyo Sequit Watershed as the reference watershed for development of TMDLs for the Santa Moncia Bay beaches and Malibu Creek (LARWQCB, 2002 and 2003). This watershed, consisting primarily of natural land use (98 percent open space), discharges to Leo Carillo Beach, where 22 percent of wet-weather fecal coliform data (10 out of 46 samples) were observed to exceed the WQOs).

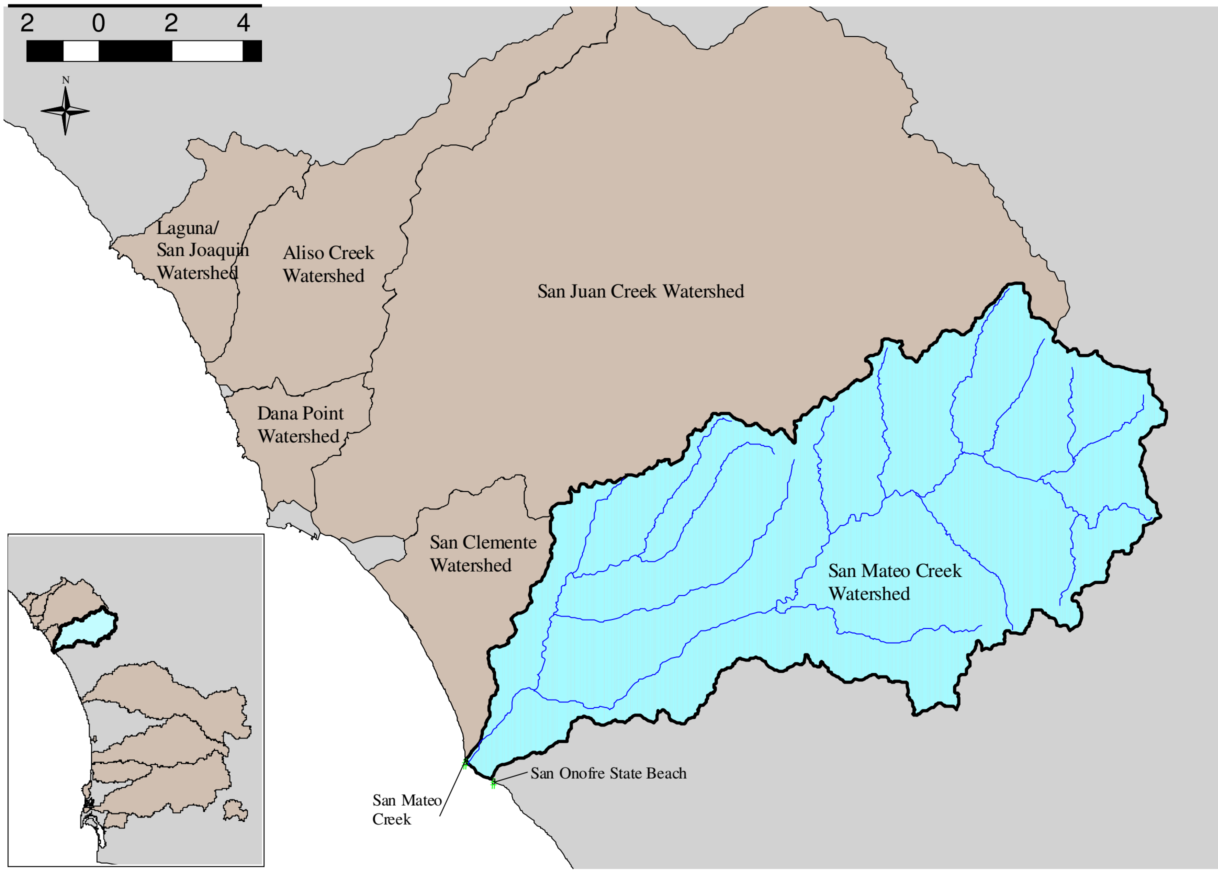

Figure 4-1. San Mateo watershed and San Onofre State Beach.

The final wet weather numeric targets cannot be implemented using the reference watershed approach because the Basin Plan for the San Diego Region does not contain a reference watershed implementation policy. A reference watershed implementation policy for bacteriological indicators is one of the Basin Planning projects being developed by the Regional Board.[3] If the Basin Plan is amended to include a reference watershed policy in the future, the final wet weather targets can be implemented using the reference watershed approach and the final TMDLs recalculated.

Implementing the dry weather numeric targets with a reference watershed approach is not necessary. Water quality data from the mouth of San Mateo Creek and San Onofre State Beach (Table 4-2) indicate that exceedances of WQOs during dry weather conditions are uncommon in these relatively undeveloped watersheds. Therefore, WQOs are sufficient for use as dry weather TMDL targets.

[3] This basin planning project ranked seventh on the 2004 Triennial Review list of priority projects.

Table 4-1. Reference Watershed Wet Weather Exceedances

Site ID	Location	Number of wet weather samples	Number of wet weather exceedances	Wet weather exceedance probability
Fecal Coliform				
EH-520	San Mateo Creek	6	2	33%
EH-510	San Onofre State Beach	5	2	40%
Total Coliform				
EH-520	San Mateo Creek	6	1	17%
EH-510	San Onofre State Beach	5	1	20%
Enterococcus				
EH-520	San Mateo Creek	6	3	50%
EH-510	San Onofre State Beach	5	2	40%

Table 4-2. Reference Watershed Dry Weather Exceedances

Site ID	Location	Number of dry weather samples	Number of dry weather exceedances	Dry weather exceedance probability
Fecal Coliform				
EH-520	San Mateo Creek	101	0	0%
EH-510	San Onofre State Beach	72	0	0%
Total Coliform				
EH-520	San Mateo Creek	100	0	0%
EH-510	San Onofre State Beach	72	0	0%
Enterococcus				
EH-520	San Mateo Creek	101	3	3%
EH-510	San Onofre State Beach	72	1	1%

4.2 Dry-Weather Targets

For beaches, the **interim** dry weather numeric targets are: fecal coliform: 200/100 mL, total coliform: 1,000/100 mL, enterococci: 35/100 mL (30-day geometric mean in all instances). The **final** dry weather numeric targets are fecal coliform: 200/100 mL, total coliform: 70/100 mL, enterococci: 35/100 mL (30-day geometric mean in all instances).

For Aliso Creek and the San Diego River, the **interim** dry weather numeric targets are fecal coliform: 200/100 mL, total coliform: 1,000/100 mL, enterococci: 33/100 mL (30-day geometric mean in all instances). The **final** numeric targets are fecal coliform: 200/100 mL, total coliform: 1,000/100 mL, enterococci: 33/100 mL (30-day geometric mean in all instances).

For Chollas, San Juan, and Forrester Creeks, the **interim** dry weather numeric targets are fecal coliform: 200/100 mL, enterococci: 33/100 mL (30-day geometric mean in all instances). The **final** numeric targets are fecal coliform: 200/100 mL, enterococci: 33/100 mL (30-day geometric mean in all instances).

4.3 Wet-Weather Targets

For beaches, the **interim** wet weather numeric targets are fecal coliform: 400/100 mL, total coliform: 10,000/100 mL, enterococci: 104/100 mL (these are single sample maximum values that can be exceeded 22 percent of the time). The **final** wet weather numeric targets are fecal coliform: 400/100 mL, total coliform: 230/100 mL, enterococci: 104/100 mL (single sample maximums in all instances).

For Aliso Creek and the San Diego River, the **interim** wet weather numeric targets are fecal coliform: 400/100 mL, total coliform: 10,000/100 mL, enterococci: 61/100 mL (these are single sample maximum values that can be exceeded 22 percent of the time). The **final** numeric targets are fecal coliform: 400/100 mL, total coliform: 10,000/100 mL, enterococci: 61/100 mL (single sample maximums in all instances).

For Chollas, San Juan, and Forrester Creeks, the **interim** wet weather numeric targets are fecal coliform: 400/100 mL, enterococci: 61/100 mL (these are single sample maximum values that can be exceeded 22 percent of the time). The **final** numeric targets are fecal coliform: 400/100 mL, enterococci: 61/100 mL (single sample maximums in all instances).

5 Data Inventory and Analysis

Data from numerous sources were used to characterize the watersheds and water quality conditions, identify bacteria sources, and support the calculation of TMDLs for the watersheds (Appendix B). No new data were collected as part of this effort. The data analysis provided an understanding of the conditions that result in impairments.

5.1 Data Inventory

The categories of data used in developing these TMDLs include physiographic data that describe the physical conditions of the watershed and environmental monitoring data that identify past and current conditions and support the identification of potential pollutant sources. Table 5-1 presents the various data types and data sources used in the development of these TMDLs. The following sections describe the key data sets used for TMDL development.

5.1.1 Water Quality Data

Monitoring data for the impaired beaches were received from a number of agencies in San Diego and Orange County. Data were received for 52 locations monitored along listed shorelines, in addition to 7 unimpaired shoreline locations (Figures 5-1 and 5-2) (Appendix B, No. 15-20). Bacteria data (including FC, TC, and ENT) were collected at various times from 1999 through 2002, and the amount of data varied among monitored locations. Most locations had FC, TC, and ENT data for assessment of existing conditions.

Special studies were conducted for Aliso Creek and San Juan Creek (SDRWQCB, 2002b) by the Orange County Public Facilities and Resources Department and the Orange County Public Health Laboratory, respectively (Figure 5-3) (Appendix B, No. 4&6). The City of San Diego conducted studies of Rose Creek and Tecolote Creek (Figure 5-4 data were collected in 2001—2002, and the project is scheduled for completion in June 2004) (Appendix B, No. 5). For each of the studies, multiple bacteria samples were collected throughout the year at stations throughout the watersheds and along several tributaries.

In addition, monitoring data were obtained for the following five rivers or creeks from various entities in the region: San Diego River (Padre Dam Municipal Water District), San Mateo Creek (Southwest Division Naval Facilities Engineering Command), Santa Margarita River (Southwest Division Naval Facilities Engineering Command), and San Luis Rey River (City of Oceanside)) (Appendix B).

Water quality data from six major inland dischargers • five at Camp Pendleton and one on Murrietta Creek (Santa Rosa Water Reclamation Facility)—were obtained. All these sources are in the Santa Margarita River watershed. Discharge data for inland outfalls to streams are limited to the period prior to 2002, after which these major inland discharges were either discontinued or diverted to ocean outfalls.

Table 5-1. Inventory of Data and Information Used for the Source Assessment of Bacteria

Data Set	Type of Information	Data Source(s)
Watershed physiographic data	Location of dams	USEPA BASINS
	Stream network	USEPA BASINS (Reach File, Versions 1 and 3); USGS National Hydrography Dataset (NHD) reach file; special studies of Aliso Creek, Tecolote Creek, and Rose Creek.
	Land use	USGS MRLC (1993); San Diego Regional Planning Agency – 2000 land use coverage for San Diego County (SANDAG); Southern California Association of Governments (SCAG) land use coverage of Orange and portions of Riverside Counties (1993)
	Counties	USEPA BASINS
	Cities/populated places	USEPA BASINS, U.S. Census Bureau's Tiger Data
	Soils	USEPA BASINS (USDA-NRCS STATSGO)
	Watershed boundaries	USEPA BASINS (8-digit hydrologic catalogoing unit); CALWTR 2.2 (1995)
	Topographic and digital elevation models (DEMs)	USEPA BASINS; USGS
Environmental monitoring data	Water quality monitoring data	USEPA's STORET; California Department of Environmental Health; County of San Diego Department of Environmental Health; Orange County Pubic Facilities and Resources Department; City of San Diego; City of Oceanside; Orange County Public Health Laboratory, Regional Board; Padre Dam Municipal Water District; Southwest Division Naval Facilities Engineering Command
	Streamflow data	USGS; Orange County Public Facilities and Resources Department; City of San Diego
	Meteorological station locations	BASINS; National Oceanic and Atmospheric Administration - National Climatic Data Center (NOAA-NCDC); California Irrigation Management Information System (CIMIS); California Department of Water Resources, Division of Flood Management; ALERT (Automatic Local Evaluation in Real-Time) Flood Warning System

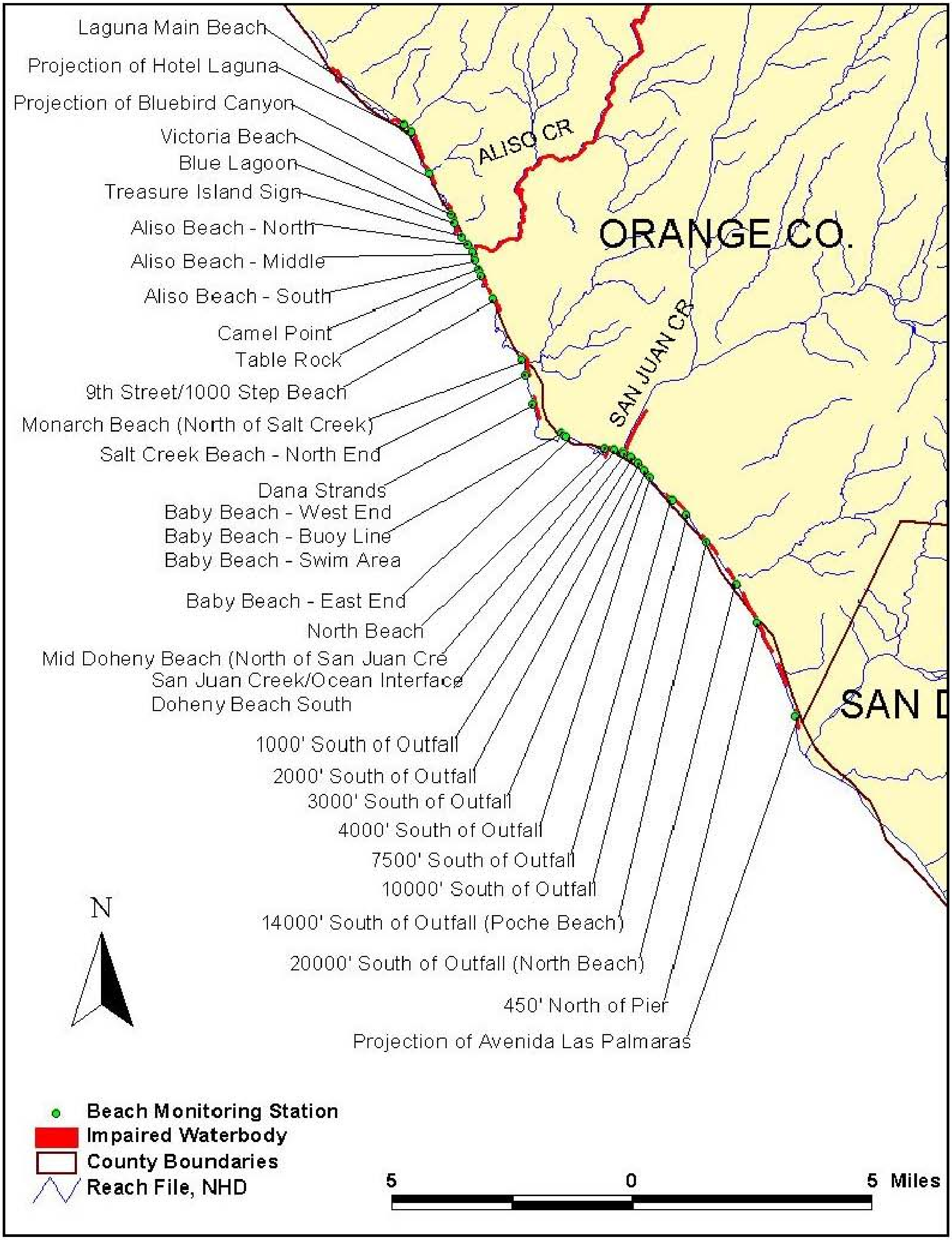

Figure 5-1. Beach monitoring station locations in Orange County.

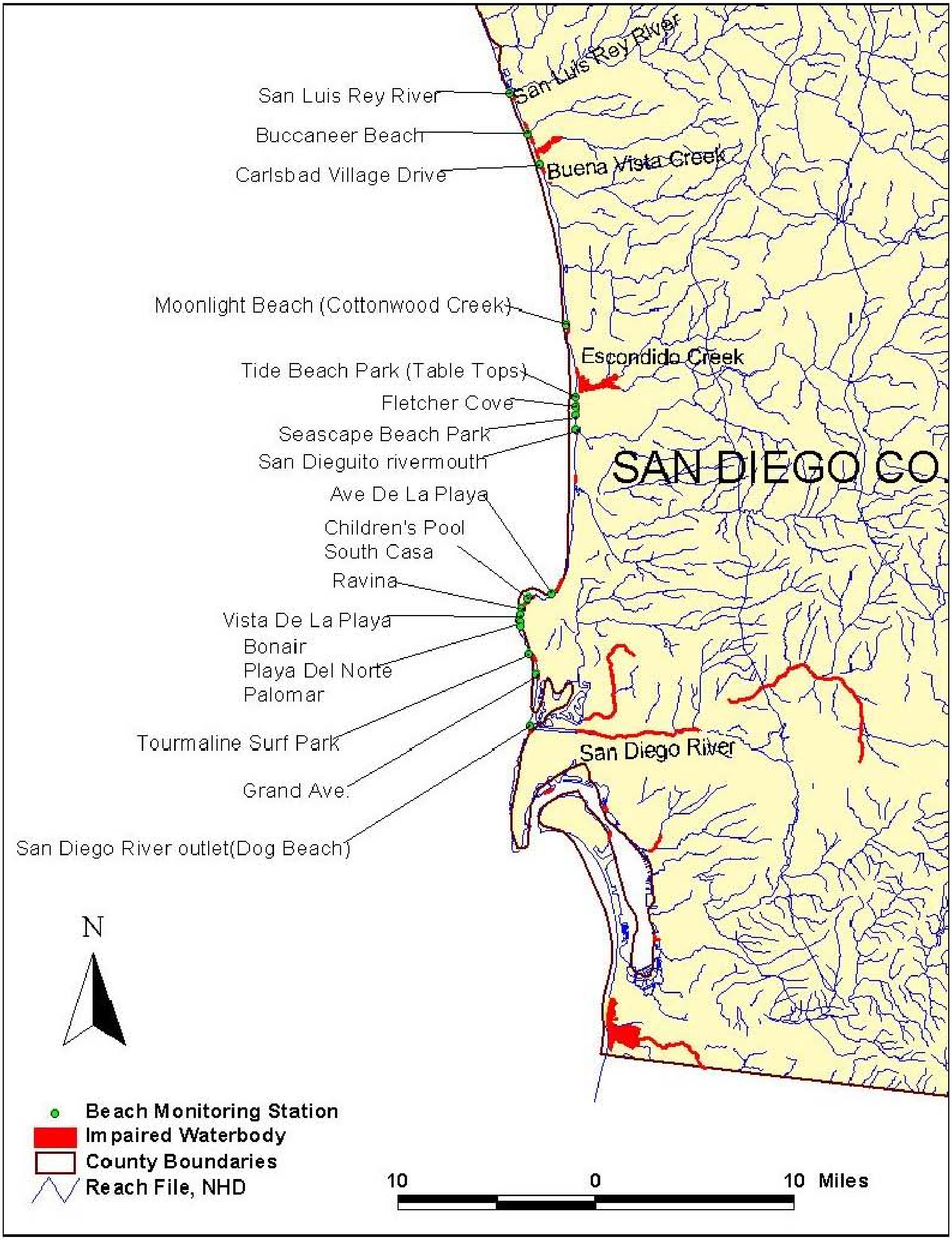

Figure 5-2. Beach monitoring station locations in San Diego County.

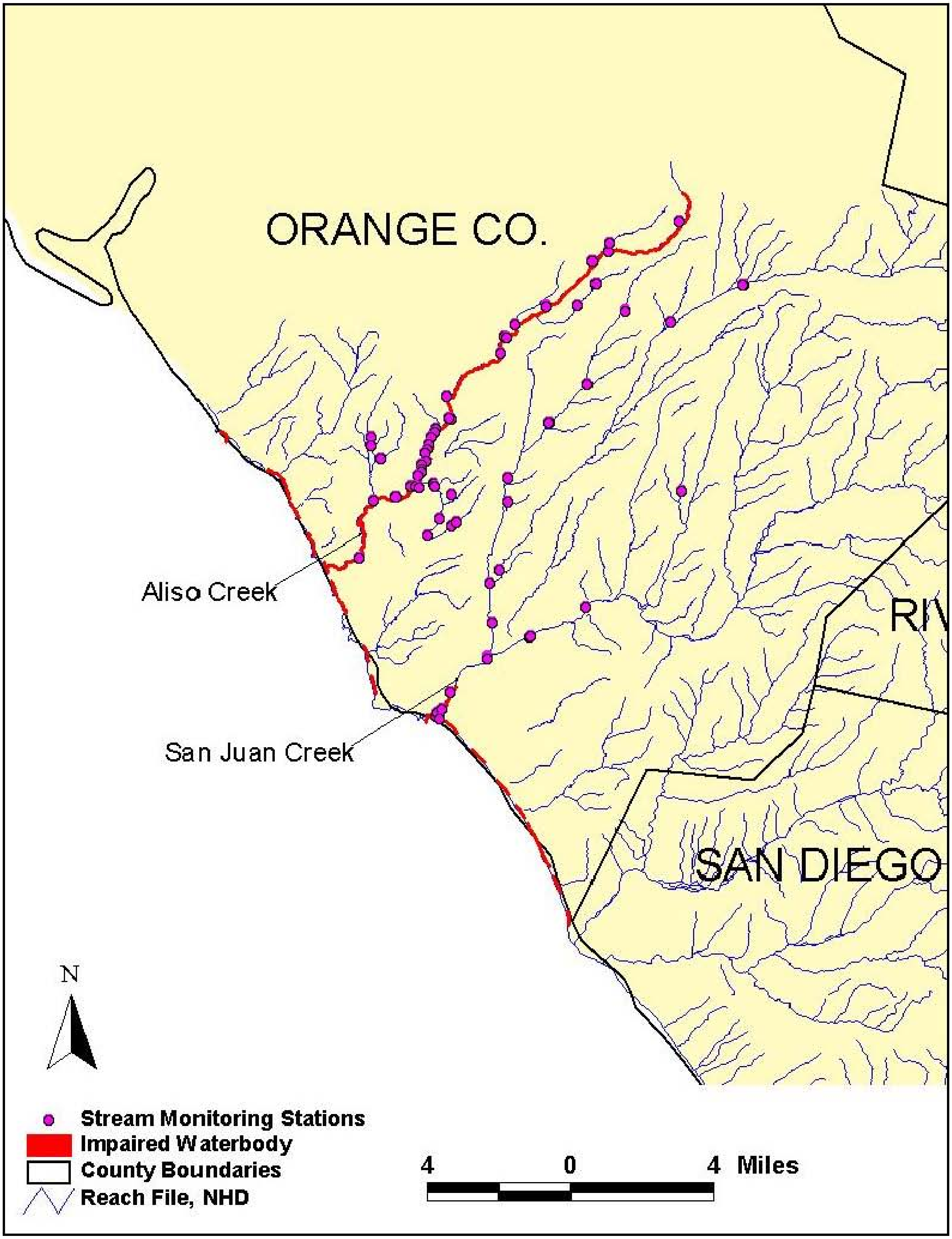

Figure 5-3. Bacteria monitoring stations on Aliso Creek and San Juan Creek.

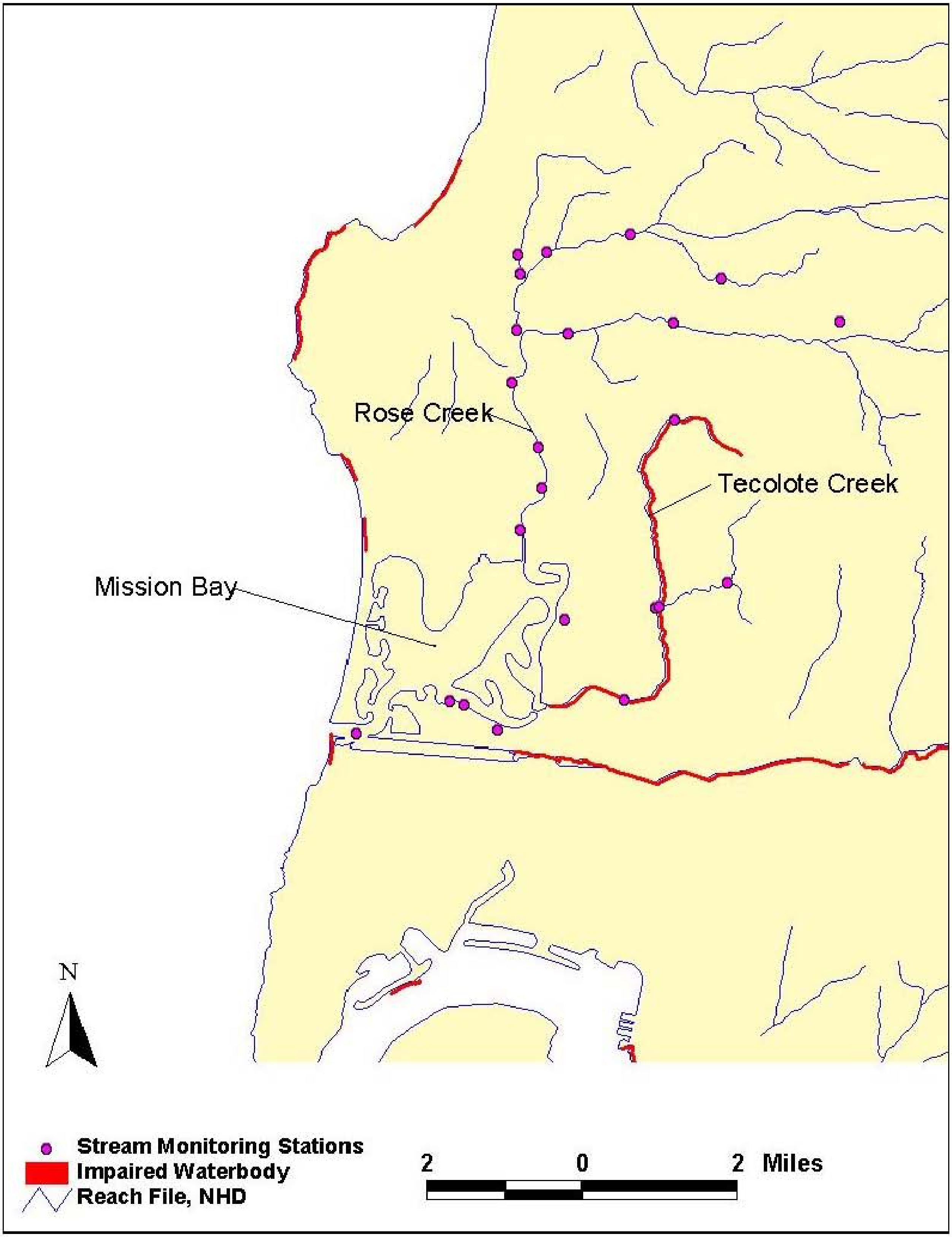

Figure 5-4. Bacteria monitoring stations on Rose Creek and Tecolote Creek.

5.1.2 Waterbody Characteristics

The assessment of waterbody characteristics involved analyzing streamflow data and assessing physical information. This information was used to determine the volume and hydraulic features of waterbodies for determining assimilative capacity and physical processes that affect bacteria transport for TMDL analysis.

A limited amount of streamflow data for the listed segments was available. The Aliso Creek, Rose Creek, and Tecolote Creek watersheds had streamflow information associated with special studies performed for the assessment of bacteria loading characteristics (see Section 5.1.1). In addition, U.S. Geological Survey (USGS) with recent streamflow records gages were identified in the study area (Table 5-2). Historical streamflow data and data for stream channel geometry (width and depth) for these gages were obtained from USGS (Appendix B, No. 3).

Table 5-2. USGS Streamflow Gages in the San Diego Region with Recent Data

Station Number	Station Name	Historical Record
11022480	San Diego River at Mast Road near Santee, CA	5/1/1912–9/30/2002
11023000	San Diego River at Fashion Valley at San Diego, CA	1/18/1982–9/30/2002
11023340	Los Penasquitos Creek near Poway, CA	10/1/1964–9/30/2002
11025500	Santa Ysabel Creek near Ramona, CA	2/1/1912–9/30/2002
11028500	Santa Maria Creek near Ramona, CA	12/1/1912–9/30/2002
11042000	San Luis Rey River at Oceanside, CA	10/1/1912–11/10/1997; 4/29/1998–9/30/2002
11042400	Temecula Creek near Aguanga, CA	8/1/1957–9/30/2002
11044300	Santa Margarita River at FPUD Sump near Fallbrook, CA	10/1/1989–9/30/2002
11046000	Santa Margarita River at Ysidora, CA	3/1/1923–2/25/1999; 10/1/2001–9/30/2002
11046530	San Juan Creek at La Novia Street Bridge near San Juan Capistrano, CA	10/1/1985–9/30/2002
11047300	Arroyo Trabuco near San Juan Capistrano, CA	10/1/1970–9/30/1989; 10/1/1995–9/30/2002
11022350	Forester Creek near El Cajon, CA	10/1/1993–9/30/2002
11039800	San Luis Rey River at Couser Canyon Bridge near Pala, CA	10/1/1986–1/4/1993

5.1.3 Meteorological Data

Hourly rainfall data were obtained from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA). To augment the NCDC data, hourly rainfall data were also obtained from the California Irrigation Management Information System (CIMIS); California Department of Water Resources, Division of Flood Management;

and the Automatic Local Evaluation in Real-Time (ALERT) Flood Warning System. In addition, hourly evapotranspiration data were obtained from CIMIS (Appendix B, No. 21-23).

5.1.4 Land Characteristic Data

Available land use data to support this study included the 1993 USGS Multi-Resolution Land Characteristic (MRLC) data, which were available for the entire study area. The San Diego Regional Planning Agency (SANDAG) had a more detailed and recent 2000 land use data set that covers San Diego County. For Orange County and portions of Riverside County, land use data were obtained from the Southern California Association of Governments (SCAG). A combination of MRLC, SANDAG, and SCAG data was used to provide the most complete and up-to-date land use representation of the region (Appendix B, No. 25).

In addition, soil data were obtained from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) State Soil Geographic (STATSGO) database and topographic information was obtained from USEPA's Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) system (Appendix B, No. 26).

5.2 Review of Impairments

Bacteria data collected from beach and creek segments were analyzed to provide guidance for the source assessment. Results of these analyses are reported in the following sections.

5.2.1 Beach Impairments

Bacteria monitoring data for beach stations (Appendix B, No. 15-20) were analyzed to provide insight into the spatial extent of impairment and the timing of any exceedances of WQOs. Results of this analysis were also used in the source assessment to identify the proximity of listed coastal segments to tributaries, outfalls, and other potential sources (see Section 6). Monitoring data were reviewed based on their association with wet or dry conditions to better understand variability during periods when methods of transport differ (wet weather runoff versus dry weather runoff). The wet period was defined to be consistent with the San Diego County Department of Environmental Health's (DEH) General Advisory to avoid contact with ocean and bay water within 300 feet on either side of any storm drain, river, or lagoon outlet, and it is designated as 72 hours after 0.2 inch or more of rain. For each monitoring station, sampling dates were compared to rainfall data collected at the closest rainfall gage to determine whether bacteria samples had been collected during wet or dry periods. Once the data for all stations were identified as wet or dry, the number of exceedances of single sample WQOs was quantified for FC, TC, and ENT at each station (not enough data were available for assessment of compliance to 30-day geometric mean WQOs for wet weather).

To assess the spatial variability of bacteria levels during both wet and dry conditions, the exceedance frequency of the REC-1 (FC and ENT) and SHELL (TC) single sample WQO for each station is shown in Figures F-1 through F-6 of Appendix F. Results show that at some locations, bacteria concentrations frequently exceed the WQOs for indicator bacteria. The frequency of exceedances varies for each indicator bacteria, location, and wet or dry weather conditions. Also, higher exceedance frequencies are observed in the vicinity of creeks or lagoons and major stormwater outfalls, especially at the mouths of those creeks and lagoons listed as impaired due to bacteria.

5.2.2 Creek Impairments

The analysis of beach monitoring data confirms that the highest number of exceedances of WQOs was in the vicinity of rivers, major stormwater outfalls, and known local sources (e.g., waterfowl at lagoons) (Appendix B, No. 15-20). This analysis is important in review of creek impairments because high numbers of exceedances were observed at the mouths of Aliso Creek, San Juan Creek, and the San Diego River. Tables 5-3 through 5-5 list the number of monitoring stations and observed data, ranges of indicator bacteria levels observed, and exceedance frequencies of WQOs in the watershed of each impaired creek addressed in this TMDL where data were available (Appendix B, No. 4, 6, 10, 11, 13, & 14), and respective indicator bacteria were listed as the pollutant/stressor (see Appendix A). For each impaired watershed, exceedances of WQOs were observed. Although the data represent water quality measurements in freshwater systems (creeks), the WQOs associated with marine waters were used to tally the number of exceedances. This is because Tables 5-3 through 5-5 are included for illustrative purposes—demonstrating that high bacteria counts in the watershed generally lead to high bacteria counts downstream, at the shoreline.

Table 5-3. Summary of Fecal Coliform Data for Impaired Creeks

Stream	Number of Monitoring Stations	Total Number of Samples	Fecal Coliforms (MPN/100mL)			Frequency of Exceedance of WQOs
			Minimum	Mean	Maximum	
Aliso Creek	108	8,816	2	10,739	684,600	77%
San Diego River	6	36	2	1,557	24,000	36%
San Juan Creek	31	357	10	5,680	350,000	58%

Table 5-4. Summary of Total Coliform Data for Impaired Creeks

Stream	Number of Monitoring Stations	Total Number of Samples	Total Coliform (MPN/100 mL)			Frequency of Exceedance of WQOs
			Minimum	Mean	Maximum	
Aliso Creek	108	8,815	2	40,750	878,400	55%
San Diego River	6	34	300	14,885	300,000	15%
San Juan Creek	31	357	10	130,683	14,900,000	45%

Table 5-5. Summary of Enterococcus Data for Impaired Creeks

Stream	Number of Monitoring Stations	Total Number of Samples	Enterococcus (MPN/100 mL)			Frequency of Exceedance of WQOs
			Minimum	Mean	Maximum	
Aliso Creek	108	8,817	1	6,018	492,800	98%
Pine Valley Creek	4	78	1	348	20,000	15%
San Juan Creek	31	357	5	4,834	280,000	89%

5.3 Analyses of Beach Water Quality Versus Magnitude of Streamflow

A statistical comparison of flow versus bacteria density was also performed to evaluate historical effects of high- and low-flow conditions near the mouths of the creeks. Two USGS gage stations in close proximity to the monitoring locations had flow data for the same time period as the bacteria monitoring data: San Diego River–Dog Beach (USGS 11023000 and FM-010) and San Luis Rey River (USGS 11042000 and OC-100) (Appendix B, No. 3, 18-19). Figures 5-6 and 5-7 show the flow versus fecal coliform density comparisons. In general, high bacteria levels were observed under a range of flow levels. For both locations, high fecal coliform densities were observed under low-flow and high-flow conditions. This indicates the need to assess bacteria sources during both wet weather events and dry weather conditions.

Location: Dog Beach
Pollutant: Fecal Coliform
Data from: 1/4/1999 to 9/27/2001 (316 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (#/100 mL)		
Percentile	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
0-10	32	1.059	0.790	1.200	170.73	6.00	1400.00
10-20	32	1.422	1.200	1.700	552.58	2.00	16000.00
20-30	32	1.809	1.700	2.000	299.54	2.00	3200.00
30-40	31	2.529	2.100	3.200	552.92	2.00	6800.00
40-50	31	3.961	3.200	4.700	360.19	2.00	7600.00
50-60	32	5.934	4.800	6.700	494.83	2.00	3600.00
60-70	31	7.968	6.800	8.800	86.50	20.00	800.00
70-80	31	12.581	9.000	14.000	135.76	16.00	800.00
80-90	32	25.094	15.000	39.000	245.75	2.00	2300.00
90-100	32	114.094	42.000	347.000	1438.09	20.00	12000.00

Location: Dog Beach
Pollutant: Fecal Coliform
Data from: 1/4/1999 to 9/27/2001 (316 Observations)

Time Period	# Obs	Flow (cfs)			Concentration (#/100 mL)		
Month	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
January	15	19.013	4.900	153.000	614.71	2.00	2400.00
February	38	54.066	5.500	347.000	2179.54	2.00	12000.00
March	25	56.960	11.000	182.000	199.64	2.00	2300.00
April	26	26.262	6.500	248.000	687.87	2.00	1800.00
May	42	7.421	3.600	11.000	282.45	2.00	3600.00
June	41	3.566	1.500	5.600	370.64	2.00	7600.00
July	52	1.830	0.980	2.600	680.52	2.00	16000.00
August	23	1.346	0.790	2.100	61.05	4.00	300.00
September	19	1.284	0.930	1.900	198.19	6.00	1600.00
October	13	34.908	1.000	146.000	260.46	2.00	1500.00
November	13	4.815	1.500	15.000	150.41	20.00	3200.00
December	9	5.344	2.400	14.000	72.16	2.00	500.00

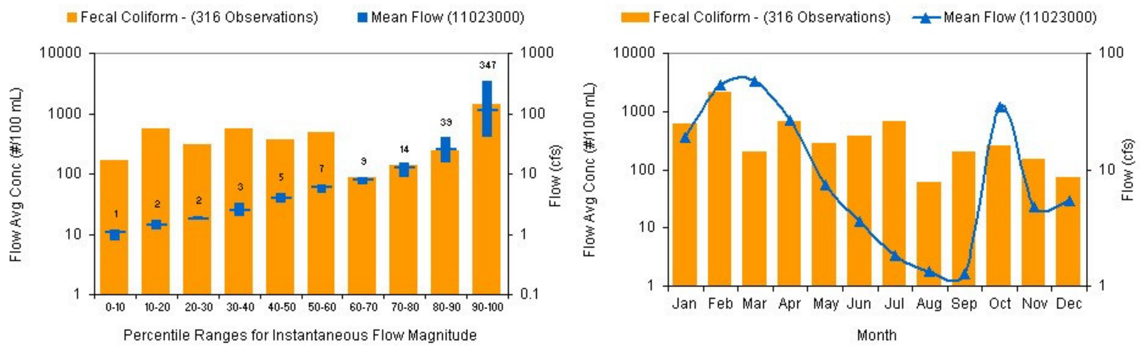

Figure 5-6. Flow versus fecal coliform concentration near San Diego River outlet (Dog Beach).

Location: San Luis Rey River
Pollutant: Fecal Coliform
Data from: 1/11/1999 to 9/25/2001 (144 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (#/100 mL)		
Percentile	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
0-10	15	0.000	0.000	0.000	195.85	2.00	2400.00
10-20	14	0.000	0.000	0.000	285.52	2.00	1600.00
20-30	14	0.041	0.000	0.060	11.19	2.00	240.00
30-40	15	0.239	0.090	0.460	59.52	4.00	500.00
40-50	14	1.098	0.570	1.600	57.09	2.00	240.00
50-60	14	2.057	1.600	2.600	78.52	2.00	240.00
60-70	15	4.260	2.900	5.700	144.03	11.00	500.00
70-80	15	10.173	6.200	14.000	177.98	17.00	700.00
80-90	13	20.385	15.000	24.000	128.66	2.00	300.00
90-100	15	71.533	28.000	180.000	741.48	5.00	3000.00

Location: San Luis Rey River
Pollutant: Fecal Coliform
Data from: 1/11/1999 to 9/25/2001 (144 Observations)

Time Period	# Obs	Flow (cfs)			Concentration (#/100 mL)		
Month	*Count*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
January	7	31.570	0.060	180.000	2449.41	2.00	3000.00
February	5	53.140	5.700	124.000	440.47	11.00	700.00
March	8	50.875	22.000	137.000	135.83	13.00	300.00
April	12	35.750	13.000	95.000	271.09	5.00	900.00
May	17	9.700	4.500	19.000	169.62	17.00	700.00
June	10	5.200	1.600	12.000	74.53	17.00	130.00
July	15	1.799	0.420	5.100	61.14	2.00	240.00
August	15	0.579	0.000	2.100	86.87	7.00	130.00
September	17	1.231	0.000	3.700	134.64	2.00	500.00
October	17	0.241	0.000	4.100	500.00	2.00	2400.00
November	13	0.178	0.000	0.990	168.30	2.00	500.00
December	8	0.029	0.000	0.060	15.39	2.00	240.00

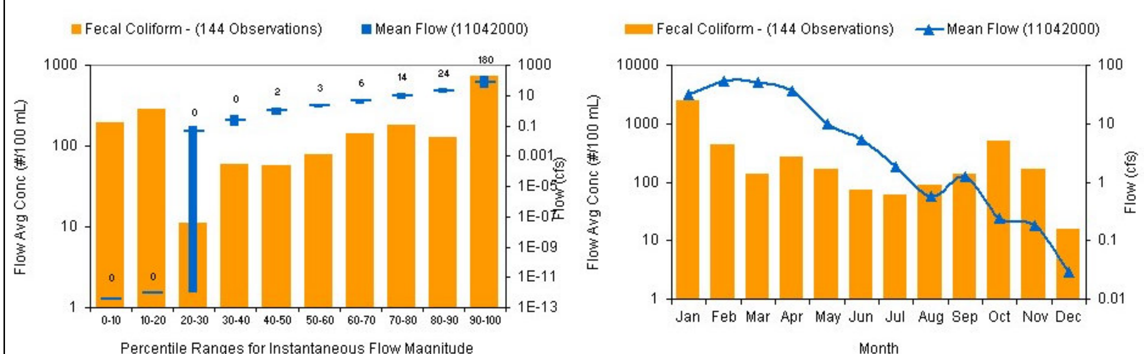

Figure 5-7. Flow versus fecal coliform concentration near San Luis Rey River.

6 Source Analysis

This section presents the approach used to identify and quantify the sources of bacteria to impaired beaches and creeks. Both in-stream and watershed data were used to identify potential sources and characterize the relationship between point and nonpoint source loadings and in-stream response under wet and dry conditions. Bacteria enter surface waters from both point and nonpoint sources. Point sources typically discharge at a specific location from pipes, outfalls, and conveyance channels from municipal wastewater treatment plants, industrial waste treatment facilities, or Municipal Separate Storm Sewer System (MS4) permitted stormwater discharges. Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters. During wet and dry periods multiple nonpoint sources of bacteria contribute to overall loads to the impaired waterbodies. These sources are deposited both directly to the waterways and also onto land surfaces. Sources include sewer line breaks, leaking septic systems, agricultural activities, deposit of waste from aquatic and terrestrial wildlife and pets, decaying matter, soil and deposit of waste from encampments of homeless persons. Discharges directly to marine shorelines include illegal sewage disposal from boats along the coastline, direct input to waterbodies from waterfowl, and even swimmers themselves.

Although sources of bacteria vary amongst all watersheds, in this analysis they were quantified by land-use type since bacteria loading can be highly correlated with land-use practices. See Appendices H and I for further discussion. This approach worked despite sources existing across several land use areas; i.e. wildlife living in both urbanized and non-urbanized watersheds.

Bacteria sources are the same under both wet and dry conditions. However, the method of transport between the two conditions is very different. Because the relative loads from these sources vary between wet or dry conditions, assessment of loads requires separate analyses.

6.1 Nonpoint Sources

The following sections explain how loadings from the nonpoint sources identified as contributors of bacteria to surface waters were incorporated into the TMDL calculations.

6.1.1 Natural Background (Aquatic and Terrestrial Wildlife)

Direct input of animal waste to land surfaces and waterbodies is a significant source of bacteria during both wet and dry conditions. Studies have shown that bacteria from waterfowl can potentially contribute significant loads of bacteria to coastal waters (Fleming and Fraser, 2001; Grant et al., 2001). In the San Diego Region, coastal lagoons are frequented by large populations of waterfowl that contribute feces directly to the water surface or to the low-lying mud flats in the marsh that become submerged during high tides. Such bacteria loads can be transported to the beaches during tidal fluctuations or during wet weather flows.

Although natural background is a significant source of bacteria, it is largely considered uncontrollable. The reference approach allows for incorporation of natural bacteria sources into each of the distinct waste load allocations for wet weather conditions (See section 8.1.5). . For dry weather conditions, the reference approach was not utilized since existing data indicate that exceedances of WQOs during dry weather conditions are uncommon in the relatively undeveloped watersheds in the San Diego Region (see section 4.1).

6.1.2 Encampments

During rainfall events, wash-off from encampments of homeless persons can potentially contribute elevated bacteria loads to waterbodies due to improper disposal of human waste. Such contributions are extremely difficult to quantify from analysis of individual encampment populations. Rather, loads from such encampments were considered to be included within urban runoff characterized through the watershed modeling analysis of wet weather conditions (see Section 7.2 and Appendix I). Urban runoff from these areas was considered along with stormwater and was categorized as point sources discharges through MS4 stormwater permits (see Section 6.2).

If bacteria loads from encampments of homeless persons result from direct discharge of human feces to the waterbodies, the loads are assumed to receive a 100 percent reduction for implementation of the TMDL. Direct discharges were not included explicitly in TMDL calculations.

6.2 Point Sources

A point source, according to 40 CFR 122.3, is defined as "any discernable, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged." The National Pollutant Discharge Elimination System (NPDES) Program, under Clean Water Act sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources.

6.2.1 Wastewater Treatment Plants

There are no direct point source discharges of bacteria from wastewater treatment plants to waterbodies in the San Diego Region. Wastewater treatment plants (WWTPs) are active in the watershed; however, all effluent from these facilities is discharged from offshore ocean outfalls.

Bacteria loads also periodically occur as a result of sewage spills. Although these loads potentially result in contamination of the waterbodies and bacterial concentrations that exceed WQOs, the loads attributed to these sources were not quantified for TMDL development. Because loads from sewage spills are accidental, estimation of the load reductions required to meet TMDLs is not required. Rather, all loads from sewage spills are assumed to receive a 100 percent reduction for implementation of the TMDL.

6.2.2 Urban Runoff

In 1990 USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4s) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a stormwater management program as a means to control polluted discharges from MS4s. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipally owned operations, and hazardous waste treatment. Large and medium operators are required to develop and implement Stormwater Management Plans that address, at a minimum, the following elements:

- Structural control maintenance
- Areas of significant development or redevelopment
- Roadway runoff management
- Flood control related to water quality issues
- Municipally owned operations such as landfills, wastewater treatment plants, etc.
- Hazardous waste treatment, storage, or disposal sites, etc.
- Application of pesticides, herbicides, and fertilizers
- Illicit discharge detection and elimination
- Regulation of sites classified as associated with industrial activity
- Construction site and post-construction site runoff control
- Public education and outreach

Phase II of the rule extends coverage of the NPDES stormwater program to certain small municipalities with a population of at least 10,000 and/or a population density of more than 1,000 people per square mile. A small MS4 is defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Storm Water Program.

For the San Diego Region, all discharges of urban runoff are covered by MS4 permits. For the watersheds of San Diego County, the incorporated cities of San Diego County (18 cities), and the San Diego Unified Port District, NPDES No. CAS0108758 defines the waste discharge requirements for MS4s. For the watersheds of Orange County, the incorporated cities of Orange County (11 cities), and the Orange County Flood Control District, NPDES No. CAS0108740 defines the waste discharge requirements for MS4s. Urban runoff discharges from MS4s are a leading cause of receiving water quality impairments in the San Diego Region. A direct link has been established between human illness and recreating near the outfalls of urban storm drains (SDRWQCB, 2001, and 2002a).

6.2.2.a Wet-Weather Urban Runoff

During wet weather events, washoff of bacteria from various land uses is considered the primary mechanism for transport of bacteria due to the relatively large bacteria levels observed at the mouths or within the watershed of impaired creeks. After bacteria build up on the land surface as the result of various land use sources and associated management practices (e.g., management of livestock in agricultural areas, pet waste in residential areas), many of the bacteria are washed off the surface during rainfall events. The amount of runoff and associated bacteria concentrations are therefore highly dependent on land use.

To estimate bacteria sources from runoff during wet events, a watershed model was developed (Appendix I). For assessment of bacteria loads from various land use sources, a critical wet year, based on the 92nd percentile wet year (1993) over a 12-year period from 1990 through 2002, was simulated using the watershed model. The critical wet year was used to simulate critical conditions for calculating the TMDLs.

6.2.2.b Dry-Weather Urban Runoff

From analysis of spatial distributions of bacteria concentrations along the Pacific Ocean shoreline, high bacteria levels were observed at the mouths of major stormwater outfalls and creeks under dry conditions (see Section 5.2 and Appendix F). This observance was validated through an analysis of streamflow versus bacteria concentration that indicated a significant dry-weather source to streams. During dry conditions, most impaired streams exhibit a sustained baseflow even if no rainfall has occurred for a significant period to provide runoff or groundwater flows. These flows are generally understood to result from various urban land use practices that cause water to enter storm drains and creeks. Such practices include lawn irrigation runoff, car washing, sidewalk washing, and the like. As these flows travel across lawns and urban surfaces, bacteria are carried from these areas to the receiving waterbody.

Analysis of studies performed at Aliso Creek, San Juan Creek, Tecolote Creek, and Rose Creek found that dry urban runoff and associated bacteria levels could be estimated from land use information in a given watershed. This analysis is discussed in detail in Appendix H.

7 Linkage Analysis

The technical analysis of bacteria loading and the waterbody response to this loading is referred to as the linkage analysis. The analysis results in the calculation of the total allowable bacteria loading to the impaired waterbodies and the associated reductions in current loading from individual controllable sources needed to meet water quality standards. Because the TMDL final numeric targets are set equal to the numeric water quality objectives for bacteria, attainment of the numeric targets will result in attainment of water quality standards.

For these TMDLs, a distinction is made between wet weather events and dry weather conditions because bacteria density varies between the two scenarios and implementation measures will be specific to these conditions. Two distinct models were used for calculating bacteria loads. One model specifically quantified loading during wet weather events. The other model quantified loading during dry conditions. In addition to current loading, Total Maximum Daily Loads (TMDLs) were calculated for the two conditions for each watershed. An annual TMDL was then reported for each watershed (sum of the wet weather and dry weather TMDLs). This information is available in Tables 9.1-9.6.

7.1 Consideration Factors for Model Selection

In selecting an appropriate approach for TMDL calculation, technical and regulatory criteria were considered. Technical criteria include the physical system in question, including watershed or stream characteristics and processes and the constituent of interest. Regulatory criteria include water quality objectives or procedural protocol. The following discussion details the considerations in each of these categories. Based on these considerations, appropriate models were chosen for both wet weather events and dry weather conditions. The same technical approaches were used for both beaches and creeks.

7.1.1 Technical Criteria

Technical criteria are divided into four main topics. Consideration of each topic was critical in selecting the most appropriate modeling system to address the types of sources and the numeric targets associated with the listed waters.

7.1.1.a Physical Domain

Representation of the physical domain is perhaps the most important consideration in model selection. The physical domain is the focus of the modeling effort—typically described by either the receiving water itself or a combination of the contributing watershed and the receiving water. Selection of the appropriate modeling domain depends on the constituents and the conditions under which the stream exhibits impairment. For a stream dominated by point source inputs that exhibits impairments under only low-flow conditions, a steady-state approach is typically used. This type of modeling approach focuses on only in-stream (receiving water) processes during a user-specified condition. For streams affected additionally or solely by nonpoint sources or primarily rainfall-driven flow and pollutant contributions, a dynamic approach is recommended. Dynamic watershed models consider time-variable nonpoint source contributions from a watershed surface or subsurface. Some models consider monthly or seasonal variability, while others enable assessment of conditions immediately before, during, and after individual rainfall events. Dynamic models require a substantial amount of information regarding input parameters and data for calibration purposes.

For this project, it was assumed that the San Diego Region is dominated by nonpoint sources that are generally constant on an hourly time step and deposit directly to drains. Although the sources are nonpoint in nature, their behavior in the stream is more like that of a point source.

7.1.1.b Source Contributions

Primary sources of pollution to a waterbody must be considered in the model selection process. Accurately representing contributions from nonpoint sources and permitted point sources is critical in properly representing the system and ultimately evaluating potential load reduction scenarios.

Water quality monitoring data were not sufficient to fully characterize all sources of bacteria in the listed watersheds. However, analyses of the available data indicate that the main sources are dry- and wet-weather urban runoff. As a result, models were selected to develop bacteria TMDLs for beaches and creeks to address the major source categories during wet and dry conditions considered controllable for TMDL implementation purposes.

7.1.1.c Critical Conditions

The goal of a TMDL analysis is to determine the assimilative capacity of a waterbody and to identify potential allocation scenarios that will enable the waterbody(ies) to achieve WQOs. The critical condition is the set of environmental conditions for which controls designed to protect water quality will ensure attainment of objectives for all other conditions. This is typically the period of time in which the waterbody exhibits the most vulnerability. Critical conditions are accounted for in this project by way of using separate modeling approaches for wet weather events and dry weather conditions.

7.1.1.d Constituents

Another important consideration in model selection and application is the constituent(s) to be assessed. Choice of state variables is a critical part of model application. The more state variables included, the more difficult the model is to apply and calibrate. However, if key state variables are omitted from the simulation, the model might not simulate all necessary aspects of the system and might produce unrealistic results. A delicate balance must be met between minimal constituent simulation and maximum applicability.

The focus of development of this TMDL project is on FC, TC, and ENT. Factors affecting the survival of bacteria include soil moisture content, pH, solar radiation, and available nutrients. In-stream bacteria dynamics can be extremely complex, and accurate estimation of bacteria concentrations relies on a host of interrelated environmental factors. Bacteria concentrations in the water column are influenced by die-off, regrowth, partitioning of bacteria between water and sediment during transport, settling, and resuspension of bottom materials. First-order die-off is likely the most important dynamic process to simulate in the San Diego Region, despite observations that bacteria re-grows in low flow conditions. The limited data available provide few insights into which of the other factors listed above might be most influential on bacterial behavior for the models. A description of assumptions regarding these factors is described in Appendix J.

7.1.2 Regulatory Criteria

A properly designed and applied model provides the source-response linkage component for this project and enables accurate assessment of assimilative capacity and allocation distribution. A stream's a ssimilative capacity is determined by assuming adherence to water quality objectives. The Regional Board's Basin Plan establishes, for all waters in the San Diego Region, the beneficial uses for each waterbody to be protected, the WQOs that protect those uses, and an implementation plan that accomplishes those objectives (see Section 3.3). The modeling platform must enable direct comparison of model results to in-stream concentrations and allow for the analysis of the duration of those concentrations. For the watershed loading analysis and implementation of required reductions, it is also important that the modeling platform enable examination of gross land use loading as well as in-stream concentration.

7.2 Wet-Weather Modeling Analysis

During wet-weather conditions, sources of bacteria are associated with wash-off of bacteria accumulated on the land surface. During rainy periods, the bacteria are delivered to receiving waters through creeks and stormwater collection systems. Often, bacteria sources can be linked to specific land use types that have higher relative bacteria accumulation rates or are more likely to deliver bacteria to waterbodies because of delivery through stormwater collection systems. To assess the link between sources of bacteria and the impaired waters, a modeling system that simulates the build-up and wash-off of bacteria and the hydrologic and hydraulic processes that affect delivery is often used. Understanding and modeling of these processes provides the necessary decision support for TMDL development and allocation of loads to sources. This approach assumes the following:

- All sources can be represented through build-up/wash-off of bacteria from specific land use types.
- The discharge of sewage is zero. Sewage spill information was reserved for use during the calibration process to account for observed spikes in bacteria indicators, as applicable; however, the calibration process did not necessitate removal of any wet-weather data considered to be affected by sewage spill information. In other words, data from wet weather events used for calibration were not indicative of sewage spills.
- For numeric target assessment at beaches, the critical points were assumed to be the point where the creek/watershed or storm drain initially mixes with ocean water at the surf zone.

The wet-weather approach chosen for use in this project is based on the application of USEPA's Loading Simulation Program in C++ (LSPC) to estimate bacteria loading from streams and assimilation within the waterbody. LSPC is a recoded C++ version of USEPA's Hydrological Simulation Program–FORTRAN (HSPF) that relies on fundamental (and USEPA-approved) algorithms. LSPC has been successfully applied and calibrated in the Los Angeles, San Gabriel, and San Jacinto Rivers in Southern California. For a complete discussion of LSPC configuration, calibration, and application, refer to Appendix G. Additional assumptions for wet weather modeling can be found in Appendix J.

7.3 Dry-Weather Modeling Analysis

The concentration of bacteria during dry weather is extremely variable in nature. This necessitated an approach that relied on detailed analysis of available data to better identify and characterize sources. Data collected from dry-weather samples were used to develop empirical relationships that represent water quantity and water quality associated with dry-weather runoff from various land uses. For each monitoring station, a watershed was delineated and the land use was related to flow and bacteria concentrations. A statistical relationship was established between flow, bacteria concentrations, and areas of each land use. A complete discussion of the statistical analysis of data and development of the empirical framework for estimating watershed bacterial loads is provided in Appendix H.

To represent the linkage between source contributions and in-stream response, a steady-state mass balance model was developed to simulate transport of bacteria in the impaired streams and the streams flowing to impaired shorelines. This predictive model represents the streams as a series of plug-flow reactors, with each reactor having a constant, steady-state flow and bacteria load. A complete description of configuration and calibration of the stream modeling network is provided in Appendix H.

The model was created to estimate bacteria concentrations in the San Diego Region, to develop necessary load allocations for TMDL development, and to allow for readily incorporating any new data. Bacteria concentrations in each segment were calculated using available water quality data, and assuming values for a first-order die-off rate, stream infiltration, basic channel geometry, and flow. Assumptions for dry weather modeling can be found in Appendix J.

8 Identification of Load Allocations and Reductions

The calibrated models were used to simulate flow and indicator bacteria densities for use in estimating existing bacteria loads to the impaired waterbodies. Current estimated loads were compared to calculated TMDLs for identification of necessary load reductions. Methodologies for determining load reductions to wet and dry urban runoff are described in the following sections. Assumptions included in TMDL calculations can be found in Appendix J.

8.1 Wet Weather Loading Analysis

The calibrated LSPC model (see Appendix I) was used to estimate existing bacteria loads at critical conditions for comparison to numeric targets and determination of required load reductions for each watershed identified as a source of bacteria to the impaired waterbodies (see Figures 3-1 and 3-2 and Table 3-1). The optimal reduction scenario resulted in reduced bacteria loads from controllable land uses. (Natural and anthropogenic sources from urban runoff associated with MS4 permits were deemed controllable, whereas natural sources from open space were not).

8.1.1 Identification of the Critical Wet Weather Condition

To ensure protection of the impaired waterbodies during wet periods, a conservative approach, a critical period associated with extreme wet conditions was selected for loading analysis and TMDL calculations. This critical wet condition was selected based on identification of the 92nd percentile of annual rainfalls observed over the past 12 years (1990 through 2002) at multiple rainfall gages in the San Diego Region (wettest year of the past 12) (Appendix B, No.21-23). This resulted in selection of 1993 as the critical wet year for assessment of wet weather loading conditions. This condition was consistent with studies performed by the Southern California Coastal Research Project (SCCWRP), where a 90th percentile year was selected based on rainfall data for the Los Angeles Airport (LAX) from 1947 to 2000, also resulting in selection of 1993 as the critical year (LARWQCB, 2002).

8.1.2 Wet Weather Load Estimation

Estimation of current loading to the impaired waterbodies required use of the model to predict flows and bacteria densities. The dynamic model-simulated watershed processes, based on observed rainfall data as model input, provided temporally variable load estimates for the critical period. These load estimates were simulated using calibrated, land use-specific processes associated with hydrology and build-up and wash-off of bacteria from the land surface. Transport processes of bacteria loads from the source to the impaired waterbodies were also simulated in the model with a first-order loss rate based on literature values (see Appendix I).

For estimation of bacteria loading during wet weather events, the model was utilized using local rainfall data. The wet weather event was defined to be consistent with DEH's General Advisory to avoid contact with ocean and bay water within 300 feet on either side of any storm drain, river, or lagoon outlet, and it is designated as 72 hours after 0.2 inch or more of rain. The total number of wet days for each watershed containing impaired waterbodies is listed in Table 8-1. For larger watersheds that extend into the mountains, where more rainfall is observed (e.g., San Luis Rey River, San Dieguito River, San Diego River), more wet days were identified. Although the Miramar watershed is near the coast and does not extend into the mountains as do the larger watersheds, localized rainfall patterns for 1993 suggested that there were large number of wet days relative to neighboring watersheds.

Table 8-1. Wet Days of the Critical Period (1993) Identified for Watersheds Affecting Impaired Waterbodies

Watershed	Number of Wet Days in 1993
Laguna/San Joaquin	69
Aliso Creek	69
Dana Point	69
San Juan Creek	76
San Clemente	73
San Luis Rey River	90
San Marcos	49
San Dieguito River	98
Miramar	94
Scripps	57
San Diego River	86
Chollas Creek	65
Pine Valley Creek	37

Only the model-predicted flows and bacteria densities for wet days defined above were considered in estimating existing loads and calculating TMDLs. A separate modeling approach was used for assessment of dry-weather loads (see Section 8.2).

8.1.3 Identification of Wet Weather Numeric Targets

As mentioned in Section 4.3, a two-phased approach was used for calculating TMDLs based on interim numeric targets and final numeric targets (WQOs). The interim targets for FC, TC, and ENT for all waterbodies (including beaches and creeks) are based on REC-1 WQOs, with allowable frequencies of exceedance of WQOs based on the reference conditions of the Arroyo Sequit watershed in the Los Angeles Region. This interim period provides an opportunity for data collection and identification of exceedance frequencies for a reference watershed in the San Diego Region, such as San Mateo. This interim period also allows for development and inclusion of a reference watershed implementation policy in the Basin Plan.

The final targets are based on WQOs defined by the REC-1 beneficial uses of creeks, as well as the REC-1 *and* SHELL beneficial uses of beaches. Therefore, TMDL targets for creeks are based on REC-1 WQOs for FC, TC, and ENT; final TMDL targets for beaches are based on REC-1 WQOs for FC and ENT and SHELL WQOs for TC. For both beaches and creeks, no allowable exceedance frequencies are included because the Basin Plan does not include a reference watershed implementation policy for bacteriological WQOs. An appropriate reference watershed could be identified to represent the local environmental and bacteria loading conditions in the San Diego Region, and also to provide the information necessary for calculating exceedance frequencies associated with the SHELL WQOs. (The Los Angeles reference condition was established based on REC-1 WQOs). The TMDL can be reopened and revised if appropriate reference conditions are identified for the beaches and creeks of the San Diego Region and a reference watershed implementation policy is added to the Basin Plan.

Numeric targets are based on the single sample WQOs defined in the Basin Plan. Because wet-weather runoff and flows containing bacteria concentrations have a quick time of travel, resulting in a short residence time of bacteria in the waterbodies, the single-sample WQOs were determined most appropriate. Summaries of the interim and TMDL numeric targets for beaches and creeks are provided in Tables 8-2 and 8-3. For information regarding the schedule of implementation of these targets, see Section 10.

Table 8-2. Interim and Final Wet-Weather Numeric Targets for Beaches

Indicator Bacteria	Interim Targets		Final Targets	
	Numeric Target[a] (MPN/100mL)	Allowable Exceedance Frequency[b]	Numeric Target[c] (MPN/100mL)	Allowable Exceedance Frequency[d]
Fecal coliforms	400	0.22	400	0
Total coliforms	10,000	0.22	230	0
Enteroccoci	104	0.22	104	0

[a] Targets based on REC-1 single sample WQOs.
[b] Exceedance frequency based on reference condition observed in the Los Angeles Region.
[c] Targets based on REC-1 single-sample WQOs for FC and ENT and SHELL single-sample WQOs for TC.
[d] No reference watershed identified for the San Diego Region; if a reference watershed is identified for the San Diego Region in the interim period, the TMDL can be revised.

Table 8-3. Interim and Final Wet-Weather Numeric Targets for Creeks

Indicator Bacteria	Interim Targets		Final Targets	
	Numeric Target[a] (MPN/100mL)	Allowable Exceedance Frequency[b]	Numeric Target[a] (MPN/100mL)	Allowable Exceedance Frequency[c]
Fecal coliforms	400	0.22	400	0
Total coliforms	10,000	0.22	10,000	0
Enteroccoci	61	0.22	61	0

[a] Targets based on REC-1 single sample WQOs.
[b] Exceedance frequency based on reference condition observed in the Los Angeles Region.
[c] No reference watershed identified for the San Diego Region; if a reference watershed is identified for the San Diego Region in the interim period, the TMDL can be revised.

For the interim period, the total number of days that numeric targets may be exceeded based on reference conditions, or allowable exceedance days, was calculated for each of the watersheds contributing to impairments of the waterbodies addressed in this document. Calculations were performed by multiplying the allowable exceedance frequency (0.22) by the number of wet days for the critical period (Table 8-1). The resulting number of allowable exceedance days for each watershed is listed in Table 8-4.

Table 8-4. Allowable Exceedance Days for Watersheds Affecting Impaired Waterbodies

Watershed	Number of Allowable Exceedance Days for Interim Period
Laguna/San Joaquin	15
Aliso Creek	15
Dana Point	15
San Juan Creek	17
San Clemente	16
San Luis Rey River	20
San Marcos	11
San Dieguito River	22
Miramar	21
Scripps	13
San Diego River	19
Chollas Creek	14
Pine Valley Creek	8

8.1.4 Critical Points for TMDL Calculation

For TMDL calculation, the water quality at a *critical point* or location in an impaired waterbody was compared to numeric targets for assessment of required reductions of pollutant loads to meet TMDLs. This critical point is considered to be a conservative location for assessment of water quality conditions, and is therefore selected based on high bacteria loads predicted at that location. Although this critical point for water quality assessment is utilized for TMDL analysis, compliance to WQOs must be assessed and maintained for all segments of a waterbody to ensure that impairments of beneficial uses are not observed. Beneficial uses apply throughout all segments of a waterbody.

For beaches, the critical points for meeting numeric targets are at the mouths of the watersheds. Therefore, surf zone mixing and dilution of discharges from creeks and storm drains to the beach were not considered. Because beneficial uses of the beach are to be maintained at all locations, including the discharge point of creeks, the conservative approach is to mandate compliance with numeric targets at those discharge points where bacterial densities are assumed to be greatest.

For development of TMDLs for impaired creeks, critical points were also selected at the mouths or bottom of the impaired creek segments. This approach provides an implicit margin of safety to ensure protection of the beneficial uses of the beaches and creeks under critical conditions.

8.1.5 Calculation of TMDLs and Allocations of Bacteria Loads

For each modeled subwatershed discharging to an impaired waterbody (subwatersheds and proximity to impaired waterbodies shown Appendix G), current wet weather loads were compared to calculated allowable waste loads through the use of load-duration curves. Load duration curves rank the modeled flows into percentiles. This allows current estimated bacteria loads to be compared to interim and final numeric targets. Load-duration curves and TMDL calculations for the watersheds for interim and final targets are provided in Appendices K and L, respectively. On each load-duration curve, much of the lower range of flow has no associated bacteria loads. This is due to model predicted flows or bacterial concentrations close to zero. Although days were categorized as wet periods based on a criterion associated with rainfall (0.2 inches or more of rainfall and the following 72 hours), some of these days were actually dry in terms of streamflow. For this reason, the separate dry weather approach provides an effective assessment of bacteria loads during dry periods.

TMDLs and allocations of bacteria loads were calculated using the following steps:

1. Determined the existing loads and ranked into percentiles of increasing flows (represented as bars in load-duration curves);
2. Calculated waste load allocations (WLAs) —flows multiplied by respective numeric targets (represented as line in load-duration curves);
3. Determined the allowable exceedance loads as the highest loads corresponding to the number of allowable exceedance days (shown in blue in load-duration curves);
4. Calculated non-allowable exceedance loads (loads exceeding targets minus allowable exceedance loads from Step 3); and
5. Calculated the required annual load reduction (non-allowable exceedance minus WLAs).

Wet weather WLAs, combined with annual dry weather WLAs (see Section 6.2), provided annual TMDLs for the watersheds addressed.

8.1.6 Margin of Safety

There are two ways to incorporate the MOS (USEPA, 1991): (1) implicitly incorporate the MOS using conservative model assumptions to develop allocations and (2) explicitly specify a portion of the total TMDL as the MOS and use the remainder for allocations. For the wet-weather bacteria TMDLs, an implicit MOS was incorporated. Throughout the TMDL development process, conservative assumptions were employed. For example, assuming that the location of the critical point for beach bacteria TMDLs is at the point of stormwater discharge provides an MOS by ensuring that targets are met at increasing distances from the discharge, where dilution in the surf zone occurs.

8.1.7 Seasonality

Through simulation of an entire critical wet year, daily wet-weather loads were estimated for all seasons of that year and compared to TMDLs to determine necessary load reductions. Model simulation of a full year accounted for seasonal variations in rainfall, evaporation, and associated impacts on runoff and transport of bacteria loads to waterbodies. Although large storms in the wet season of the critical year were associated with large volumes of runoff that transported large bacteria loads, smaller storms during the dry season also provided large bacteria loads resulting from wash-off of bacteria that had accumulated on the surface during the preceding extended dry period. For estimating bacteria loads during dry weather conditions, the separate dry-weather modeling approach was used.

8.2 *Dry-Weather Loading Analysis*

The calibrated, low-flow, steady state model was used to estimate bacteria loads during dry weather conditions. The steady-state aspect of the model resulted in estimation of a constant load from each watershed. This load was assumed representative of the average flow and bacteria loading conditions resulting from various urban land use practices (e.g., runoff from lawn irrigation or sidewalk washing). A complete discussion of model development, calibration, and validation is provided in Appendix H.

8.2.1 Identification of the Critical Dry weather Condition

The critical dry period was based on predictions of steady-state flows based on results of analysis of average dry-weather flows observed in Aliso Creek, Rose Creek, and Tecolote Creek (Appendix B, No. 1-2). Dry-weather days were selected based on the criterion that less than 0.2 inch of rainfall was observed on each of the previous 3 days. Based on analysis of dry-weather flow, critical flows were predicted for each impaired watershed (see Appendix H).

8.2.2 Dry Weather Load Estimation

For each watershed that affects impaired waterbodies addressed in this study, the dry weather model was used to estimate the flows and bacteria densities resulting from dry-weather urban runoff. Estimation of source loadings was based on empirical relationships established between both flow and bacteria densities and land use distribution in the watershed. Transport of bacteria loads was simulated using standard plug-flow equations to describe steady-state losses resulting from first-order die-off and stream infiltration (see Appendix H for more detail). Steady-state estimates of bacteria loads were assumed constant for all dry days. Assumptions incorporated in the dry weather loading analysis are described in Appendix J.

For consistency with the wet-weather approach, dry days were assessed for the critical wet year, identified as 1993. This was an accounting measure used so that total combined TMDLs for each waterbody could be based on annual loads. The dry days in 1993 for each watershed are listed in Table 8-5.

Table 8-5. Dry Days of the Critical Period (1993) Identified for Watersheds Affecting Impaired Waterbodies

Watershed	Number of Dry Days in 1993
Laguna/San Joaquin	296
Aliso Creek	296
Dana Point	296
San Juan Creek	289
San Clemente	292
San Luis Rey River	275
San Marcos	316
San Dieguito River	267
Miramar	271
Scripps	308
San Diego River	279
Chollas Creek	300
Pine Valley Creek	328

8.2.3 Identification of Dry weather Numeric Targets

A two-phased approach was used for calculating TMDLs based on interim numeric targets and final numeric targets (WQOs). For the interim period, TMDLs for FC, TC, and ENT were based on REC-1 WQOs. For TC, WQOs specific to the SHELL beneficial use are applicable at beaches. As a result, following expiration of the interim period, TMDL final targets are based on REC-1 WQOs for FC and ENT, and SHELL WQOs for TC. The interim period allows sufficient time for data collection and special studies to verify the appropriateness of the SHELL beneficial use and associated WQOs for TC. Should these studies result in information that necessitates revisions of WQOs or the technical approach, the TMDL can be reopened and revised.

Because of the steady-state characteristic of bacteria loads predicted through modeling analysis, the 30-day geometric mean WQOs were selected as appropriate numeric targets. Interim and final numeric targets are presented in Table 8-6.

Table 8-6. Interim and Final Numeric Dry-Weather Targets for Beaches and Creeks

Indicator Bacteria	Interim Targets (MPN/100 mL)		Final Targets (MPN/100 mL)	
	Beaches[a]	Creeks[a]	Beaches[b]	Creeks[b]
Fecal coliforms	200	200	200	200
Total coliforms	1,000	1,000	70	1,000
Enteroccoci	35	33	35	33

[a] Targets consistent with WQOs; TC based on REC-1 beneficial use.

[b] Targets consistent with WQOs; TC based on SHELL beneficial use.

8.2.4 Critical Points for TMDL Calculation

Consistent with the approach used for wet weather analysis (Section 8.1.4), critical points for assessment of TMDL targets were selected at the mouths and bottom of creeks and watersheds that contribute to the impairment of beaches. This conservative approach provides an implicit margin of safety to ensure protection of the beneficial uses of the beaches and creeks under critical conditions.

8.2.5 Calculation of TMDLs and Allocations of Bacteria Loads

For each modeled watershed discharging to an impaired waterbody (see Figures 3-1 and 3-2), calculation of bacteria WLAs and required load reductions were performed using the following steps:

1. Calculated the WLAs based on model-predicted flows multiplied by applicable numeric targets; and
2. Calculated required load reductions based on the difference between WLAs and model-predicted loads.

Results were combined with wet weather WLAs for determination of the total annual TMDLs.

8.2.6 Margin of Safety

An implicit MOS was incorporated through application of conservative assumptions throughout TMDL development. An important conservative assumption was the identification of the 30-day geometric mean WQOs as TMDL numeric targets. Compliance with the 30-day geometric mean WQOs provides assurance that TMDLs will result in the protection of beneficial uses by stressing the importance of maintaining sustained safe levels of bacteria densities over all dry periods. Another conservative assumption was the designation of the critical point for beach bacteria TMDLs as the point of stormwater discharge. Such conservativeness provides an MOS by ensuring that targets are met at increasing distances from the discharge, where dilution in the surf zone occurs.

8.2.7 Seasonality

The dry-weather approach uses a unique modeling system designed to assess average dry conditions and associated TMDLs. This approach is distinct from the wet weather approach described in Section 8.1.

9 Total Maximum Daily Loads and Allocations

The TMDL for a given pollutant and waterbody is the total amount of pollutant that can be assimilated by the receiving waterbody while still achieving WQOs. Once calculated, the TMDL is equal to the sum of individual waste load allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

TMDL = • •WLAs + • •LAs + MOS

In the case of beaches and creeks of the San Diego Region, applicable WQOs relate to the REC-1 and SHELL beneficial uses. In TMDL development, allowable loadings from pollutant sources that cumulatively amount to no more than the TMDL must be established; this provides the basis to establish water quality-based controls. TMDLs can be expressed on a mass loading basis (e.g., pounds of bacteria per year) or as a concentration in accordance with 40 CFR 130.2(l).

9.1.1 Waste load Allocations

Federal regulations (40 CFR 130.7) require TMDLs to include individual WLAs for each point source. The only point sources identified to affect impaired waterbodies addressed in this study were MS4s. USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for all stormwater discharges from MS4s. The existing loads estimated for TMDL calculations were solely the result of watershed runoff. Coverage of existing MS4 permits include portions of watersheds determined to impact the impaired waterbodies addressed in this study.

9.1.2 Load Allocations

Currently, no load allocations were assigned to nonpoint sources and natural background levels in the region. Until better information is available that describes the spatial coverage of MS4 permits, no distinction can be made regarding those areas of the watersheds included within MS4 coverages and areas currently not permitted for stormwater discharge. Once this information becomes available for the entire region, WLAs determined for MS4 permits can be redistributed to nonpoint source runoff and LAs can be established. Such nonpoint source runoff includes background levels associated with runoff from natural areas not included within coverage of an MS4 permit. The interim implementation strategy provides sufficient time for collection of information that better distinguishes areas covered by MS4 permits so that TMDL allocations can potentially be reassigned from WLAs to LAs for nonpoint source runoff and background levels.

9.1.3 TMDLs and WLAs

TMDLs and associated WLAs are presented in Tables 9-1 through 9-6 for both interim and final targets. TMDLs are presented for each impaired waterbody, with wet weather and dry weather WLAs reported separately.

Table 9-1. Interim TMDLs for Fecal Coliform

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12) Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	101	309	5,179	51.6%	1,181	52,676	74.1%	154	5,041	96.9%	1,335
	103	872	47,497	77.2%							
Laguna Beach HSA (901.12) at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Ave. Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Rd. Laguna Beach at Dumond Drive	104	10,505	592,496	74.7%	15,611	652,339	71.4%	2,083	21,999	90.5%	17,694
	105	4,174	47,842	57.7%							
	106	932	12,001	63.8%							
Aliso HSA (901.13) Laguna Beach at Lagunita Place / Blue Lagoon Place at Aliso Beach Aliso Creek	201	630	19,386	83.8%	105,422	1,752,095	67.2%	2,383	53,972	95.6%	107,805
	202	104,792	1,732,709	66.9%							
Dana Point HSA (901.14) Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	301	507	12,677	78.8%	22,317	403,911	64.1%	912	18,263	95.0%	23,229
	302	715	13,426	72.1%							
	304	19,885	356,926	61.7%							
	305	367	10,149	80.6%							
	306	843	10,733	64.1%							
Lower San Juan HSA (901.27) San Juan Creek	401	381,639	15,304,790	62.2%	381,639	15,304,790	62.2%	16,038	62,179	74.2%	397,677

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Clemente HA (901.30) at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal St. Stairs San Clemente City Beach at Mariposa St. San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane San Clemente City Beach at Lifeguard Headquarters Under San Clemente Municipal Pier San Clemente City Beach at Trafalgar Canyon (Trafalgar Ln.) San Clemente State Beach at Riviera Beach San Clemente State Beach at Cypress Shores	501	13,761	503,463	69.0%	39,339	1,441,719	63.3%	1,865	32,382	94.2%	41,204
	502	3,342	81,333	52.2%							
	503	13,867	736,628	61.3%							
	504	4,235	81,576	60.5%							
	505	2,875	22,705	38.7%							
	506	1,259	16,014	38.8%							
San Luis Rey HU (903.00) at San Luis Rey River Mouth	701	662,782	33,120,012	51.2%	662,782	33,120,012	51.2%	9,697	15,918	39.1%	672,479
San Marcos HA (904.50) at Moonlight State Beach	1101	1,845	20,886	70.1%	1,845	20,886	70.1%	273	1,571	82.6%	2,118
San Dieguito HU (905.00) at San Dieguito Lagoon Mouth	1301	418	3,081	13.3%	467,838	21,286,909	29.5%	11,512	14,517	20.7%	479,350
	1302	467,420	21,283,828	29.5%							
Miramar Reservoir HA (906.10) Torrey Pines State Beach at Del Mar (Anderson Canyon)	1401	335	10,392	30.3%	335	10,392	30.3%	66	1,849	96.4%	401

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
Scripps HA (906.30) La Jolla Shores Beach at El Paseo Grande La Jolla Shores Beach at Caminito Del Oro La Jolla Shores Beach at Vallecitos La Jolla Shores Beach at Ave de la Playa at Casa Beach, Children' s Pool South Casa Beach at Coast Blvd. Whispering Sands Beach at Ravina St. Windansea Beach at Vista de la Playa Windansea Beach at Bonair St. Windansea Beach at Playa del Norte Windansea Beach at Palomar Ave. at Tourmaline Surf Park Pacific Beach at Grand Ave.	1501	2,487	28,044	62.6%	12,561	204,057	72.4%	1,221	34,085	96.4%	13,782
	1503	4,692	98,955	77.1%							
	1505	2,530	44,212	74.0%							
	1507	2,852	32,846	58.8%							
San Diego HU (907.11) at San Diego River Mouth (aka Dog Beach)	1801	312,219	4,932,380	44.7%	312,219	4,932,380	44.7%	14,003	45,831	69.4%	326,222
Santee HSA (907.12) Forrester Creek	1801	312,219	4,932,380	44.7%	312,219	4,932,380	44.7%	14,003	45,831	69.4%	326,222
San Diego HU (907.11) & Santee HSA (907.12) San Diego River, Lower	1801	312,219	4,932,380	44.7%	312,219	4,932,380	44.7%	14,003	45,831	69.4%	326,222
Chollas HSA (908.22) Chollas Creek	1901	67,232	603,863	60.0%	67,232	603,863	60.0%	3,982	50,680	92.1%	71,214

[a] Model subwatershed (see Appendix G) is the number used in LSPC to identify the subwatershed associated with the listed segment(s) within a hydrologic region. Load duration curves and detailed TMDL tables for each subwatershed are provided in Appendix K.

[b] Percent reduction is calculated by dividing the non-allowable exceedance load by the total load using the allowance criteria. These values are presented for each subwatershed in Appendix K.

Table 9-2. Final TMDLs for Fecal Coliform

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12) Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	101	309	5,179	95.1%	1,181	52,676	97.9%	154	5,041	96.9%	1,335
	103	872	47,497	98.2%							
Laguna Beach HSA (901.12) at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Ave. Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Rd. Laguna Beach at Dumond Drive	104	10,505	592,496	98.2%	15,611	652,339	97.7%	2,083	21,999	90.5%	17,694
	105	4,174	47,842	92.3%							
	106	932	12,001	93.2%							
Aliso HSA (901.13) Laguna Beach at Lagunita Place / Blue Lagoon Place at Aliso Beach Aliso Creek	201	630	19,386	97.1%	105,422	1,752,095	95.2%	2,383	53,972	95.6%	107,805
	202	104,792	1,732,709	95.2%							
Dana Point HSA (901.14) Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	301	507	12,677	96.5%	22,317	403,911	96.3%	912	18,263	95.0%	23,229
	302	715	13,426	95.4%							
	304	19,885	356,926	96.5%							
	305	367	10,149	96.5%							
	306	843	10,733	92.4%							
Lower San Juan HSA (901.27) San Juan Creek	401	381,639	15,304,790	97.7%	381,639	15,304,790	97.7%	16,038	62,179	74.2%	397,677

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year))
	Model Subwatershed[a]	**Waste Load Allocation (Billion MPN/year)**	**Total Load for Existing Condition (Billion MPN/year)**	**Percent Reduction**[b]	**Basinwide Waste Load Allocation (Billion MPN/year)**	**Basinwide Existing Load (Billion MPN/year)**	**Basinwide Percent Reduction**	**Basinwide Waste Load Allocation (Billion MPN/year)**	**Basinwide Existing Load (Billion MPN/year)**	**Basinwide Percent Reduction**	
San Clemente HA (901.30) at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal St. Stairs San Clemente City Beach at Mariposa St. San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane San Clemente City Beach at Lifeguard Headquarters Under San Clemente Municipal Pier San Clemente City Beach at Trafalgar Canyon (Trafalgar Ln.) San Clemente State Beach at Riviera Beach San Clemente State Beach at Cypress Shores	501	13,761	503,463	97.3%	39,339	1,441,719	97.5%	1,865	32,382	94.2%	41,204
	502	3,342	81,333	97.1%							
	503	13,867	736,628	98.1%							
	504	4,235	81,576	94.9%							
	505	2,875	22,705	94.6%							
	506	1,259	16,014	92.3%							
San Luis Rey HU (903.00) at San Luis Rey River Mouth	701	662,782	33,120,012	98.1%	662,782	33,120,012	98.1%	9,697	15,918	39.1%	672,479
San Marcos HA (904.50) at Moonlight State Beach	1101	1,845	20,886	92.5%	1,845	20,886	92.5%	273	1,571	82.6%	2,118
San Dieguito HU (905.00) at San Dieguito Lagoon Mouth	1301	418	3,081	86.7%	467,838	21,286,909	98.0%	11,512	14,517	20.7%	479,350
	1302	467,420	21,283,828	98.0%							
Miramar Reservoir HA (906.10) Torrey Pines State Beach at Del Mar (Anderson Canyon)	1401	335	10,392	97.0%	335	10,392	97.0%	66	1,849	96.4%	401

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
Scripps HA (906.30) La Jolla Shores Beach at El Paseo Grande La Jolla Shores Beach at Caminito Del Oro La Jolla Shores Beach at Vallecitos La Jolla Shores Beach at Ave de la Playa at Casa Beach, Children' s Pool South Casa Beach at Coast Blvd. Whispering Sands Beach at Ravina St. Windansea Beach at Vista de la Playa Windansea Beach at Bonair St. Windansea Beach at Playa del Norte Windansea Beach at Palomar Ave. at Tourmaline Surf Park Pacific Beach at Grand Ave.	1501	2,487	28,044	92.9%	12,561	204,057	94.9%	1,221	34,085	96.4%	13,782
	1503	4,692	98,955	95.3%							
	1505	2,530	44,212	95.4%							
	1507	2,852	32,846	95.0%							
San Diego HU (907.11) at San Diego River Mouth (aka Dog Beach)	1801	312,219	4,932,380	93.7%	312,219	4,932,380	93.7%	14,003	45,831	69.4%	326,222
Santee HSA (907.12) Forrester Creek	1801	312,219	4,932,380	93.7%	312,219	4,932,380	93.7%	14,003	45,831	69.4%	326,222
San Diego HU (907.11) & Santee HSA (907.12) San Diego River, Lower	1801	312,219	4,932,380	93.7%	312,219	4,932,380	93.7%	14,003	45,831	69.4%	326,222
Chollas HSA (908.22) Chollas Creek	1901	67,232	603,863	90.8%	67,232	603,863	90.8%	3,982	50,680	92.1%	71,214

[a] Model subwatershed (see Appendix G) is the number used in LSPC to identify the subwatershed associated with the listed segment(s) within a hydrologic region. Load duration curves and detailed TMDL tables for each subwatershed are provided in Appendix K.

[b] Percent reduction is calculated by dividing the non-allowable exceedance load by the total load using the allowance criteria. These values are presented for each subwatershed in Appendix K.

Table 9-3. Interim TMDLs for Total Coliform

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12) Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	101	7,716	67,350	48.5%	29,520	628,669	68.6%	770	25,369	97.0%	30,290
	103	21,804	561,319	71.8%							
Laguna Beach HSA (901.12) at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Ave. Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Rd. Laguna Beach at Dumond Drive	104	262,616	6,278,214	67.0%	390,266	7,593,233	65.7%	10,415	110,707	90.6%	400,681
	105	104,355	1,076,489	62.6%							
	106	23,295	238,530	61.8%							
Aliso HSA (901.13) Laguna Beach at Lagunita Place / Blue Lagoon Place at Aliso Beach Aliso Creek	201	15,761	364,715	81.4%	2,635,557	23,210,774	58.9%	11,915	262,841	95.9%	2,647,472
	202	2,619,796	22,846,059	58.5%							
Dana Point HSA (901.14) Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	301	12,680	224,286	76.0%	557,910	6,546,962	58.1%	4,558	91,908	95.0%	562,468
	302	17,868	261,979	71.6%							
	304	497,130	5,599,516	54.3%							
	305	9,164	209,193	77.4%							
	306	21,068	251,988	62.6%							
Lower San Juan HSA (901.27) San Juan Creek	401	9,540,977	130,258,863	45.2%	9,540,977	130,258,863	45.2%	80,190	297,153	73.0%	9,621,167

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Clemente HA (901.30) at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal St. Stairs San Clemente City Beach at Mariposa St. San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane San Clemente City Beach at Lifeguard Headquarters Under San Clemente Municipal Pier San Clemente City Beach at Trafalgar Canyon (Trafalgar Ln.) San Clemente State Beach at Riviera Beach San Clemente State Beach at Cypress Shores	501	344,015	5,276,541	58.5%	983,469	16,236,540	54.4%	9,326	162,961	94.3%	992,795
	502	83,546	1,216,982	42.3%							
	503	346,674	7,101,860	52.3%							
	504	105,876	1,903,632	58.8%							
	505	71,873	439,306	36.5%							
	506	31,485	298,219	37.8%							
San Luis Rey HU (903.00) at San Luis Rey River Mouth	701	16,569,557	231,598,677	31.6%	16,569,557	231,598,677	31.6%	48,483	78,370	38.1%	16,618,040
San Marcos HA (904.50) at Moonlight State Beach	1101	46,114	515,278	69.8%	46,114	515,278	69.8%	1,364	7,907	82.7%	47,478
San Dieguito HU (905.00) at San Dieguito Lagoon Mouth	1301	10,447	130,532	22.1%	11,695,958	163,541,132	24.8%	57,563	67,236	14.4%	11,753,521
	1302	11,685,511	163,410,600	24.8%							
Miramar Reservoir HA (906.10) Torrey Pines State Beach at Del Mar (Anderson Canyon)	1401	8,363	212,986	26.4%	8,363	212,986	26.4%	328	9,307	96.5%	8,691

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
Scripps HA (906.30) La Jolla Shores Beach at El Paseo Grande La Jolla Shores Beach at Caminito Del Oro La Jolla Shores Beach at Vallecitos La Jolla Shores Beach at Ave de la Playa at Casa Beach, Children' s Pool South Casa Beach at Coast Blvd. Whispering Sands Beach at Ravina St. Windansea Beach at Vista de la Playa Windansea Beach at Bonair St. Windansea Beach at Playa del Norte Windansea Beach at Palomar Ave. at Tourmaline Surf Park Pacific Beach at Grand Ave.	1501	62,173	768,912	65.4%	314,011	5,029,518	72.3%	6,103	171,530	96.4%	320,114
	1503	117,295	2,485,458	77.2%							
	1505	63,238	958,988	71.2%							
	1507	71,305	816,160	57.9%							
San Diego HU (907.11) at San Diego River Mouth (aka Dog Beach)	1801	7,805,470	72,757,569	46.1%	7,805,470	72,757,569	46.1%	70,017	269,592	74.0%	7,875,487
Santee HSA (907.12) Forrester Creek	1801	7,805,470	72,757,569	46.1%	7,805,470	72,757,569	46.1%	70,017	269,592	74.0%	7,875,487
San Diego HU (907.11) & Santee HSA (907.12) San Diego River, Lower	1801	7,805,470	72,757,569	46.1%	7,805,470	72,757,569	46.1%	70,017	269,592	74.0%	7,875,487
Chollas HSA (908.22) Chollas Creek	1901	1,680,809	15,390,608	60.7%	1,680,809	15,390,608	60.7%	19,910	250,803	92.1%	1,700,719

[a] Model subwatershed (see Appendix G) is the number used in LSPC to identify the subwatershed associated with the listed segment(s) within a hydrologic region. Load duration curves and detailed TMDL tables for each subwatershed are provided in Appendix K.

[b] Percent reduction is calculated by dividing the non-allowable exceedance load by the total load using the allowance criteria. These values are presented for each subwatershed in Appendix K.

Table 9-4. Final TMDLs for Total Coliform

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12) Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	101	177	67,350	99.8%	678	628,669	99.9%	54	25,369	99.8%	732
	103	501	561,319	99.9%							
Laguna Beach HSA (901.12) at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Ave. Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Rd. Laguna Beach at Dumond Drive	104	6,040	6,278,214	99.9%	8,976	7,593,233	99.9%	729	110,707	99.3%	9,705
	105	2,400	1,076,489	99.8%							
	106	536	238,530	99.8%							
Aliso HSA (901.13) Laguna Beach at Lagunita Place / Blue Lagoon Place at Aliso Beach Aliso Creek	201	362	364,715	99.9%	60,617	23,210,774	99.8%	834	262,841	99.7%	61,451
	202	60,255	22,846,059	99.7%							
Dana Point HSA (901.14) Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	301	292	224,286	99.9%	12,833	6,546,962	99.9%	319	91,908	99.7%	13,152
	302	411	261,979	99.9%							
	304	11,434	5,599,516	99.9%							
	305	211	209,193	99.9%							
	306	485	251,988	99.8%							
Lower San Juan HSA (901.27)[c] San Juan Creek	401	9,540,977	130,258,863	93.1%	9,540,977	130,258,863	93.1%	80,190	297,153	73.0%	9,621,167

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Clemente HA (901.30) at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal St. Stairs San Clemente City Beach at Mariposa St. San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane San Clemente City Beach at Lifeguard Headquarters Under San Clemente Municipal Pier San Clemente City Beach at Trafalgar Canyon (Trafalgar Ln.) San Clemente State Beach at Riviera Beach San Clemente State Beach at Cypress Shores	501	7,912	5,276,541	99.9%	22,620	16,236,540	99.9%	653	162,960	99.6%	23,273
	502	1,922	1,216,982	99.9%							
	503	7,974	7,101,860	99.9%							
	504	2,435	1,903,632	99.9%							
	505	1,653	439,306	99.8%							
	506	724	298,219	99.8%							
San Luis Rey HU (903.00) at San Luis Rey River Mouth	701	381,100	231,598,677	99.8%	381,100	231,598,677	99.8%	3,394	78,370	95.7%	384,494
San Marcos HA (904.50) at Moonlight State Beach	1101	1,061	515,278	99.8%	1,061	515,278	99.8%	95	7,907	98.8%	1,156
San Dieguito HU (905.00) at San Dieguito Lagoon Mouth	1301	240	130,532	99.8%	269,007	163,541,132	99.7%	4,029	67,236	94.0%	273,036
	1302	268,767	163,410,600	99.7%							
Miramar Reservoir HA (906.10) Torrey Pines State Beach at Del Mar (Anderson Canyon)	1401	192	212,986	99.9%	192	212,986	99.9%	23	9,307	99.8%	215

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
Scripps HA (906.30) La Jolla Shores Beach at El Paseo Grande La Jolla Shores Beach at Caminito Del Oro La Jolla Shores Beach at Vallecitos La Jolla Shores Beach at Ave de la Playa at Casa Beach, Children' s Pool South Casa Beach at Coast Blvd. Whispering Sands Beach at Ravina St. Windansea Beach at Vista de la Playa Windansea Beach at Bonair St. Windansea Beach at Playa del Norte Windansea Beach at Palomar Ave. at Tourmaline Surf Park Pacific Beach at Grand Ave.	1501	1,430	768,912	99.9%	7,222	5,029,518	99.9%	427	171,529	99.8%	7,649
	1503	2,698	2,485,458	99.9%							
	1505	1,454	958,988	99.9%							
	1507	1,640	816,160	99.9%							
San Diego HU (907.11) at San Diego River Mouth (aka Dog Beach)	1801	179,526	72,757,569	99.7%	179,526	72,757,569	99.7%	4,901	269,592	98.2%	184,427
Santee HSA (907.12)[c] Forrester Creek	1801	179,526	72,757,569	99.7%	179,526	72,757,569	99.7%	4,901	269,592	98.2%	184,427
San Diego HU (907.11) & Santee HSA (907.12)[c] San Diego River, Lower	1801	179,526	72,757,569	99.7%	179,526	72,757,569	99.7%	4,901	269,592	98.2%	184,427
Chollas HSA (908.22)[c] Chollas Creek	1901	1,680,809	15,390,608	91.0%	1,680,809	15,390,608	91.0%	19,910	250,803	92.1%	1,700,719

[a] Model subwatershed (see Appendix G) is the number used in LSPC to identify the subwatershed associated with the listed segment(s) within a hydrologic region. Load duration curves and detailed TMDL tables for each subwatershed are provided in Appendix K.

[b] Percent reduction is calculated by dividing the non-allowable exceedance load by the total load using the allowance criteria. These values are presented for each subwatershed in Appendix K.

[c] TMDL results are based on the numeric target for creeks.

Table 9-5. Interim TMDLs for Enterococci

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12) Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	101	80	8,374	93.5%	307	61,351	94.4%	27	4,268	99.4%	334
	103	227	52,977	94.7%							
Laguna Beach HSA (901.12) at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Ave. Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Rd. Laguna Beach at Dumond Drive	104	2,731	650,651	94.0%	4,058	791,298	94.4%	365	18,624	98.0%	4,423
	105	1,085	117,393	95.1%							
	106	242	23,254	94.3%							
Aliso HSA (901.13) Laguna Beach at Lagunita Place / Blue Lagoon Place at Aliso Beach Aliso Creek	201	164	21,646	95.9%	16,145	2,230,206	95.3%	394	45,525	99.1%	16,539
	202	15,981	2,208,560	95.3%							
Dana Point HSA (901.14) Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	301	132	16,137	95.4%	5,802	501,525	91.0%	160	15,462	99.0%	5,962
	302	186	22,871	95.5%							
	304	5,170	428,285	89.5%							
	305	95	11,603	95.3%							
	306	219	22,629	94.2%							
Lower San Juan HSA (901.27) San Juan Creek	401	58,200	12,980,098	93.7%	58,200	12,980,098	93.7%	2,646	52,338	94.9%	60,846

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Clemente HA (901.30) at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal St. Stairs San Clemente City Beach at Mariposa St. San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane San Clemente City Beach at Lifeguard Headquarters Under San Clemente Municipal Pier San Clemente City Beach at Trafalgar Canyon (Trafalgar Ln.) San Clemente State Beach at Riviera Beach San Clemente State Beach at Cypress Shores	501	3,578	570,531	92.5%	10,227	1,663,093	91.3%	326	27,415	98.8%	10,553
	502	869	105,718	86.9%							
	503	3,605	806,852	91.6%							
	504	1,101	120,842	89.9%							
	505	747	33,570	81.1%							
	506	327	25,580	82.3%							
San Luis Rey HU (903.00) at San Luis Rey River Mouth	701	172,323	18,439,920	84.8%	172,323	18,439,920	84.8%	1,697	13,442	87.4%	174,020
San Marcos HA (904.50) at Moonlight State Beach	1101	480	40,558	94.9%	480	40,558	94.9%	48	1,330	96.4%	528
San Dieguito HU (905.00) at San Dieguito Lagoon Mouth	1301	109	14,763	76.2%	121,638	14,796,210	77.8%	2,015	12,175	83.4%	123,653
	1302	121,529	14,781,447	77.8%							

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
Miramar Reservoir HA (906.10) Torrey Pines State Beach at Del Mar (Anderson Canyon)	1401	87	11,564	66.3%	87	11,564	66.3%	11	1,566	99.3%	98
Scripps HA (906.30) La Jolla Shores Beach at El Paseo Grande La Jolla Shores Beach at Caminito Del Oro La Jolla Shores Beach at Vallecitos La Jolla Shores Beach at Ave de la Playa at Casa Beach, Children' s Pool South Casa Beach at Coast Blvd. Whispering Sands Beach at Ravina St. Windansea Beach at Vista de la Playa Windansea Beach at Bonair St. Windansea Beach at Playa del Norte Windansea Beach at Palomar Ave. at Tourmaline Surf Park Pacific Beach at Grand Ave.	1501	647	74,057	94.8%	3,267	377,839	95.2%	214	28,856	99.3%	3,481
	1503	1,220	185,674	96.3%							
	1505	658	62,646	94.1%							
	1507	742	55,462	91.4%							
San Diego HU (907.11) at San Diego River Mouth (aka Dog Beach)	1801	47,613	7,255,759	93.2%	47,613	7,255,759	93.2%	2,311	38,190	93.9%	49,924
Santee HSA (907.12) Forrester Creek	1801	47,613	7,255,759	93.2%	47,613	7,255,759	93.2%	2,311	38,190	93.9%	49,924
San Diego HU (907.11) & Santee HSA (907.12) San Diego River, Lower	1801	47,613	7,255,759	93.2%	47,613	7,255,759	93.2%	2,311	38,190	93.9%	49,924
Chollas HSA (908.22) Chollas Creek	1901	10,253	1,371,972	96.0%	10,253	1,371,972	96.0%	657	42,826	98.5%	10,910

[a] Model subwatershed (see Appendix G) is the number used in LSPC to identify the subwatershed associated with the listed segment(s) within a hydrologic region. Load duration curves and detailed TMDL tables for each subwatershed are provided in Appendix K.

[b] Percent reduction is calculated by dividing the non-allowable exceedance load by the total load using the allowance criteria. These values are presented for each subwatershed in Appendix K.

Table 9-6. Final TMDLs for Enterococci

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12) Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	101	80	8,374	99.2%	307	61,351	99.5%	27	4,268	99.4%	334
	103	227	52,977	99.6%							
Laguna Beach HSA (901.12) at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Ave. Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Rd. Laguna Beach at Dumond Drive	104	2,731	650,651	99.6%	4,058	791,298	99.5%	365	18,624	98.0%	4,423
	105	1,085	117,393	99.2%							
	106	242	23,254	99.1%							
Aliso HSA (901.13) Laguna Beach at Lagunita Place / Blue Lagoon Place at Aliso Beach Aliso Creek	201	164	21,646	99.3%	16,145	2,230,206	99.4%	394	45,525	99.1%	16,539
	202	15,981	2,208,560	99.4%							
Dana Point HSA (901.14) Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	301	132	16,137	99.3%	5,802	501,525	99.2%	160	15,462	99.0%	5,962
	302	186	22,871	99.3%							
	304	5,170	428,285	99.2%							
	305	95	11,603	99.2%							
	306	219	22,629	99.1%							
Lower San Juan HSA (901.27) San Juan Creek	401	58,200	12,980,098	99.6%	58,200	12,980,098	99.6%	2,646	52,338	94.9%	60,846

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
San Clemente HA (901.30) at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal St. Stairs San Clemente City Beach at Mariposa St. San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane San Clemente City Beach at Lifeguard Headquarters Under San Clemente Municipal Pier San Clemente City Beach at Trafalgar Canyon (Trafalgar Ln.) San Clemente State Beach at Riviera Beach San Clemente State Beach at Cypress Shores	501	3,578	570,531	99.4%	10,227	1,663,093	99.4%	326	27,415	98.8%	10,553
	502	869	105,718	99.4%							
	503	3,605	806,852	99.6%							
	504	1,101	120,842	99.1%							
	505	747	33,570	99.0%							
	506	327	25,580	98.8%							
San Luis Rey HU (903.00) at San Luis Rey River Mouth	701	172,323	18,439,920	99.1%	172,323	18,439,920	99.1%	1,697	13,442	87.4%	174,020
San Marcos HA (904.50) at Moonlight State Beach	1101	480	40,558	99.0%	480	40,558	99.0%	48	1,330	96.4%	528
San Dieguito HU (905.00) at San Dieguito Lagoon Mouth	1301	109	14,763	99.3%	121,638	14,796,210	99.1%	2,015	12,175	83.4%	123,653
	1302	121,529	14,781,447	99.1%							
Miramar Reservoir HA (906.10) Torrey Pines State Beach at Del Mar (Anderson Canyon)	1401	87	11,564	99.3%	87	11,564	99.3%	11	1,566	99.3%	98

Hydrologic Descriptor	Wet Weather TMDL Results							Dry Weather TMDL Results			TMDL (Billion MPN/year)
	Model Subwatershed[a]	Waste Load Allocation (Billion MPN/year)	Total Load for Existing Condition (Billion MPN/year)	Percent Reduction[b]	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	Basinwide Waste Load Allocation (Billion MPN/year)	Basinwide Existing Load (Billion MPN/year)	Basinwide Percent Reduction	
Scripps HA (906.30) La Jolla Shores Beach at El Paseo Grande La Jolla Shores Beach at Caminito Del Oro La Jolla Shores Beach at Vallecitos La Jolla Shores Beach at Ave de la Playa at Casa Beach, Children' s Pool South Casa Beach at Coast Blvd. Whispering Sands Beach at Ravina St. Windansea Beach at Vista de la Playa Windansea Beach at Bonair St. Windansea Beach at Playa del Norte Windansea Beach at Palomar Ave. at Tourmaline Surf Park Pacific Beach at Grand Ave.	1501	647	74,057	99.3%	3,267	377,839	99.3%	214	28,856	99.3%	3,481
	1503	1,220	185,674	99.3%							
	1505	658	62,646	99.2%							
	1507	742	55,462	99.2%							
San Diego HU (907.11) at San Diego River Mouth (aka Dog Beach)	1801	47,613	7,255,759	99.3%	47,613	7,255,759	99.3%	2,311	38,190	93.9%	49,924
Santee HSA (907.12) Forrester Creek	1801	47,613	7,255,759	99.3%	47,613	7,255,759	99.3%	2,311	38,190	93.9%	49,924
San Diego HU (907.11) & Santee HSA (907.12) San Diego River, Lower	1801	47,613	7,255,759	99.3%	47,613	7,255,759	99.3%	2,311	38,190	93.9%	49,924
Chollas HSA (908.22) Chollas Creek	1901	10,253	1,371,972	99.3%	10,253	1,371,972	99.3%	657	42,826	98.5%	10,910

[a] Model subwatershed (see Appendix G) is the number used in LSPC to identify the subwatershed associated with the listed segment(s) within a hydrologic region. Load duration curves and detailed TMDL tables for each subwatershed are provided in Appendix K.

[b] Percent reduction is calculated by dividing the non-allowable exceedance load by the total load using the allowance criteria. These values are presented for each subwatershed in Appendix K.

10 Implementation

The Regional Board is currently developing the Implementation Plan for this project. The Implementation Plan describes the pollutant reduction actions that must be taken by various responsible parties to meet the allocations. Specifically, the Regional Board can issue or amend existing Waste Discharge Requirements, including those that implement National Pollutant Discharge Elimination System (NPDES) regulations, or Waivers of Waste Discharge Requirements, or adopt Basin Plan prohibitions. The implementation provisions may also require studies by the dischargers to fill data gaps, refine the TMDLs and required load reductions, or modify compliance requirements. The dischargers will also be ordered to conduct monitoring to assess the effectiveness of the implementation measures at meeting the load and waste load reductions. Public participation is a key element of the TMDL process, and stakeholder involvement is encouraged and required.

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Appendix A
Bacteria-Impaired Waterbodies Addressed

	Hydrologic Descriptor	Waterbody	Segment or Area	Pollutant or Stressor	Extent of Impairment	Year Listed
Beach Shoreline Listings (North to South)						
1	San Joaquin Hills HSA (901.11) & Laguna Beach HSA (901.12)	Pacific Ocean Shoreline	Cameo Cove at Irvine Cove Dr. - Riviera Way at Heisler Park – North	Bacteria Indicators[a]	0.6 miles	1998
2	Laguna Beach HSA (901.12)	Pacific Ocean Shoreline	at Main Laguna Beach Laguna Beach at Ocean Avenue Laguna Beach at Laguna Avenue Laguna Beach at Cleo Street Arch Cove at Bluebird Canyon Road Laguna Beach at Dumond Drive	Bacteria Indicators[a]	1.8 miles	1998
3	Aliso HSA (901.13)	Pacific Ocean Shoreline	Laguna Beach at Lagunita Place/Blue Lagoon Place at Aliso Beach	Bacteria Indicators[a]	0.7 miles	1998
4	Dana Point HSA (901.14)	Pacific Ocean Shoreline	Aliso Beach at West Street Aliso Beach at Table Rock Drive 1000 Steps Beach at Pacific Coast Hwy at Hospital (9th Ave) at Salt Creek (large outlet) Salt Creek Beach at Salt Creek service road Salt Creek Beach at Dana Strand Road	Bacteria Indicators[a]	1.88 miles	1998
5	San Clemente HA (901.30)	Pacific Ocean Shoreline	at Poche Beach (large outlet) Ole Hanson Beach Club Beach at Pico Drain San Clemente City Beach at El Portal Street Stairs San Clemente City Beach at Mariposa Street San Clemente City Beach at Linda Lane San Clemente City Beach at South Linda Lane	Bacteria Indicators[a]	3.4 miles	1998
			San Clemente City Beach at Lifeguard Headquarters			

	Hydrologic Descriptor	Waterbody	Segment or Area	Pollutant or Stressor	Extent of Impairment	Year Listed
			Under San Clemente Municipal Pier			
			San Clemente City Beach at Trafalgar Canyon (Trafalgar Lane)			
			San Clemente State Beach at Riviera Beach			
			San Clemente State Beach at Cypress Shores			
6	San Marcos HA (904.50)	Pacific Ocean Shoreline	at Moonlight State Beach	Bacteria Indicators[a]	0.4 miles	1998
7	Miramar Reservoir HA (906.10)	Pacific Ocean Shoreline	Torrey Pines State Beach at Del Mar (Anderson Canyon)	Bacteria Indicators[a]	0.4 miles	2002
8	Scripps HA (906.30)	Pacific Ocean Shoreline	La Jolla Shores Beach at El Paseo Grande	Bacteria Indicators[a]	3.9 miles	1998
			La Jolla Shores Beach at Caminito Del Oro			
			La Jolla Shores Beach at Vallecitos			
			La Jolla Shores Beach at Ave de la Playa			
			at Casa Beach, Children's Pool[B]			
			South Casa Beach at Coast Blvd.			
			Whispering Sands Beach at Ravina Street			
			Windansea Beach at Vista de la Playa			
			Windansea Beach at Bonair Street			
			Windansea Beach at Playa del Norte			
			Windansea Beach at Palomar Ave.			
			at Tourmaline Surf Park			
			Pacific Beach at Grand Ave.			

Creek Listings						
	Hydrologic Descriptor	**Waterbody**	**Segment or Area**	**Pollutant or Stressor**	**Extent of Impairment**	**Year Listed**
1	Aliso HSA (901.13)	Aliso Creek	See Footnote b	Enterococci, *E. coli*, Fecal Coliform	See Footnote b	1998
2	Lower San Juan HSA (901.27)	San Juan Creek		Bacteria Indicators[a]	1 mile	1998
3	Santee HSA (907.12)	Forrester Creek		Fecal coliform	lower 1 mile	2002
4	Mission San Diego HSA (907.11) & Santee HSA (907.12)	San Diego River, Lower		Fecal coliform	lower 6 miles	2002
5	Chollas HSA (908.22)	Chollas Creek		Bacteria Indicators[a]	1.2 miles	1998
~~6~~	~~Tijuana HU (911.00)~~	~~Pine Valley Creek, Upper~~	~~lower portion~~	~~Enterococci~~	~~lower 2.9 miles~~	~~2002~~
Creek/Lagoon Mouths Listings						
	Hydrologic Descriptor	**Waterbody**	**Segment or Area**	**Pollutant or Stressor**	**Extent of Impairment**	**Year Listed**
1	Aliso HSA (901.13)	Aliso Creek	at creek mouth	Bacteria Indicators[b]	0.29 acres	1996
2	San Luis Rey HU (903.00)	Pacific Ocean Shoreline	at San Luis Rey River Mouth	Bacteria Indicators[a]	0.49 miles	1996
3	San Dieguito HU (905.00)	Pacific Ocean Shoreline	at San Dieguito Lagoon Mouth	Bacteria Indicators[a]	0.86 miles	1996
4	San Diego HSA (907.11)	Pacific Ocean Shoreline	at San Diego River Mouth (aka Dog Beach)	Bacteria Indicators[a]	0.37 miles	1996

[a] In 1998, bacteria indicators implies that impairment was due to total coliforms, fecal coliforms, or both. In 2002 impairment may have also been caused by enterococci.

[b] The entire reach (7.2 miles) is listed for enterococci, *E. coli* and fecal coliforms. In addition, Aliso Hills Channel, English Canyon Creek, Dairy Fork Creek, Sulphur Creek, and Wood Canyon Creek are listed for enterococci and *E. coli*.

Appendix B
Data Sources

Table B-1. Monitoring Data Sources

Index	Data Source	Location	Station ID	Years Compiled	Purpose
Stream Flow					
1	Orange County Pubic Facilities and Resources Department[1]	Aliso Creek	J01P08, J01P06, J07P02, J07P01, J01P0, J01P05, J01P03, J1P04, J06, J05, J01P30, J01P28, J01P27, J01P33, J01P25, J0126, J01P24, J01P23, J01P22, J03P02, J01P21, J02P05, J02P08, J03P13, J03P05, J03P01, J04	4/2001-12/2002	Instantaneous flow measurements used for development of multi-variable regression equations for prediction of dry-weather streamflows
			J01P22, J01P23, J01P27, J01P28, J06, J01P05, J01P01, J01BN8, J04, J03P13, J03P01	4/2001-12/2002	Instantaneous flow measurements used for calibration of dry-weather modeled streamflows
2	City of San Diego[1]	Rose Creek and Tecolote Creek (Mission Bay Drainage)	MBW07	11/2001-4/2003	Instantaneous flow measurements used for development of multi-variable regression equations for prediction of dry-weather streamflows
			MBW09, MBW13, MBW16	7/2001-4/2003	
			MBW11	12/2001-4/2003	
			MBW13, MBW15, MBW17	7/2001-4/2003	Instantaneous flow measurements used for calibration of dry-weather modeled streamflows
			MBW20	11/2001-4/2003	
			MBW11	12/2001-4/2003	
			MBW24	12/2001-3/2003	
			MBW06, MBW10, MBW09	7/2001-4/2003	Instantaneous flow measurements used for validation of dry-weather modeled streamflows
			MBW07, MBW08	11/2001-4/2003	
3	United States Geological Survey (USGS) [2]	San Juan Creek	11047300	10/1970-1/2002	Average daily flows on dry days used for calibration of dry-weather modeled streamflows
		San Diego River	11022480	1/1991-12/2001	Average daily flows on wet days used for calibration and validation of wet-weather modeled streamflows
		San Diego River	11023000	1/1991-12/2001	
		Miramar	11023340	1/1991-12/2001	
		San Dieguito	11025500	1/1991-12/2001	
		San Dieguito	11028500	1/1991-12/2001	
		San Luis Rev	11042000	9/1993-5/2002	
		Santa Margarita	11042400	1/1991-12/2001	

Index	Data Source	Location	Station ID	Years Compiled	Purpose
		Santa Margarita	11044300	1/1991-12/2001	
		Santa Margarita	11046000	1/1991-12/1998	
		San Juan Creek	11046530	1/1991-12/2001	
		San Juan Creek	11047300	10/1995-4/2002	
		San Diego River	11022350	1/1991-9/1993	
		San Luis Rey	11039800	1/1991-12/1992	
Water Quality					
4	Orange County Pubic Facilities and Resources Department[1]	Aliso Creek	J01P08, J01P06, J07P02, J07P01, J01P01, J01P05, J01P03, J1P04, J06, J05, J01P30, J01P28, J01P27, J01P33, J01P25, J0126, J01P24, J01P23, J01P22, J03P02, J01P21, J02P05, J02P08, J03P13, J03P05, J03P01, J04	4/2001-12/2002	Development of multi-variable regression equations for prediction of dry-weather bacteria levels
			J01P22, J01P23, J01P27, J01P28, J06, J01P05, J01P01, J01BN8, J04, J03P13, J03P01	4/2001-12/2002	Calibration of dry-weather model for bacteria levels
5	City of San Diego[1]	Rose Creek and Tecolote Creek (Mission Bay Drainage)	MBW07, MBW08	11/2001-4/2003	Development of multi-variable regression equations for prediction of dry-weather bacteria levels
			MBW06, MBW09, MBW10, MBW13, MBW15, MBW16	7/2001-4/2003	
			MBW24	12/2001-3/2003	
			MBW13, MBW15, MBW17	7/2001-4/2003	Calibration of dry-weather model for bacteria levels
			MBW20	11/2001-4/2003	
			MBW11	12/2001-4/2003	
			MBW24	12/2001-3/2003	
			MBW06, MBW10, MBW09	7/2001-4/2003	Validation of dry-weather model for bacteria levels
			MBW07, MBW08	11/2001-4/2003	

6	Orange County Public Health Laboratory (SDRWQCB, 2002)	San Juan Creek	SJ13	4/2001-7/2001	Development of multi-variable regression equations for prediction of dry-weather bacteria levels
			SJ14, SJ15, SJ16, SJ19, SJ20, SJ21, SJ29, SJ32	5/2001-7/2001	
			SJ01, SJ04, SJ05, SJ24	4/2001-7/2001	Validation of dry-weather model for bacteria levels
			SJ15, SJ17, SJ18, SJ29	5/2001-7/2001	
7	Southwest Division Naval Facilities Engineering Command	Santa Margarita	501, 504, 508, 502, 503, 505, 506, 507	12/1997-2/1999	Validation of wet weather water quality predictions
8	Rancho California Water District	Santa Margarita River	Station #1 (Upstream from Santa Rosa Plant), Station #2 (Willow Glen), Station #3 (Deluz Crossing), Station #4 (Estuary)	12/1997-2/2001	
9	Camp Pendleton	Santa Margarita River	Plant #3 Upstream; Plant #13 Upstream	1/1995-3/2002	

10	The Orange County Public Facilities and Resources Department (OCPFRD)	Aliso creek	D/S J01/J02, J01 @ TP, U/S J01/J02, J02TBN1, D/S J01P21, U/S J01P21, J01P22, D/S J01/J03, U/S J01/J03, D/S J01P23, D/S J01P24, D/S J01P25, D/S J01P26, D/S J01P27, D/S J01P33, D/S J01TBN4, J01P28, U/S J01P23, U/S J01P24, U/S J01P25, U/S J01P26, U/S J01P27, U/S J01P33, U/S J01TBN4, D/S J01P30, U/S J01P30, D/S J06, U/S J06, D/S J01P04, D/S J01P05, D/S J01P32, D/S J01TBN2, D/S J01TBN3, J01P01, J07P01J07P02, U/S J01P04, U/S J01P05, U/S J01P32, U/S J01TBN2, U/S J01TBN3, D/S J01P08, D/S J01TBN8, J01P06, J02P08, U/S J01P08, U/S J01TBN8, D/S J05, U/S J05, J01P03, J04, U/S J04, J02P05, J03P02, J03P05, J03P13, J03P01, J03TBN1, J03TBN2	4/2001-11/2003	
11	Orange County Public Health Laboratory (SDRWQCB, 2002)	San Juan Creek	SJ02, SJ09, SJ10, SJ12, SJ13, SJ25, SJ30	5/2001-12/2001	

12	City of San Diego (2000)	Rose Creek and Tecolote Creek (Mission Bay Drainage)	MBW06, MBW07, MBW08, MBW09, MBW10, MBW11, MBW12, MBW13, MBW14, MBW15, MBW16, MBW17, MBW18, MBW19, MBW20, MBW21, MBW23, MBW24	11/2001-2/2002	
13	Padre Dam Municipal Water District	San Diego River	1, 2, 3, 4, 5, 6	3/1998-4/2002	
14	City of San Diego-Water Department, Cleveland National Forest Descanso Ranger District	Pine Valley Creek	NPC3A, NPC3C, NPC3D, PVC1A	2/1998-4/1998	
15	Orange County Environmental Health	Mouth of San Juan Creek	ODB02, ODB05	6/1999-10/2002	Analyzed to confirm the water quality impairment at beaches, provide an insight regarding the spatial extent of impairments, and assess the relationship with wet and dry conditions
		Mouth of Aliso Creek	OLB00		
		Dana Point	OSL25, BDP12, BDP13, BDP14, BDP15		
16	City of San Diego, Department of Health (DEH)	Mouth of Agua Hedionda Lagoon	EH-460	5/1999-10/2001	
		Scripps	EH-260	4/1999-9/2000	
		Scripps	EH-290	4/1999-11/2000	
		Mouth of San Luis Rey River	EH-490	4/1999-10/2001	
		Mouth of Agua Hedionda Lagoon	EH-440	4/1999-10/2001	
		Mouth of Agua Hedionda Lagoon	EN-030	1/1999-11/2001	
		Scripps	EH-250, EH-280	4/1999-10/2002	
		Scripps	EH-300	1/1999-10/2002	
		Scripps	EH-310	4/1999-9/2002	
		Buena Vista	EH-475	10/1999-10/2002	
		San Marcos	EH-420	4/1999-10/2002	
		San Dieguito	EH-380, EH-390	4/1999-10/2002	
		San Clemente	EH-510	8/1999-10-2002	
		San Clemente	EH-520	6/1999-10/2002	
		Scripps	EH-305	2/2001-10/2002	

		Agua Hedionda	EH-455	1/2001-10/2001	
17	South Orange County Wastewater Authority (SOCWA)	San Clemente and mouth of San Juan Creek Lagoon	S-0, S-1, S-3, S-5, S-7, S-11, S-13, S-15, S-17, S-19, S-23	3/2000-10/2002	
		Mouth of San Juan Creek Lagoon	S-2	1/1999-10/2002	
		Dana Point and mouth Aliso Creek	S01, S02, S04, S06, S07, S08, S09, S10	1/1999-10/2002	
		Laguna/mouth of San Joaquin	S11, S13, S15, S14, S16	1/1999-10/2002	
18	City of San Diego[1]	Miramar, Scripps and mouth of San Diego River	FM-010, FM-030, FM-080	1/1999-10/2002	
			FM-050	1/1999-9/2002	
19	City of Oceanside	Mouth of San Luis Rey River	OC-100	1/1999-10/2002	
		Mouth of Loma Alta Slough	OC-022		
20	City of Escondido	Mouth of Escondido Creek and San Dieguito Creek	SE-020, SE-010	1/1999-10/2002	
Meteorological Data					
21	National Oceanographic and Atmospheric Administration-National Climatic Data Center (NOAA-NCDC)	San Diego	COOP ID #047740	1990-2002	Hourly rainfall data used for hydrologic and water quality modeling for wet-weather conditions
		Laguna/San Joaquin, Aliso, Dana Point, San Juan, San Clemente	CA4650		
		Aliso Creek, San Juan Creek	CA8992		
		San Juan Creek	CA7837		
		Santa Margarita River	CA8844		
		Santa Margarita, San Luis Rey	CA6319		
		Santa Margarita, San Luis Rey, San Luis Rey, Loma Alta, Buena Vista, Agua Hedionda, San Marcos	CA6379		
		Pine Valley Creek	CA2239		
		Miramar, Scripps, Rose Creek, Tecolate, San Diego River, Chollas	CA7740		

22	California Irrigation Management Information System (CIMIS)	Escondido Creek, San Dieguito Creek, Miramar	CIMIS74	1990-2002	Hourly rainfall, Evaporation data used for hydrologic and water quality modeling for wet-weather conditions
23	Automatic Local Evaluation in Real-Time (ALERT) Flood Warning System	San Clemente	21	1990-2002	Hourly rainfall data used for hydrologic and water quality modeling for wet-weather conditions
		San Marcos, Escondido Creek, San Deigouito Creek, Miramar	22		
		San Dieguito Creek, Miramar, Rose Creek, San Diego River	24		
		Chollas	31		
		Santa Margarita, San Luis Rey, San Dieguito	52		
		San Luis Rey, San Dieguito, Miramar, San Diego	53		

[1] Not complete at the time of TMDL report development, Final report not available for study
[2] www.usgs.gov

Table B-2. GIS Data Sources

Index	Data Type	Data Source	Years Compiled	Purpose
24	Stream network	USGS -National Hydrography Dataset (NHD)	-	Determination of representative modeled stream for each sub-watershed
25	Land Use	USGS - Multi-Resolution Land Characteristics (MRLC)	1993	Designation of Land uses in the region
		San Diego's Regional Planning Agency (SANDAG)	2001	
		Southern California Association of Governments (SCAG)	2000	
26	Soils	USDA-NRCS (STATSGO)	1994	STATSGO soil data used for modeling
27	Topographic and digital elevation models (DEMs)	USEPA BASINS, USGS[2]	-	To derive streams and watershed boundaries

[2] www.usgs.gov

Appendix C
Methodology for 303(d) Listing of Beaches for Bacteria

Methodology for Section 303(d) Listing of Beaches for Bacteria

This document summarizes the listing methodology used to determine whether a beach segment exhibiting elevated levels of bacterial indicators was sufficiently contaminated to warrant inclusion on the Clean Water Act Section 303(d) List of impaired waters. The method described below was used by each of the three southern California Regional Water Quality Control Boards during the 2002 update of the Section 303(d) list. In essence, if year-round water quality data collected from a beach segment indicated that Basin Plan water quality objectives for bacteria were exceeded 10% or more of the time, the beach segment was listed.

Data collected from 1999 to 2002 by the San Diego County Department of Environmental Health and the Orange County Health Care Agency was reviewed for the 2002 assessment of beaches in the San Diego Region. For each sampling location and each day of sampling, measurements of all three bacterial indicators -- total coliform, fecal coliform and enteroccocus -- were compared to their respective Basin Plan water quality objectives and the number of water quality objective exceedance days was tabulated. If any one of the indicators exceeded the objective, this was considered a “hit.” If two or all three indicators exceeded the objective, this was also considered a hit, but was only counted once. The identified exceedance days were then compared to Beach Closure and Advisory Reports generated by the respective agencies. If an exceedance was the direct result of a known sewage spill or forced lagoon opening, the exceedance was not included in the tabulation for Section 303(d) listing purposes. In addition, only raw data was considered. Rain advisories and precautionary beach postings were not considered for listing purposes if they did not have supporting water quality data.

For each beach segment, the number of exceedance days was compared to the number of exceedance days expected to occur at a beach downstream of a watershed that is minimally impacted by human activities. In the absence of an identified “reference beach” in the San Diego Region, the two listing thresholds recommended by the statewide Beach Water Quality Workgroup were used[1]. If year-round data was available, the threshold for listing was 10%. This means that if 10% of the total samples for a specific beach segment exceeded the numeric objectives, the segment was listed. For beach segments where data was available for the dry season only (April 1-October 31), the threshold was lowered to 4%. The 10% threshold was adopted from USEPA’s Section 305(b) Water Quality Assessment Guidance[2], in which it is loosely stated that exceedances greater than 10% of numeric objectives, for all constituents, can be interpreted as not supporting the beneficial use(s) of the waterbody. The 4% threshold originated from the Bight ‘98 Study[3], in which it was found that roughly 4% of bacterial samples collected during the dry season in a relatively minimally impacted watershed exceeded numeric water quality objectives for bacteria.

Using the above criteria, four beach segments in the San Diego Region were added to the Section 303(d) List in 2002. These segments were Shelter Island Shoreline Park (San Diego

[1] Draft 303(d) Listing Criteria, November 12, 2002. Monitoring & Reporting Subcommittee Beach Water Quality Workgroup.
[2] USEPA. 1997. "Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Supplement." EPA-841-B-97-002A. Office of Water, Washington, D.C.
[3] Southern California Coastal Water Research Project (SCCWRP). 1998. Southern California Bight ’98 Regional Monitoring Program.

Bay), Tidelands Park (San Diego Bay), Baby Beach (Dana Point Harbor) and South Capistrano Beach at Beach Road.

Appendix D
Water Quality Objectives for Bacteria Indicators

Water Quality Objectives for Bacteria Indicators

Background

Under section 304(a) of the Clean Water Act, the USEPA is required to publish water quality criteria accurately reflecting the latest scientific knowledge for the protection of human health and aquatic life. Prior to 1986, the USEPA recommended bacteria criteria based on fecal coliforms to protect human health[1]. In 1986, the USEPA recommended the use of criteria based on E. coli for fresh waters and enterococci for fresh and marine waters rather than the use of criteria based on fecal coliforms[2]. The USEPA recommended this change in the use of bacteria indicator organisms because USEPA studies demonstrated that E. coli and enteroccocci are better predictors of the presence of gastrointestinal illness-causing pathogens than fecal and total coliforms and hence provide a better means of protecting human health. Subsequent supporting research led the USEPA to reaffirm these findings in 2002.[3] The USEPA strongly recommends the replacement of water quality objectives based on fecal or total coliforms with objectives based on enterococci and E. coli. As described below, the Basin Plan for the San Diego Region contains objectives based on fecal and total coliforms as well as enterococci and E. coli for inland surface waters, enclosed bays and estuaries and coastal lagoons.

I. REC-1 Water Quality Objectives in the San Diego Region

The REC-1 water quality objectives for bacterial indicators applicable in the San Diego Region are contained in the Ocean Plan and in the San Diego Regional Board's Basin Plan. The objectives contained in both are derived from water quality criteria promulgated by the USEPA in 1976 and 1986. The Ocean Plan currently contains REC-1 objectives for total and fecal coliforms. The Basin Plan currently contains REC-1 objectives for total coliforms, fecal coliforms, enterococci and E. coli as shown below.

REC-1
Ocean Waters (from Ocean Plan)

Fecal Coliforms: Fecal coliform density based on a minimum of not less than five samples for any **30-day period**, shall not exceed a **geometric mean of 200** per 100 ml nor shall more than **10%** of the total samples during any **60-day period** exceed **400** per 100 ml.

Total Coliforms: Samples shall have a density of total coliform organisms less than **1,000** per 100 ml (10 per ml); provided that not more than **20%** of the samples at any sampling station, in any **30-day period**, may exceed **1,000** per 100 ml (10 per ml) and provided further that no **single sample** when verified by a repeat sample taken within 48 hours shall exceed **10,000** per 100 ml (100 per ml).

[1] Quality Criteria for Water. USEPA 1976
[2] Ambient Water Quality Criteria for Bacteria. USEPA 1986
[3] Implementation Guidance for Ambient Water Quality Criteria for Bacteria. May 2002 DRAFT.

REC-1
Inland Surface Waters, Enclosed Bays and Estuaries and Coastal Lagoons (from Basin Plan)

Fecal Coliforms / Fresh or Marine Waters: Fecal coliform concentration, based on a minimum of not less than five samples for any **30-day period**, shall not exceed a **log mean of 200** per 100 ml, nor shall more than **10%** of total samples during any **30-day period** exceed **400** per 100 ml.

Total Coliforms / Bays and Estuaries only: Coliform organisms shall be less than **1,000** per 100 ml (10 per ml); provided that not more than **20%** of the samples at any station, in any **30-day period**, may exceed **1,000** per 100 ml (10 per ml) and provided further that no **single sample** when verified by a repeat sample taken within 48 hours shall exceed **10,000** per 100 (100 per ml).

Enterococci / Fresh Waters: In fresh water, the **geometric mean** of enterococci shall not exceed **33** per 100 ml. The single sample maximum allowable density in designated beach areas is **61** per 100 ml with a confidence level of 75%.

Enterococci / Marine Waters: In marine waters, the **geometric mean** of enterococci shall not exceed **35** per 100 ml. The single sample maximum allowable density in designated beach areas is **104** per 100 ml with a confidence level of 75%.

E. coli / Fresh Waters: In fresh water, the **geometric mean** of E. coli shall not exceed **126** per 100 ml. The single sample maximum allowable density in designated beach areas is **235** per 100 ml with a confidence level of 75%.

II. REC- 2 Water Quality Objectives in the San Diego Region

The REC-2 water quality objectives for bacterial indicators applicable in the San Diego Region are contained in the San Diego Regional Board's Basin Plan and are derived from water quality criteria promulgated by the USEPA in 1976.

REC-2
Inland Surface Waters, Enclosed Bays and Estuaries and Coastal Lagoons (from Basin Plan)

Fecal Coliforms / Fresh or Marine Waters: In waters designated for non-contact recreation (REC-2) and not designed for contact recreation (REC-1), the average fecal coliform concentrations for any **30-day period**, shall not exceed **2,000** per 100 ml, nor shall more than **10%** of total samples collected during any **30-day period** exceed **4,000** per 100 ml.

III. Shellfish Harvesting Water Quality Objectives in the San Diego Region

The SHELL water quality objectives for bacterial indicators applicable in the San Diego Region where shellfish may be harvested for human consumption are contained in the Ocean Plan and in the San Diego Regional Board's Basin Plan. Both are derived from water quality criteria promulgated by the USEPA in 1976.

SHELL
Ocean Waters (from Ocean Plan)

Total Coliforms: The median total coliform density throughout the water column shall not exceed **70** per 100 ml and not more than **10%** of the samples shall exceed **230** per 100 ml.

SHELL
Enclosed Bays and Estuaries and Coastal Lagoons (from Basin Plan)

Total Coliforms / Marine Waters: The median total coliform concentration throughout the water column for an **30-day period** shall not exceed **70** per 100 ml nor shall more than **10%** of the samples collected during any **30-day period** exceed **230** per 100 for a five-tube decimal dilution test or 330 per 100 ml when a three-tube decimal dilution test is used.

Appendix E
What are Indicator Bacteria?

Indicator bacteria are bacterial species that when present in water, indicate the potential presence of fecal material and associated fecal pathogens. Indicator bacteria such as fecal coliform and enterococcus are part of the intestinal flora of warm-blooded animals.

Indicator organisms have been long used to protect bathers from illnesses that may be contracted from recreational activities in surface waters contaminated by fecal pollution. These organisms often do not cause illness directly, but have demonstrated characteristics that make them good indicators of harmful pathogens in waterbodies.

Microorganisms are ubiquitous in all terrestrial and aquatic ecosystems. Of the vast number of species, only a small subset are human pathogens, capable of causing varying degrees of illness in humans. The source of these harmful organisms is usually the feces or other wastes of humans and various warm-blooded animals. The pathogens most commonly identified and associated with waterborne diseases can be grouped into the three general categories: bacteria, viruses and protozoa.

The detection and enumeration of all pathogens of concern is impractical in most circumstances due to the potential for many different pathogens to reside in a single waterbody, lack of readily available and affordable methods and the variation in pathogen concentrations. The use of indicators provides a means to ascertain the likelihood that human pathogens may be present in recreational waters.

More information on indicator bacteria and USEPA guidance for implementation of water quality criteria can be found at:

http://www.epa.gov/waterscience/standards/bacteria/

Appendix F
Review of Shoreline Bacteria Data

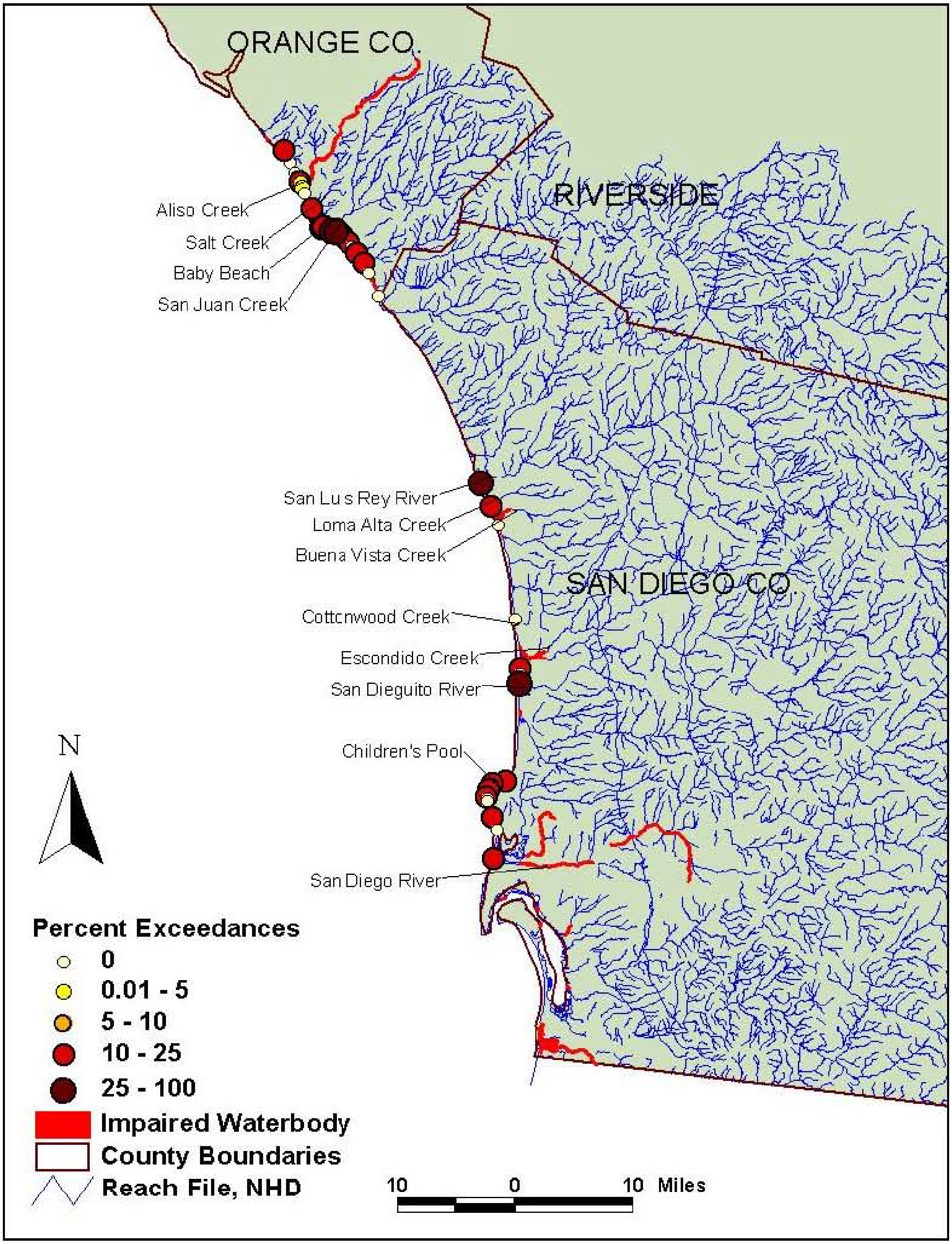

Figure F-1. Exceedances of Fecal Coliform Single Sample Objective (REC-1) During Wet Weather Conditions

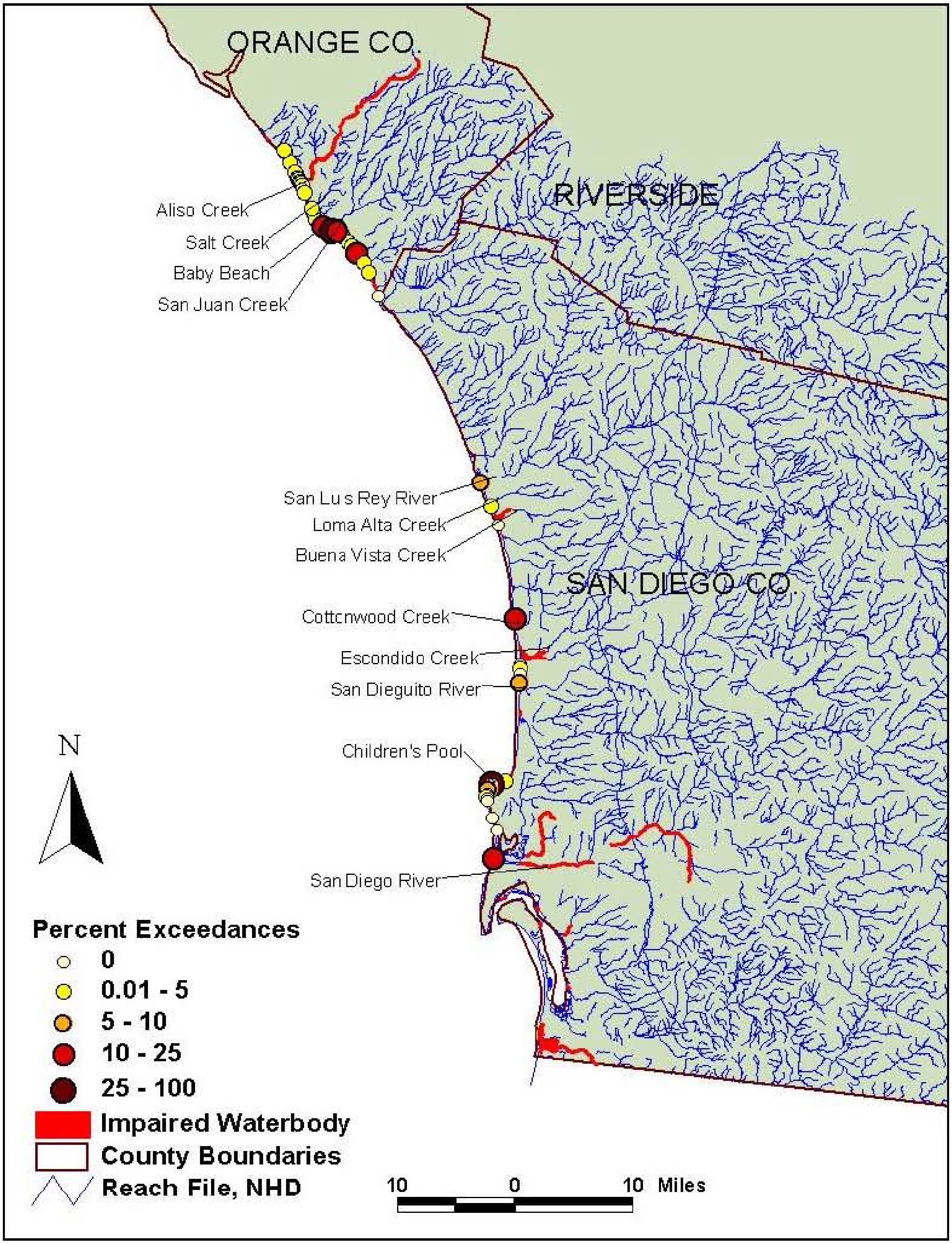

Figure F-2. Exceedances of Fecal Coliform Single Sample Objective (REC-1) During Dry Weather Conditions

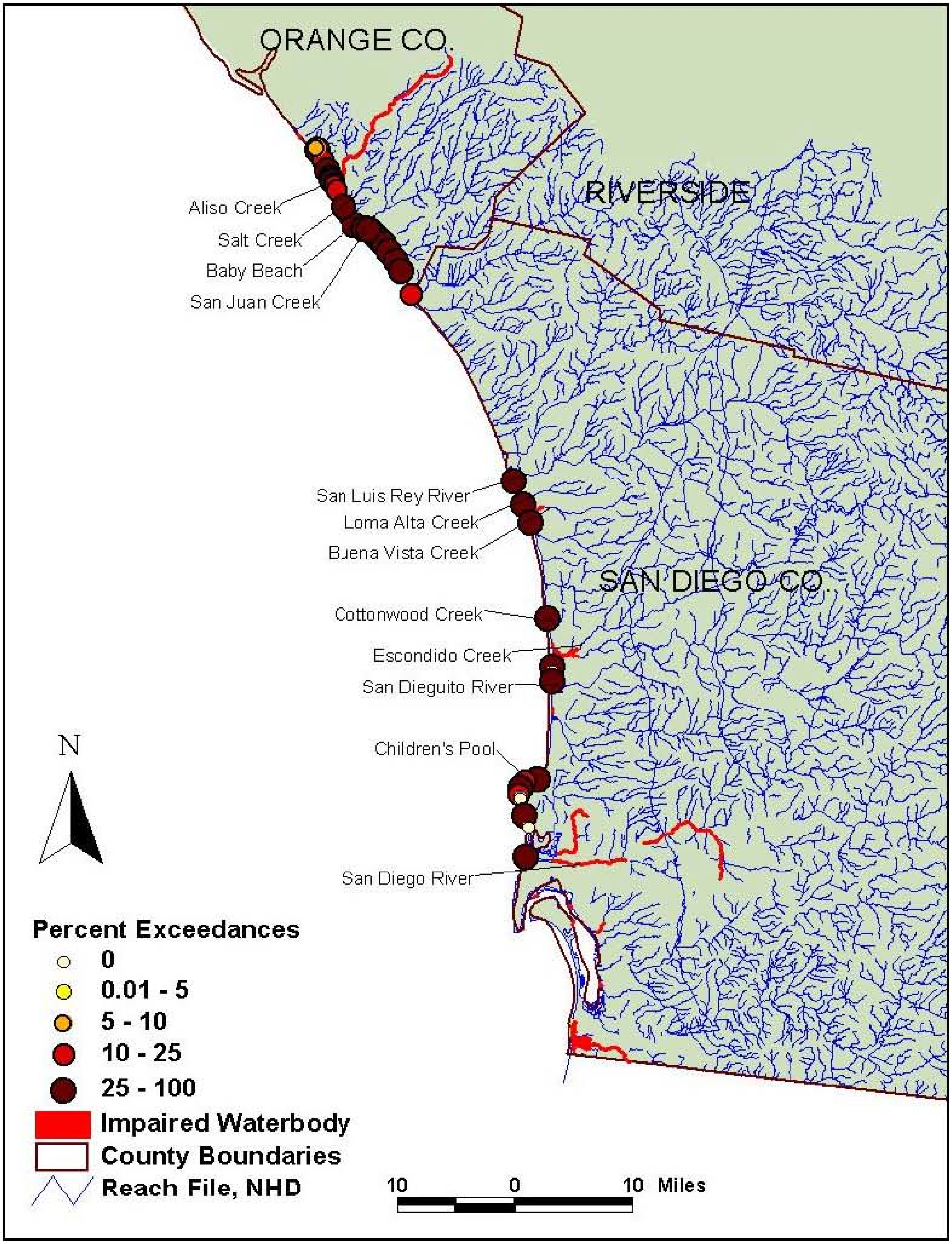

Figure F-3. Exceedances of Total Coliform Single Sample Objective (SHELL) During Wet Weather Conditions

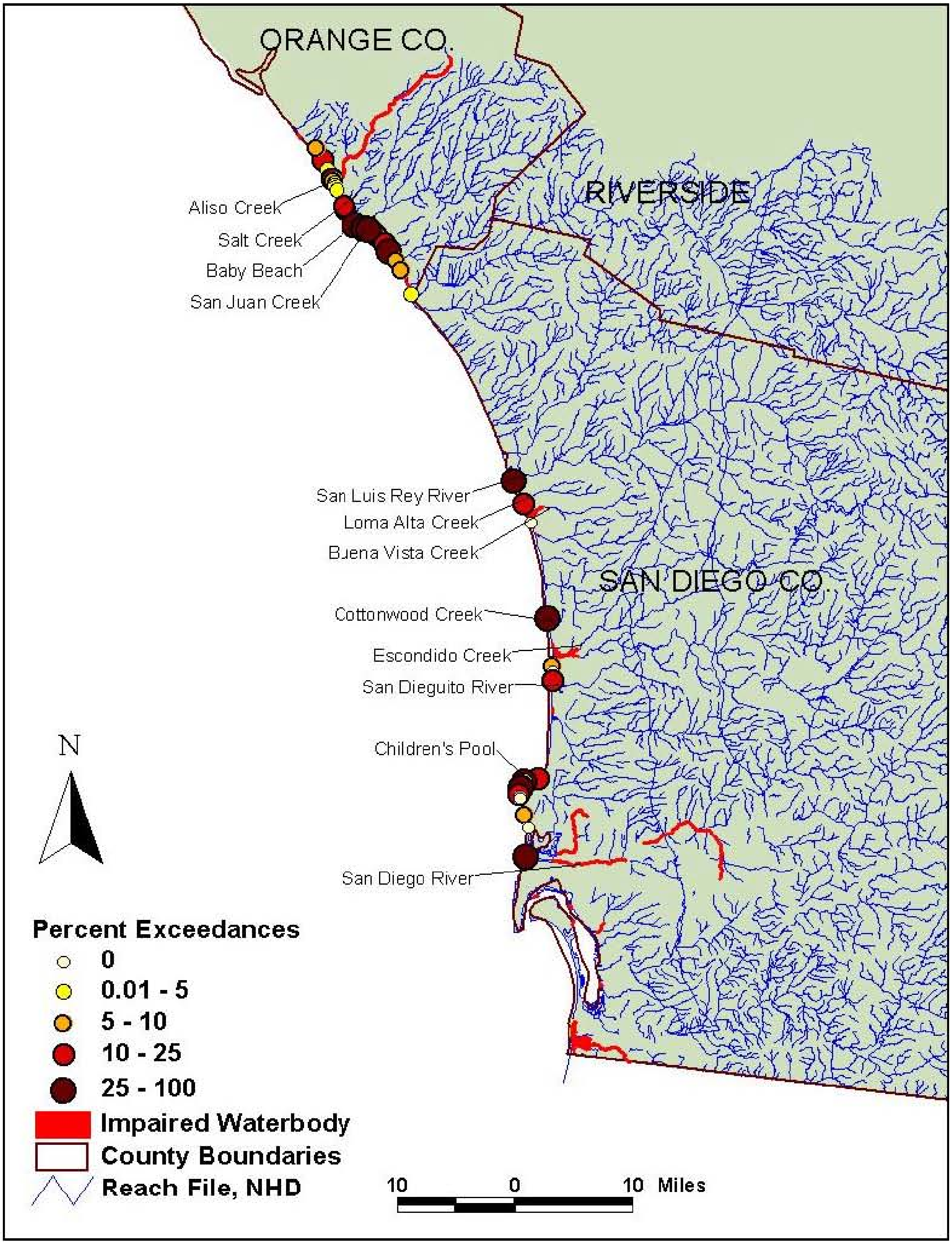

Figure F-4. Exceedances of Total Coliform Single Sample Objective (SHELL) During Dry Weather Conditions

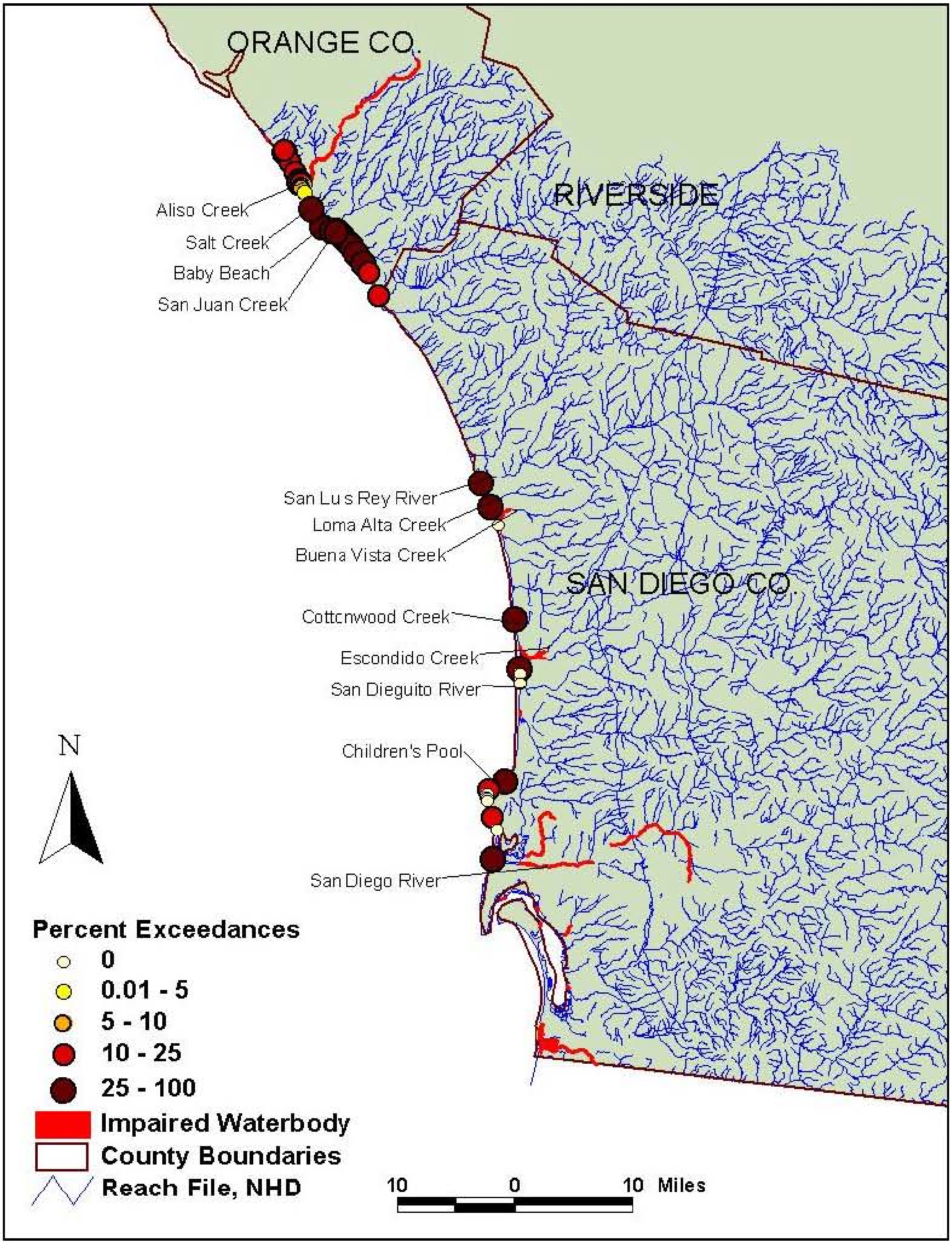

Figure F-5. Exceedances of Enterococcus Single Sample Objective (REC-1) During Wet Weather Conditions

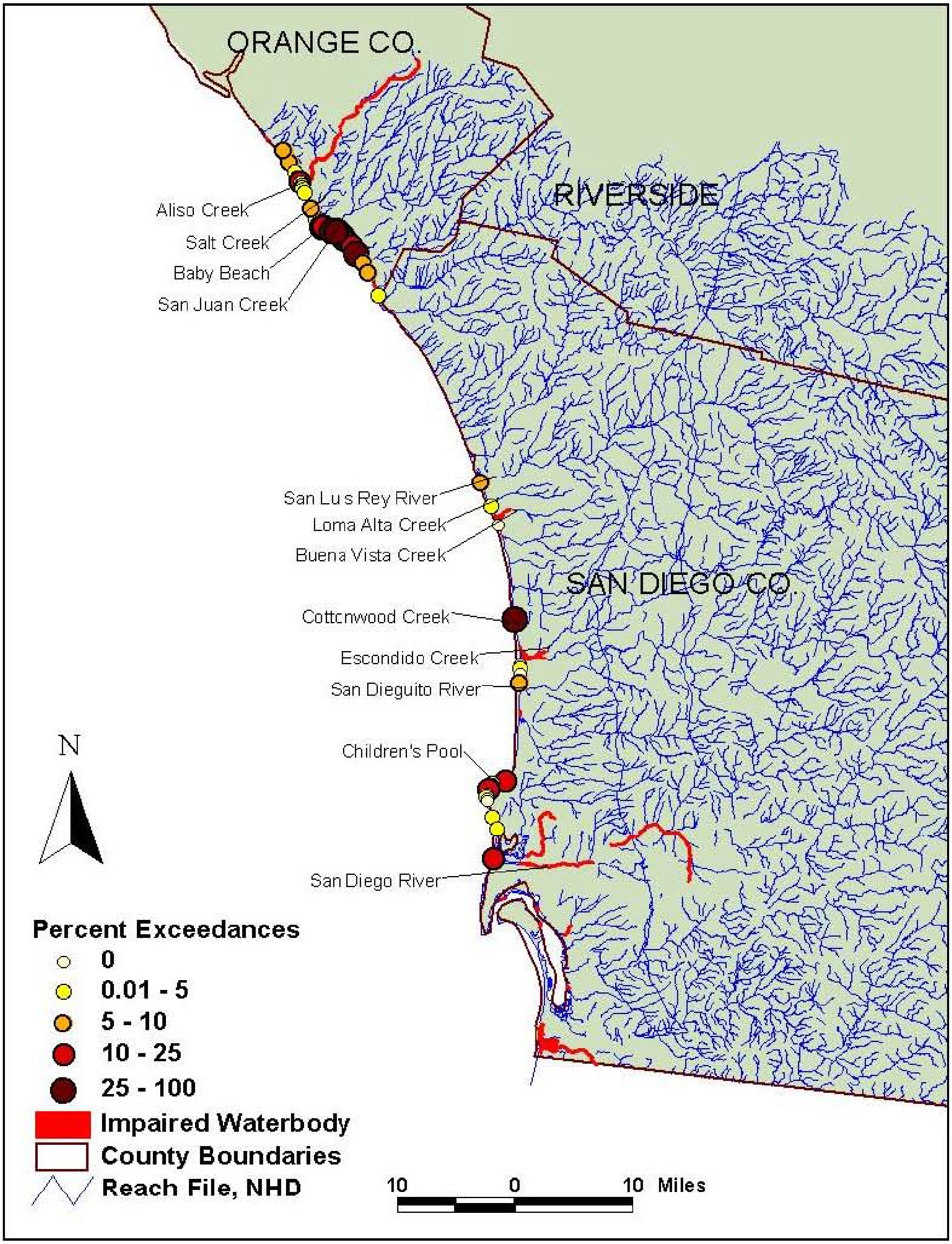

Figure F-6. Exceedances of Enterococcus Single Sample Objective (REC-1) During Dry Weather Conditions

Appendix G
Maps of Impaired Watersheds

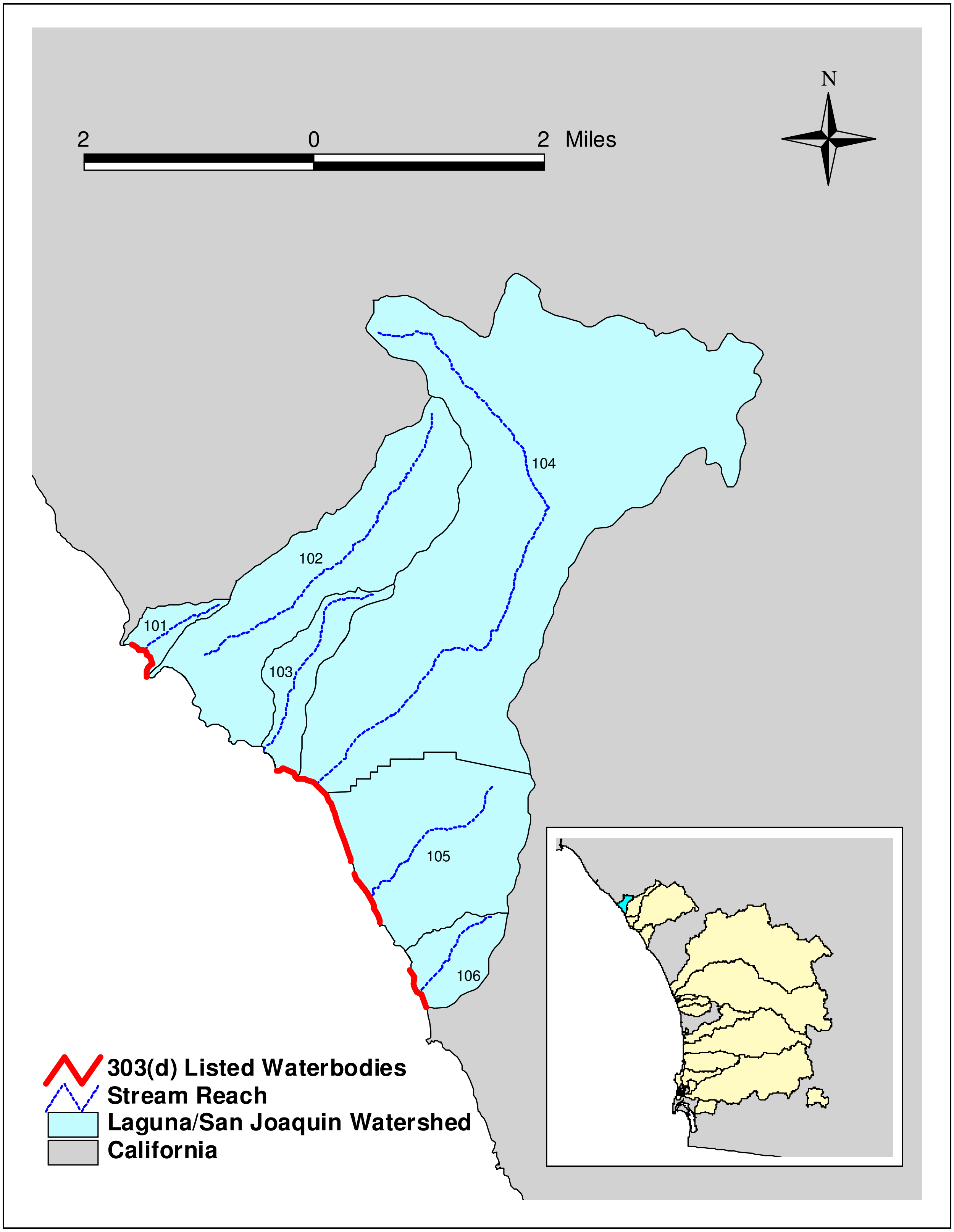

Figure G-1. Laguna/San Joaquin Watershed

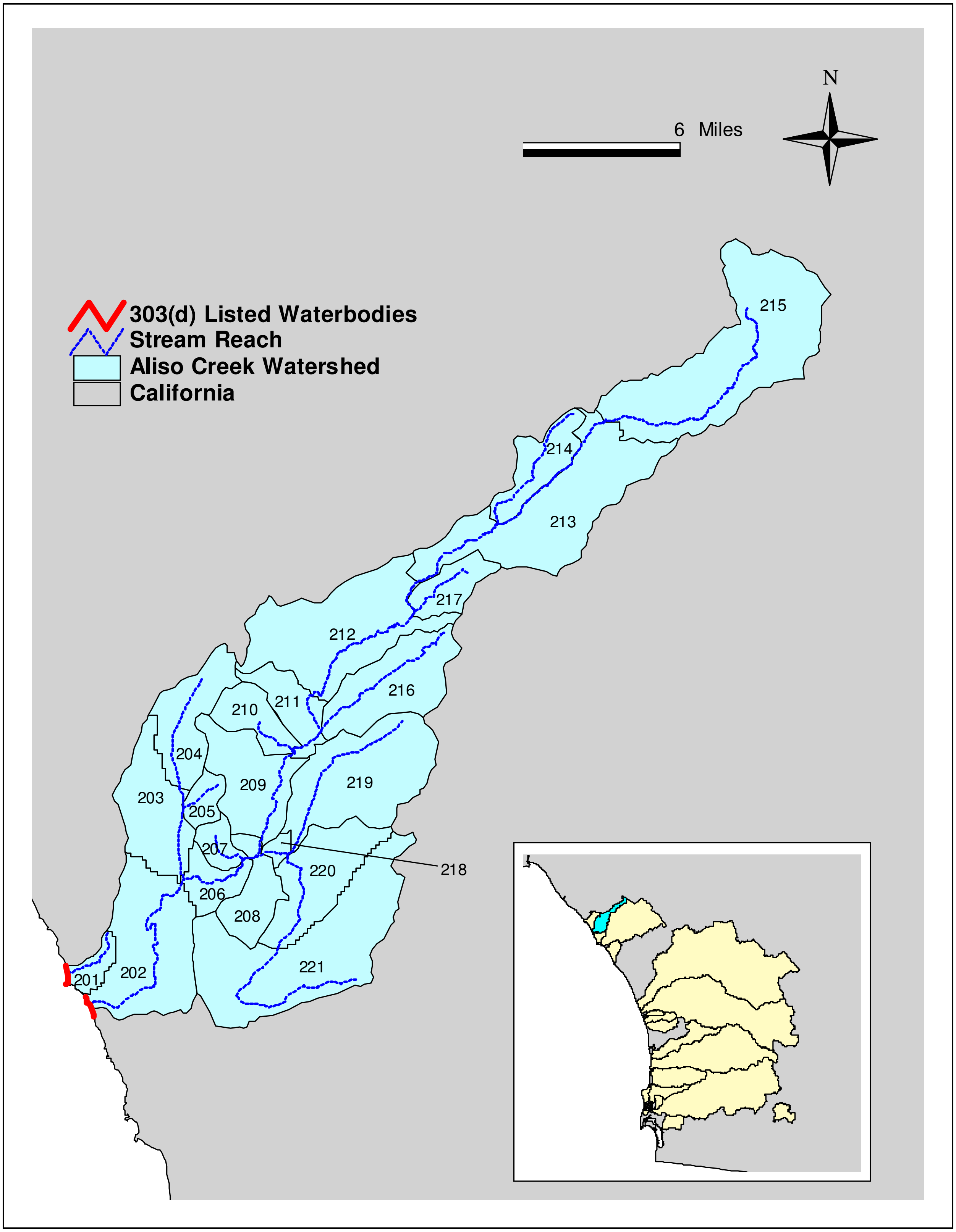

Figure G-2. Aliso Creek Watershed

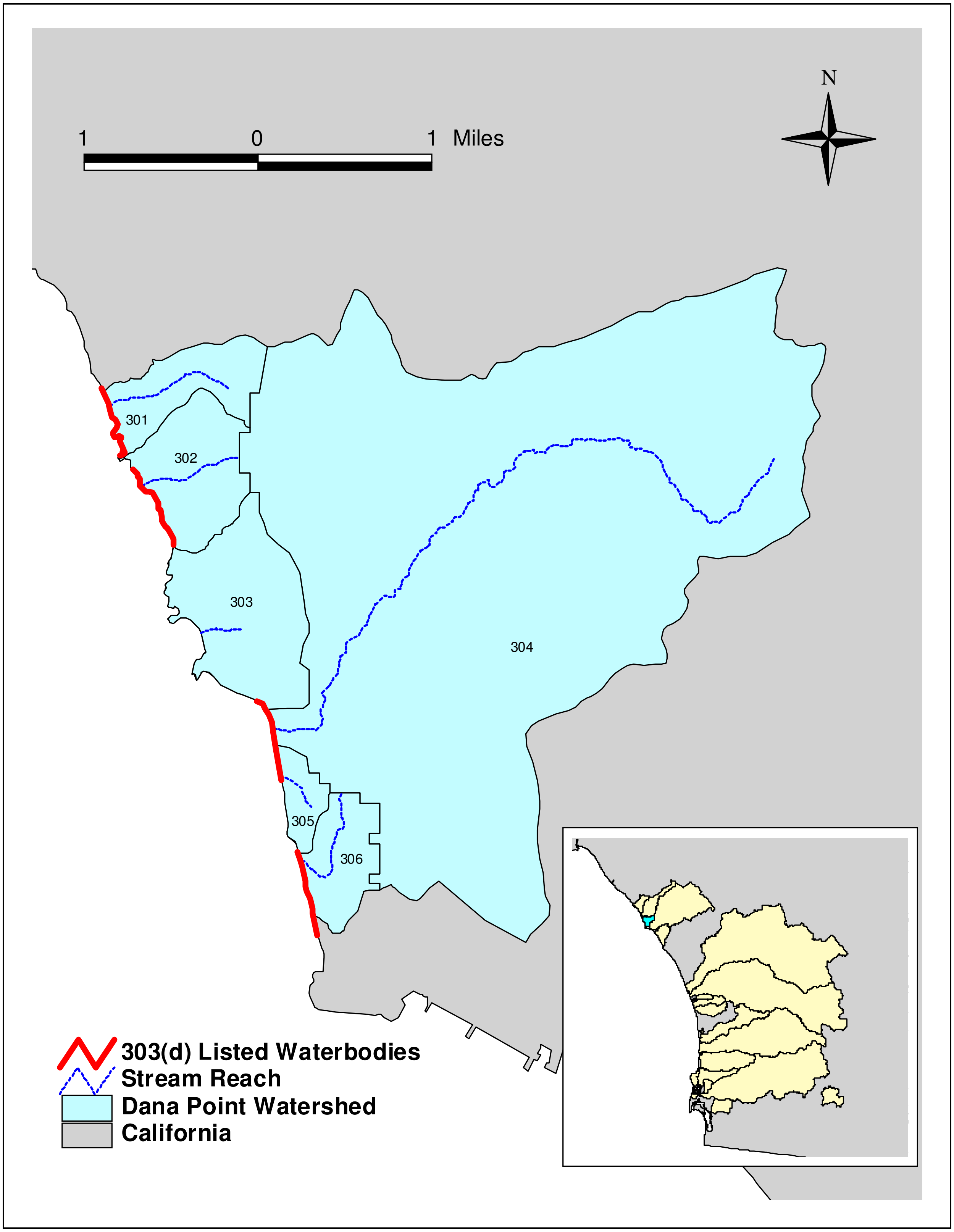

Figure G-3. Dana Point Watershed

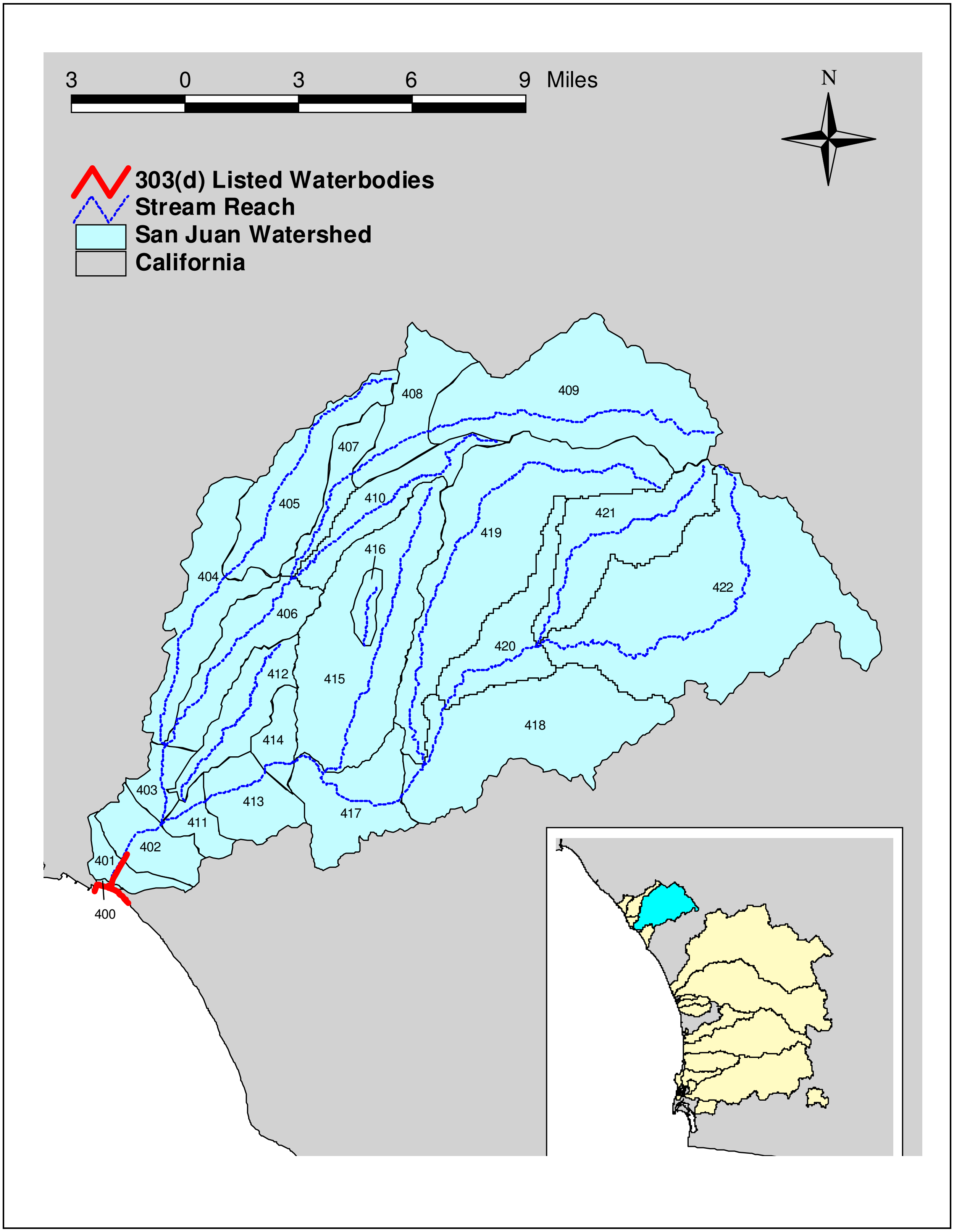

Figure G-4. San Juan Creek Watershed

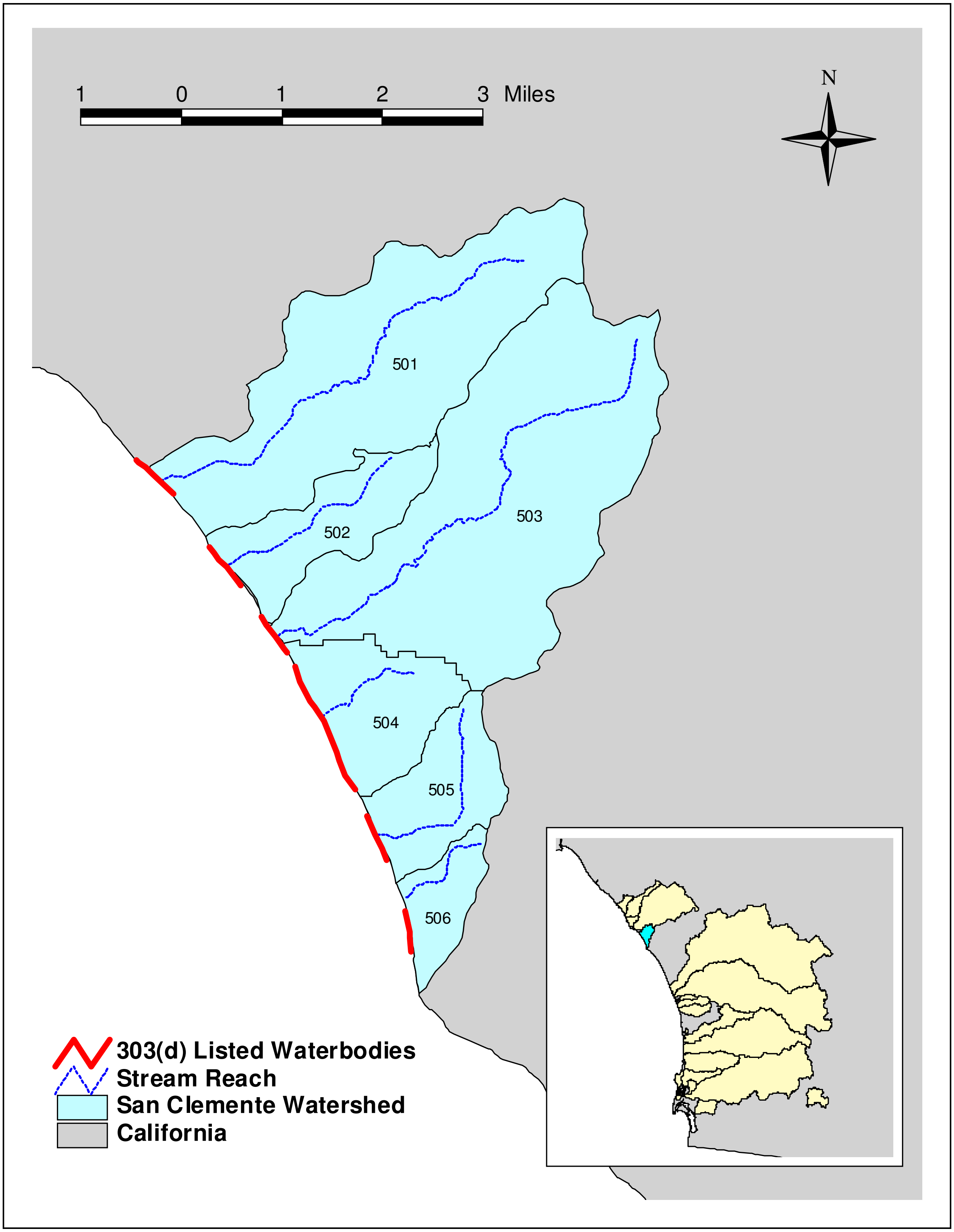

Figure G-5. San Clemente Watershed

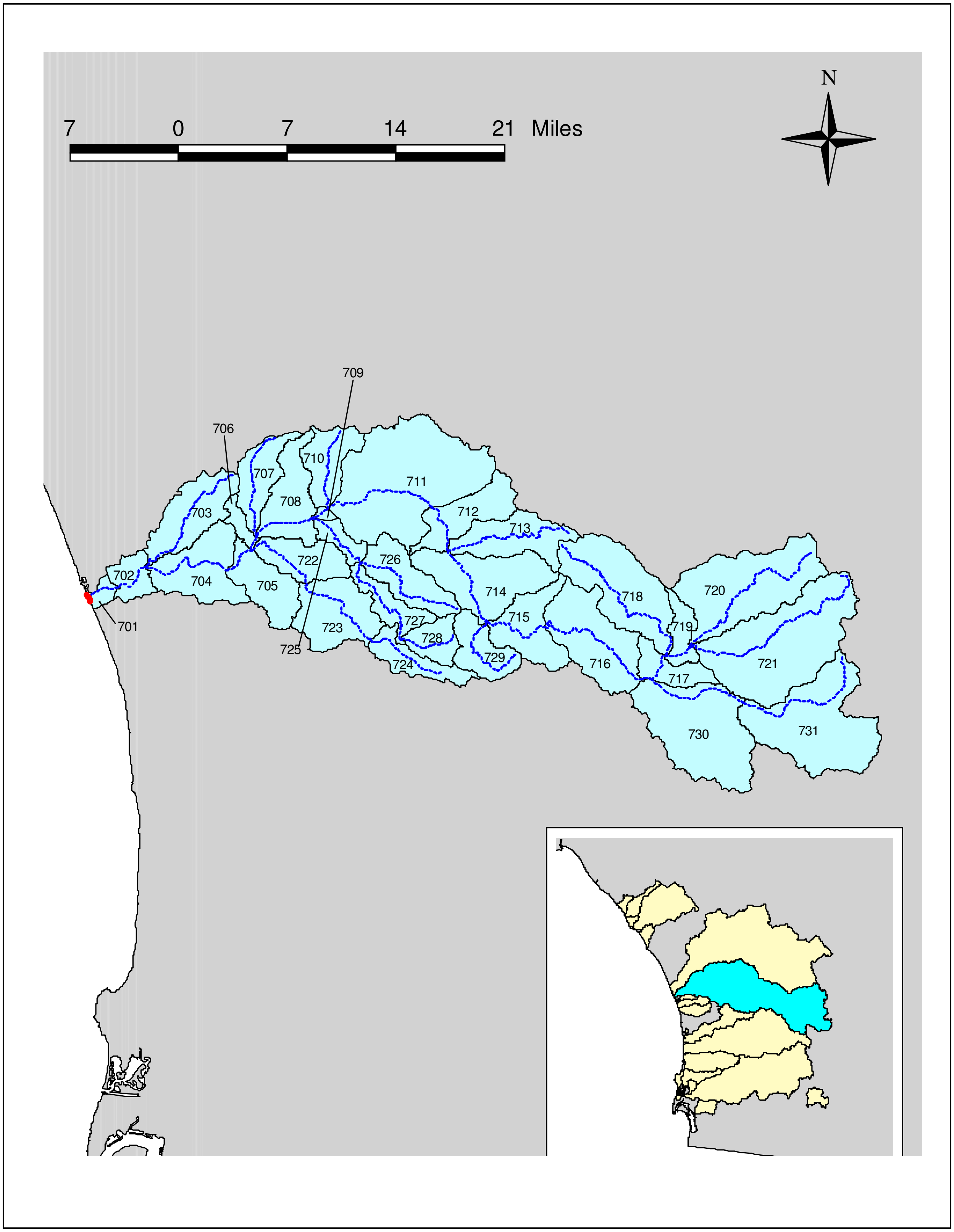

Figure G-6. San Luis Rey Watershed

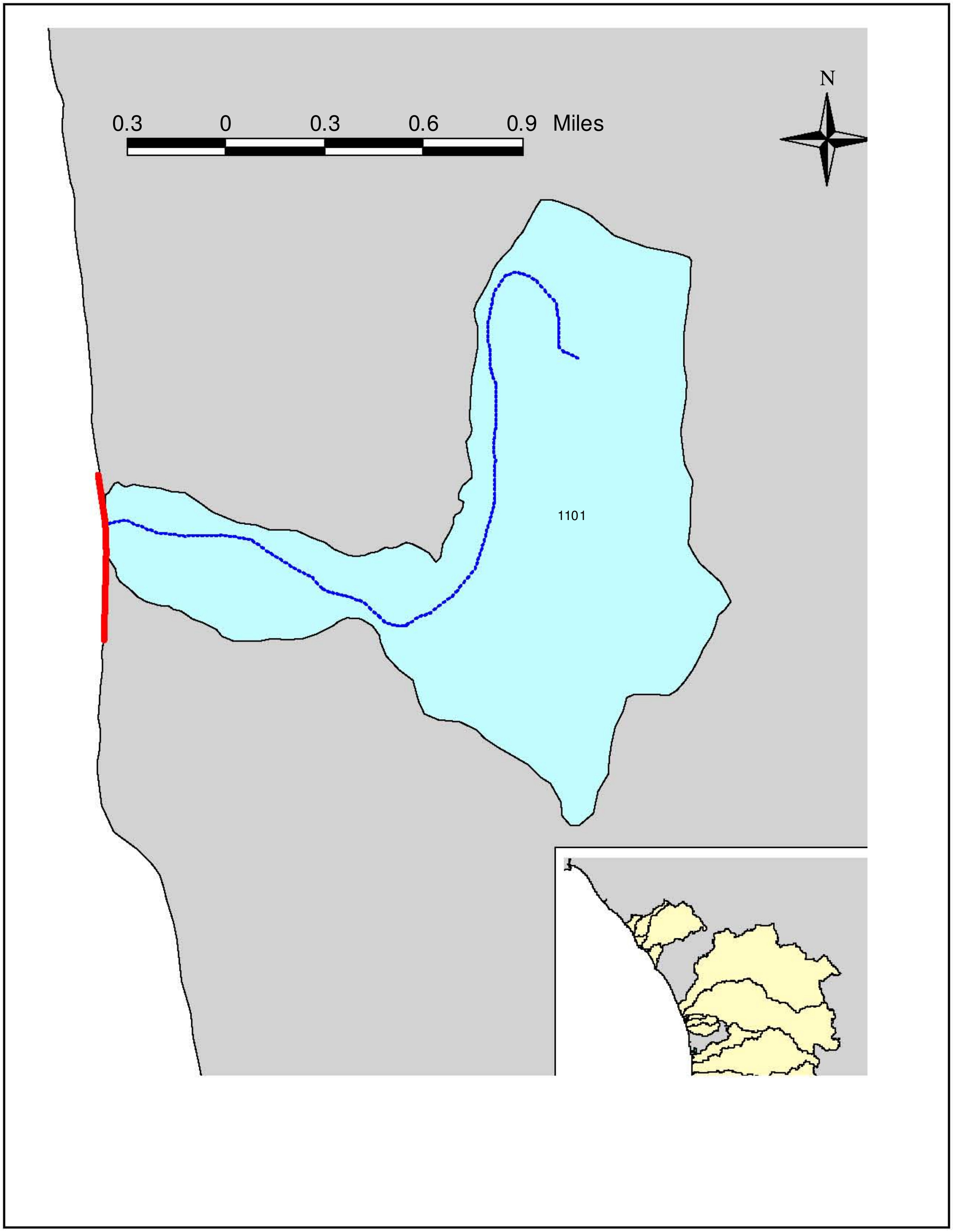

Figure G-7. San Marcos Watershed

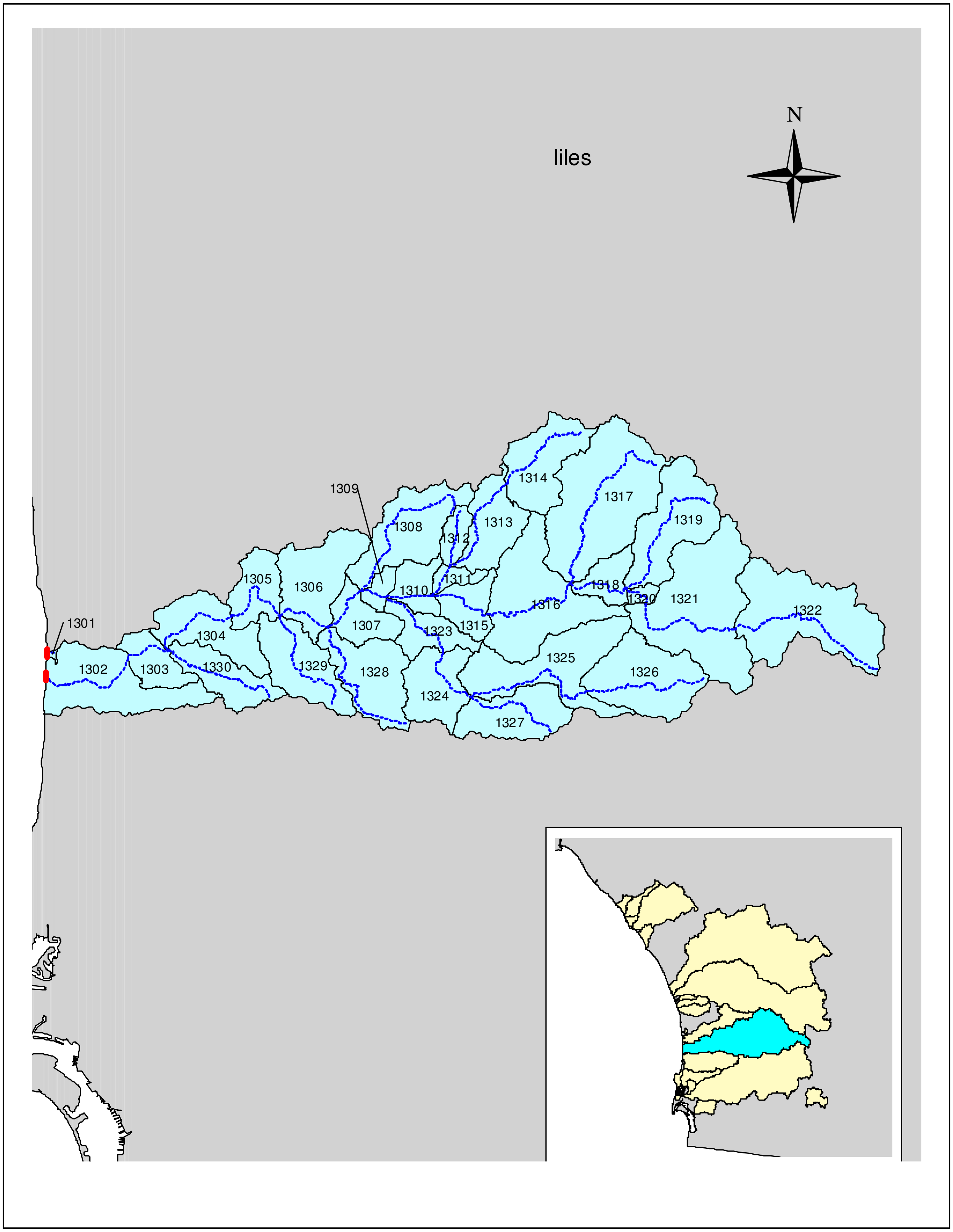

Figure G-8. San Dieguito Watershed

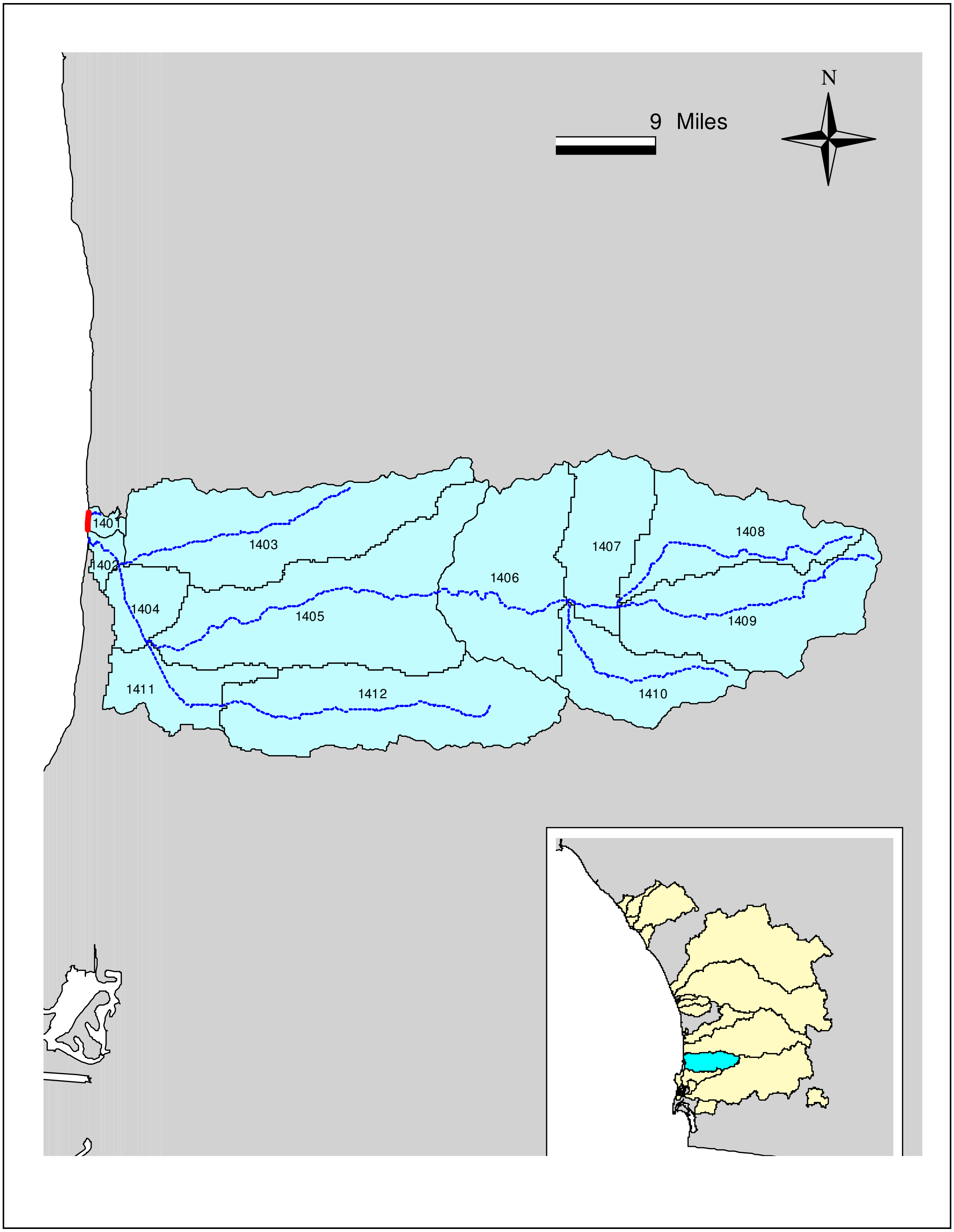

Figure G-9. Miramar Watershed

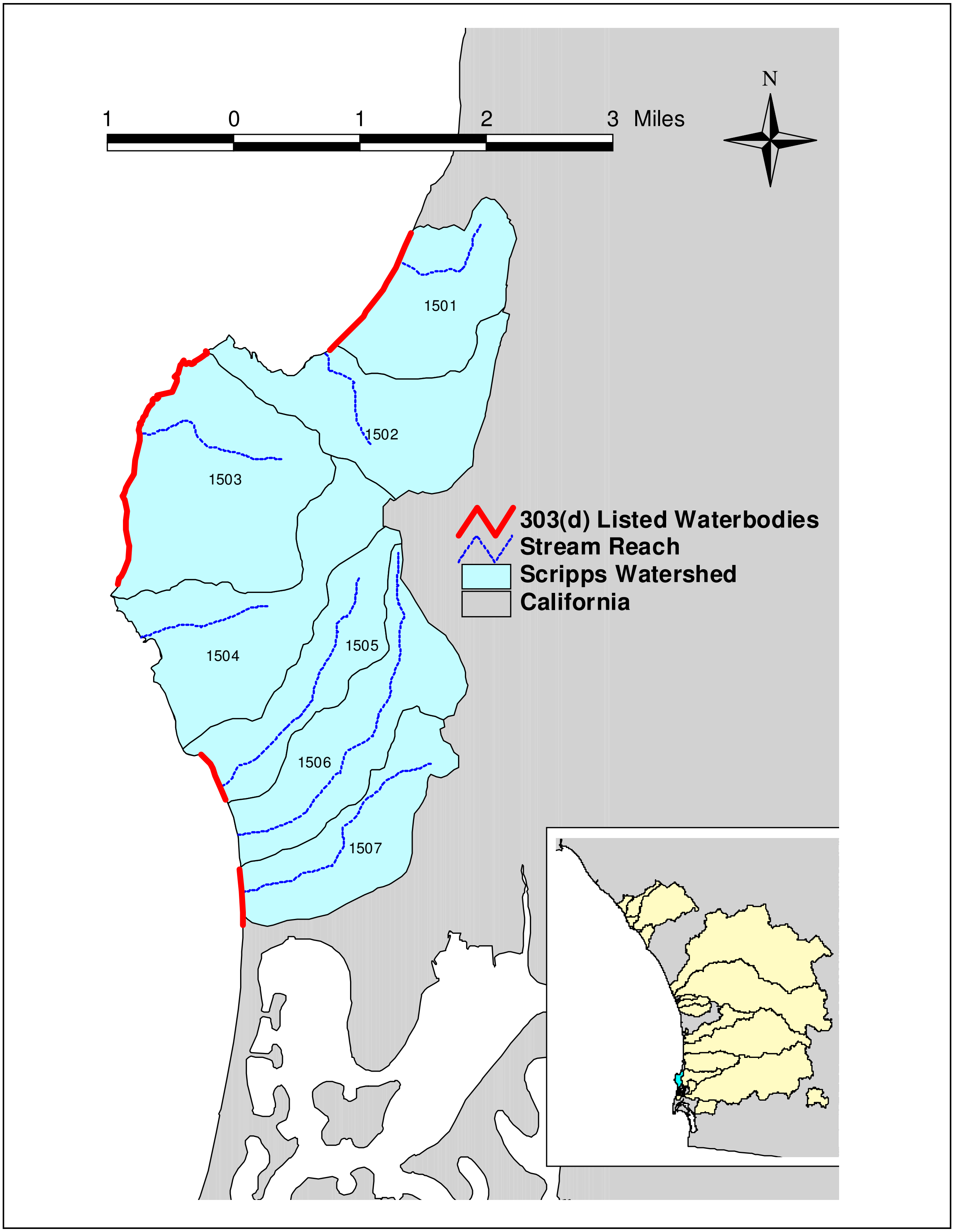

Figure G-10. Scripps Watershed

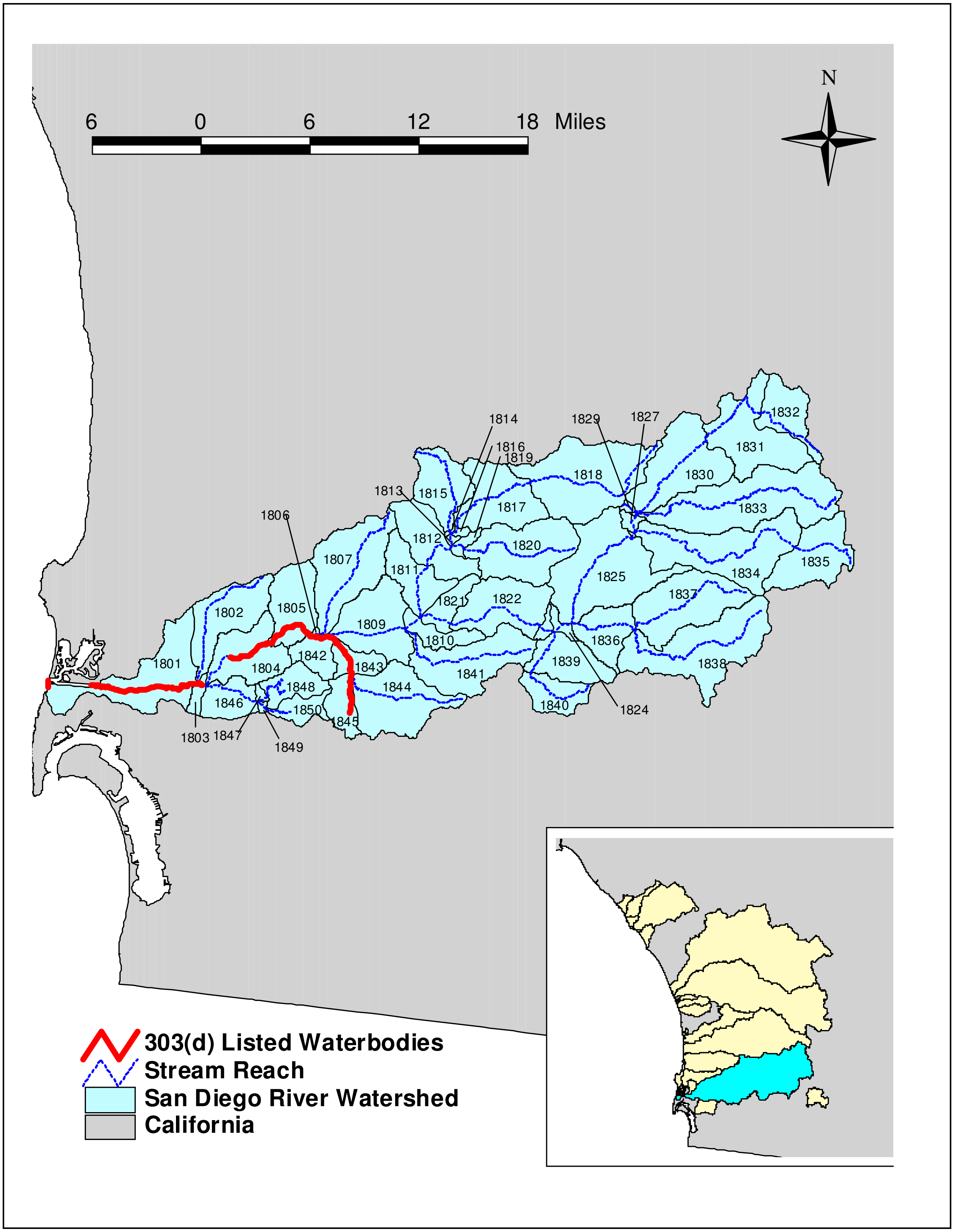

Figure G-11. San Diego River Watershed

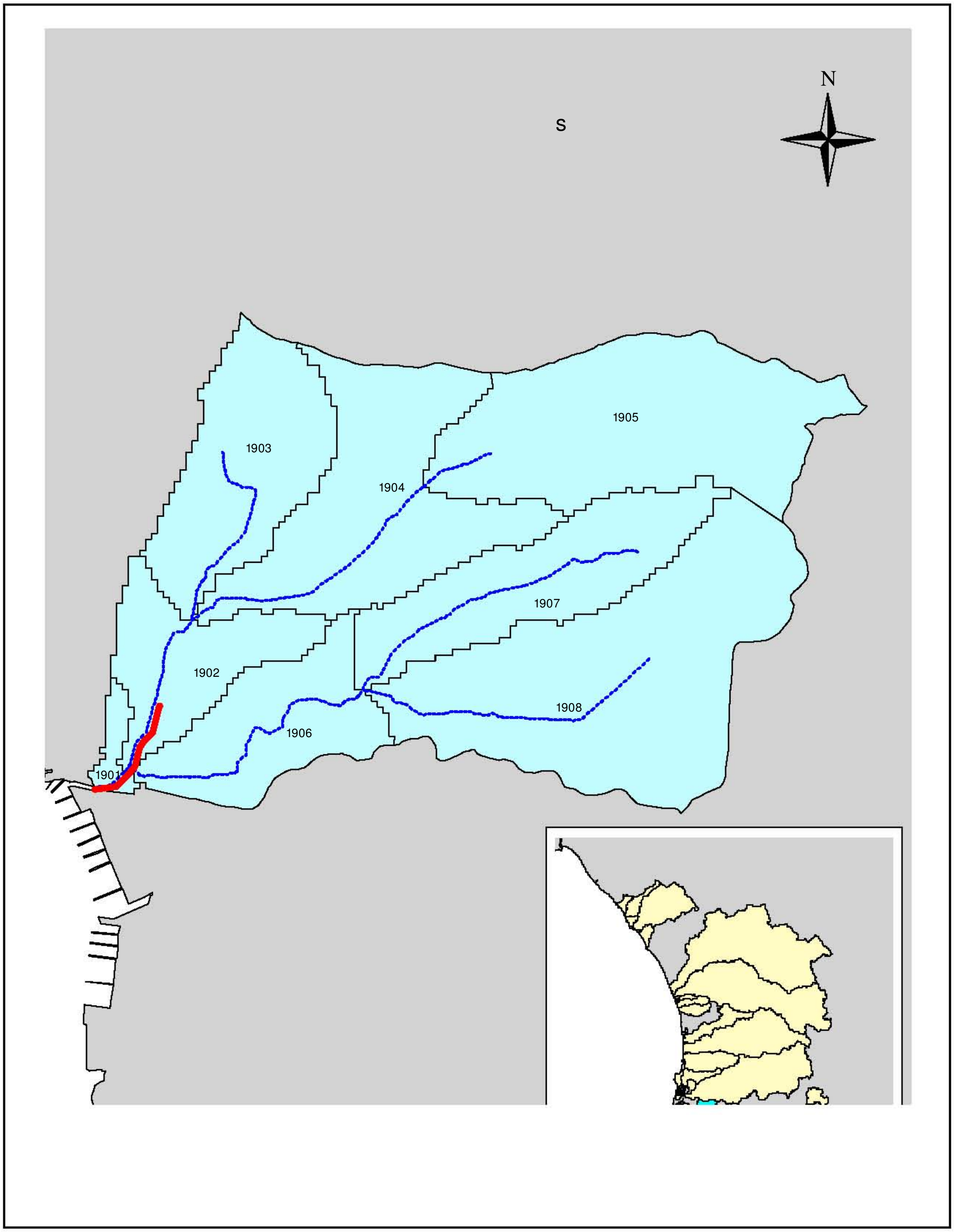

Figure G-12. Chollas Watershed

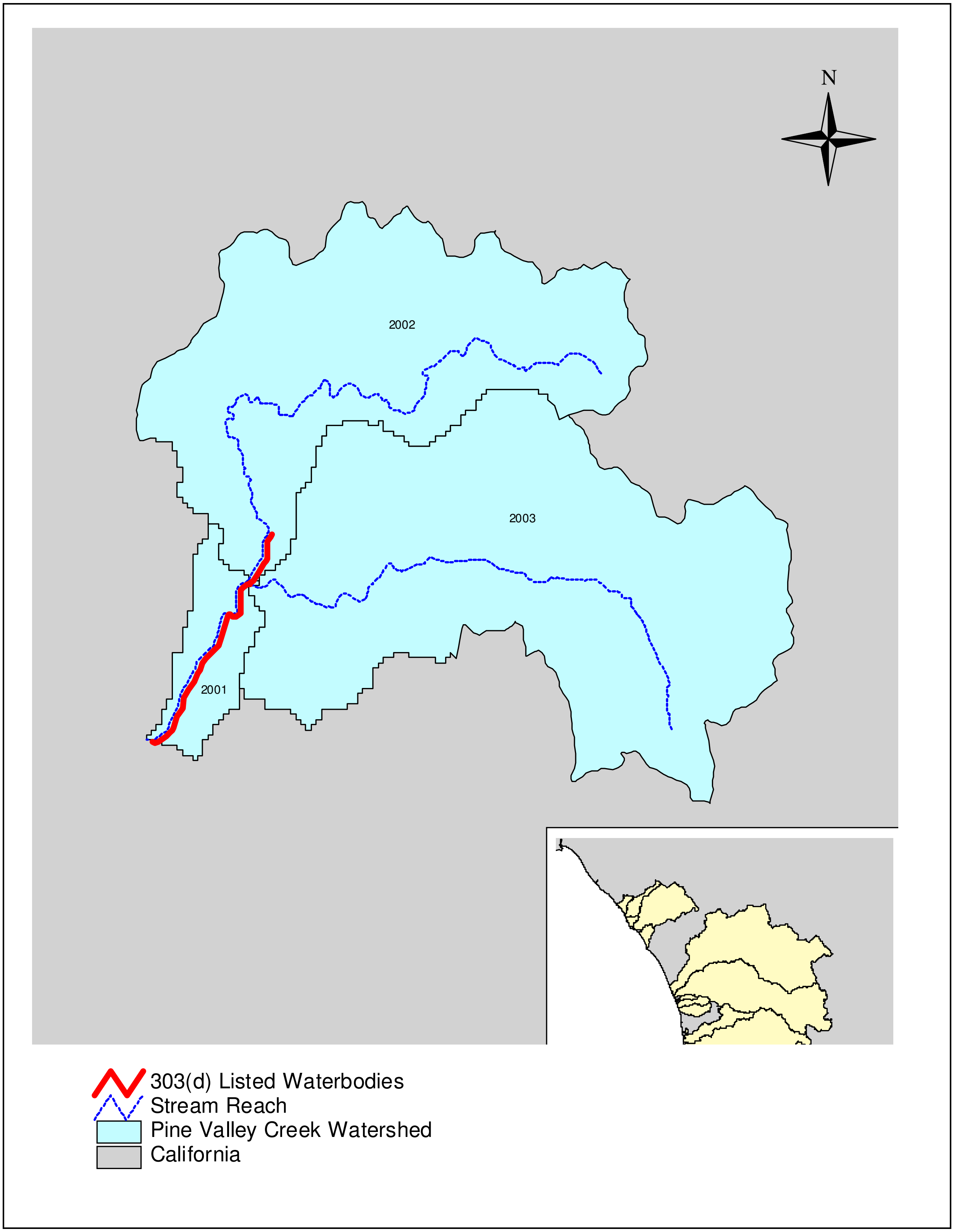

Figure G-13. Pine Valley Creek Watershed

Appendix H
Dry-Weather Model Configuration, Calibration and Validation

H. Dry Weather Model Application

H.1 Introduction

The variable nature of bacteria sources during dry weather required an approach that relied on detailed analyses of flow and water quality monitoring data to identify and characterize sources. This TMDL used data collected from dry-weather samples to develop empirical equations that represent water quantity and water quality associated with dry-weather runoff from various land uses. For each monitoring station, a watershed was delineated and the land use was related to flow and bacteria concentrations. A statistical relationship was established between areas of each land use and flow and bacteria concentrations.

To represent the linkage between source contributions and in-stream response, a mass balance spreadsheet model was developed to simulate source loadings and transport of bacteria in the impaired streams and streams flowing to impaired beaches. The model estimates bacterial concentrations to develop load allocations and to allow for future incorporation of new data. This predictive model represents the streams as a series of plug-flow reactors, with each reactor having a constant source of flow and bacteria. A plug-flow reactor can be thought of as an elongated rectangular basin with a constant level in which advection (unidirectional transport) dominates (Figure H-1).

The model segments are assumed to be well mixed laterally and vertically at a steady-state condition (constant flow and constant input). Variations in the longitudinal dimension are what determine any changes in parameters of concern. A "plug" of a

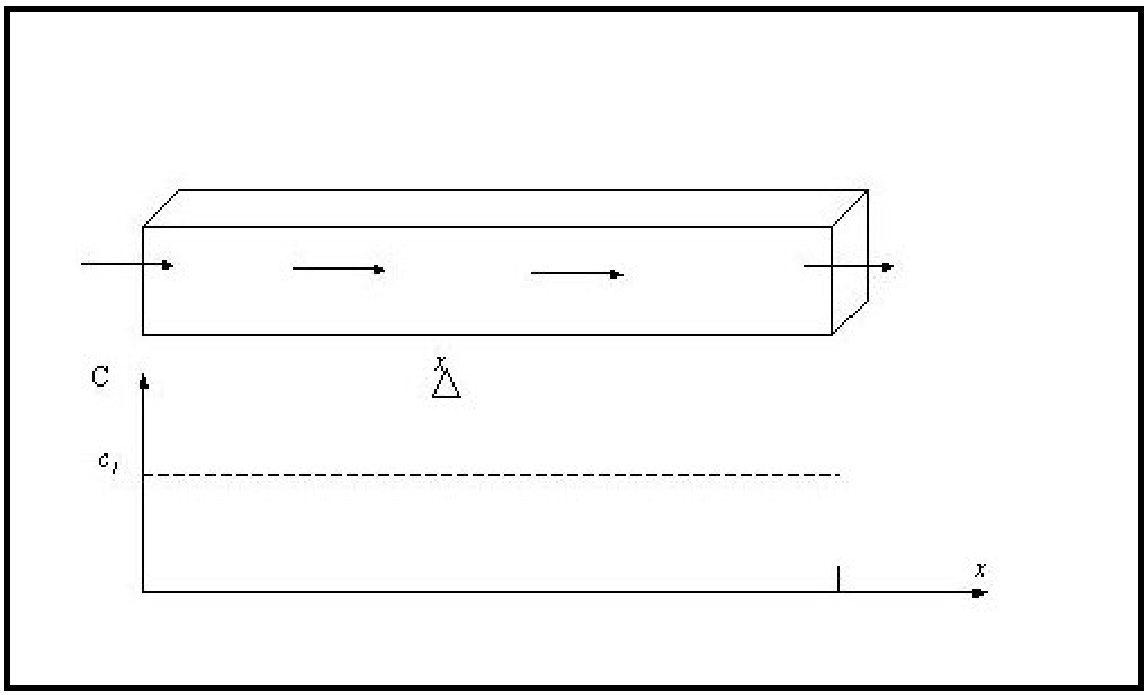

Figure H-1. Theoretical plug-flow reactor

conservative substance introduced at one end of the reactor will remain intact as it passes through the reactor. The initial concentration of bacteria can be entered for the injection point. At points farther downstream, the concentration can be estimated based on first-order die-off and mass balance.

This modeling approach relies on basic segment characteristics, which include flow, width and cross-sectional area. Model input for the flows and bacteria concentration of dry-weather urban runoff was estimated using regression equations based on analyses of observed dry-weather data. It is important to note that because each of these model parameters was estimated, the accuracy of the model is subject to the accuracy of the estimations. Bacteria concentrations in each reactor, or segment, are calculated using water quality data, a bacteria die-off rate, basic channel geometry and flow. Bacteria die-off rates, which can be attributed to solar radiation, temperature and other environmental conditions, were considered first-order.

H.2 Model Configuration

Conceptually, the streams are segmented into a series of plug-flow reactors defined along the entire length of the stream to simulate the steady-state distribution of bacteria along its length. Multiple source contributions in a reactor are lumped and represented as a single input based on empirically derived inflows and bacteria concentrations (see Sections I.2.2 and I.2.3. The model is one-dimensional (longitudinal) under a steady-state condition. Each reactor defines the mass balance for bacteria and water.

H.2.1 Physical Configuration

The first step in setting up and applying the model was the determination of an appropriate scale for analysis. Model subwatersheds were based on CALWTR 2.2 watersheds, stream networks, locations of flow and water quality monitoring stations, consistency of hydrologic factors and land use uniformity. The subwatersheds used in the dry-weather model were the same as those used for the wet-weather model (see Appendix I).

Figure H-2 depicts an example of model connectivity of segments for the Chollas Creek watershed. Segments 1905, 1903, 1908 and 1907 are headwater segments. Segment 1902 begins where Segment 1903 and 1904 converge and so forth. For each model segment, mass balance is performed on all inflows from upstream segments, input from local watershed runoff, first-order bacteria die-off, stream infiltration and evaporation and outflow.

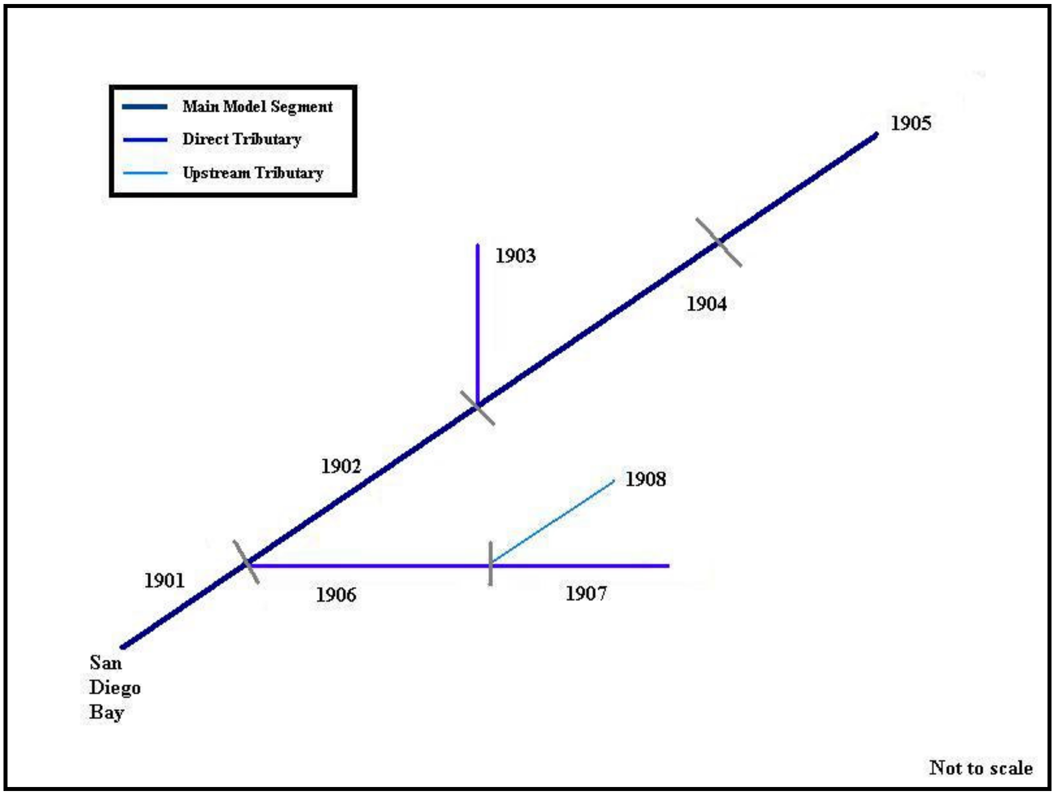

Figure H-2. Schematic of model segments for Chollas Creek and its tributaries

Using an upstream boundary condition of initial concentration (C_0) for inflow, the final water column concentration (C) in a segment can be calculated using the decay equation given below:

$$\frac{dc}{dt} = -kc \qquad \text{or} \qquad C = C_0 e^{-kt} = C_0 e^{-\left(k\frac{x}{u}\right)}$$

where

C_0 = initial concentration (#/100 mL)
C = final concentration (#/100 mL)
k = die-off rate (1/d)
χ = segment length (mi)
u = stream velocity (mi/d)

At each confluence, a mass balance of the watershed load and, if applicable, the load from the upstream tributary is performed to determine the change in concentration. This is represented by the following equation:

$$C_0 = \frac{Q_r C_r + Q_t C_t}{Q_r + Q_t}$$

where

Q = flow (ft^3/s)
C = concentration (#/100 mL)

In the previous equation, Q_r and C_r refer to the flow and concentration from the receiving watershed and Q_t and C_t refer to the flow and concentration from the upstream tributary. The concentration calculated from this equation is then used as the initial concentration (C_0) in the decay equation for the receiving segment.

Precise channel geometry data were not available for the modeled stream segments and therefore stream dimensions were estimated from analysis of observed data. Analysis was performed on streamflow data and associated stream dimension data from 53 USGS gages throughout Southern California. For this analysis, it was assumed that all streamflow at these gages less than 15 ft^3/s represented dry-weather flow conditions. Using this dry weather data, the relationship between flow and cross-sectional area was estimated (R^2 = 0.51). The following is the resulting regression equation relating flow to cross-sectional area:

$$A = e^{0.2253 \times Q}$$

where

A = cross-sectional area (ft^2)
Q = flow (ft^3/s)

In addition, data from the USGS gages were used to determine the width of each segment based on a regression between cross-sectional area and width. The best relationship (R^2 = 0.75) was based on the natural logarithms of each parameter. The following is the resulting regression equation from the analysis:

$$LN(W) = (0.6296 \times LN(A)) + 1.3003 \quad \text{or} \quad W = e^{((0.6296 \times LN(A)) + 1.3003)}$$

where

W = width of model segment (ft)
A = cross-sectional area (ft^2)

H.3 Estimation of Dry-Weather Runoff

Flow data were not available for many of the subwatersheds. Estimates of inflows from the subwatersheds to the stream model were obtained through analysis of available data. Monitoring studies for which dry-weather flow data were collected were available for Aliso Creek (performed by the Orange County Pubic Facilities and Resources

Department and the Orange County Public Health Laboratory) and for Rose Creek and Tecolote Creek (performed by the City of San Diego) (Appendix B, No. 1 and 2). Information from these studies was assumed sufficient for use in characterizing dry-weather flow conditions for the entire study area. For each study, flow data were collected throughout the year at stations throughout the watersheds. This information was used to understand the relationship between land use and stream flow.

An analysis was performed using dry weather data from the Aliso Creek (27 stations), Rose Creek (3 stations) and Tecolote Creek (2 stations) subwatersheds to determine whether there is a correlation between the respective land use types and the average of dry-weather flow measurements collected at the mouth of each subwatershed. The resulting equation showed a good correlation between the flow and the commercial/institutional, open space and industrial/transportation land uses ($R^2 = 0.78$). The following is the resulting equation from the analysis:

$$Q = (A_{1400} \times 0.00168) + (A_{4000} \times 0.000256) - (A_{1500} \times 0.00141)$$

where

Q = flow (ft^3/s)
A_{1400} = area of commercial/institutional (acres)
A_{4000} = area of open space, including military operations (acres)
A_{1500} = area of industrial/transportation (acres)

Figure H-3 shows the predicted and observed flow data used in this regression.

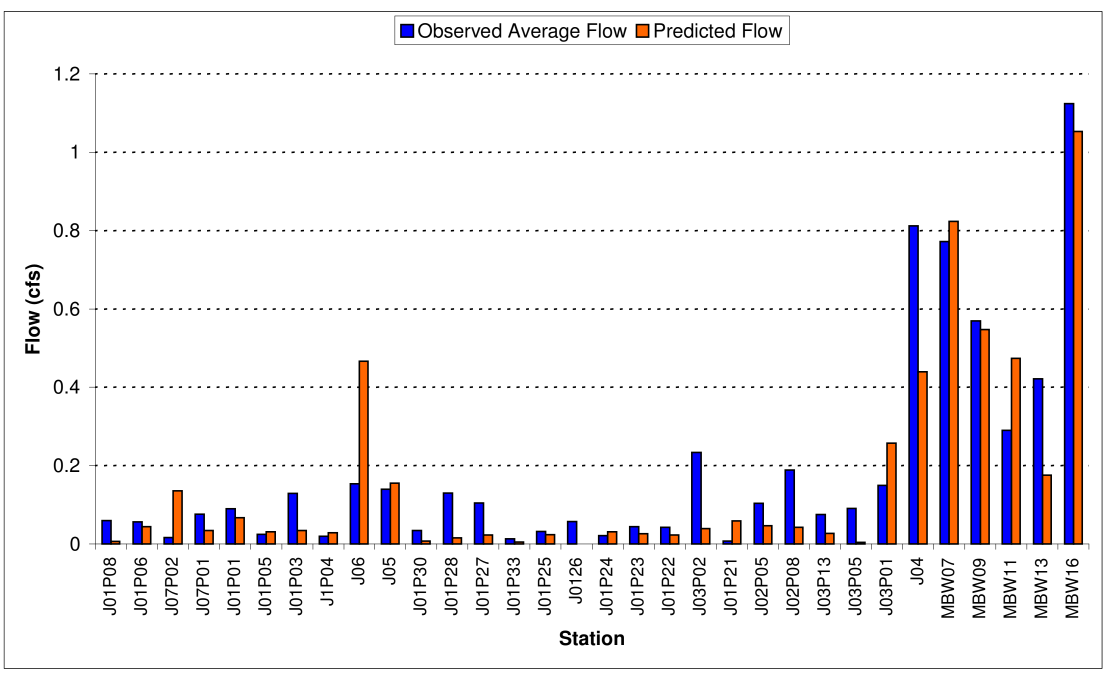

Figure H-3. Predicted and observed flows in Aliso Creek, Rose Creek and Tecolote Creek.

H.4 Estimation of Bacteria Densities

Like flow data, bacteria data were not available for many watersheds modeled. However, bacteria data had been collected for Aliso Creek (Orange County Pubic Facilities and Resources Department), San Juan Creek (Orange County Pubic Facilities and Resources Department) and Rose Creek and Tecolote Creek in the Mission Bay area (City of San Diego) (Appendix B, No. 4-6). For each study, multiple bacteria samples were collected throughout the year at stations throughout the watersheds. For this study, the information was used to understand the relationship between land use and water quality.

An analysis was performed using data from Aliso Creek (27 stations), Tecolote Creek (5 stations), Rose Creek (4 stations) and San Juan Creek (9 samples) to determine the correlation between dry-weather FC concentrations, land use distribution and the overall size of the subwatersheds. For comparison, geometric means were calculated for each station using all dry-weather data collected. Large data sets are required to reduce random error and normalize observations at each site. For example, if a station has 40 dry-weather samples, the average geometric mean of bacteria concentrations can be used for that station with confidence that they are representative of the range of conditions that normally occur. However, if a station has only two samples, there is less confidence. It is critical that the data are normalized as well as possible before regression analysis so that variability does not propagate error.

A regression analysis was then performed to determine whether there is a correlation between the representative geometric mean of fecal coliform (FC) data at each station, the percent of each land use category in the subwatershed and the total subwatershed area. Results showed a good correlation between the natural log of FC concentrations and low-density residential, high-density residential, industrial/transportation, open space, transitional, commercial/institutional and recreation land uses, as well as subwatershed size (R^2=0.74). The following is the resulting regression equation from the analysis of FC concentrations. Figure H-4 shows observed geometric means and predicted concentrations to allow comparison.

$$LN(FC) = 8.48 \times (\%LU_{LDR}) + 9.81 \times (\%LU_{HDR}) + 8.30 \times (\%LU_{IND}) + 8.46 \times (\%LU_{OPS}) + 10.76 \times (\%LU_{TRN}) + 6.60 \times (\%LU_{COM}) + 17.92 \times (\%LU_{PRK}) + 12.85 \times (\%LU_{OPR}) - 0.000245 \times A$$

where: FC = fecal coliform concentration (#/100 mL)

$\%LU_{LDR}$ = percent of low density residential

$\%LU_{HDR}$ = percent of high density residential

$\%LU_{IND}$ = percent of industrial/transportation

$\%LU_{OPS}$ = percent of open space, including military operations

$\%LU_{TRN}$ = percent of transitional space

$\%LU_{COM}$ = percent of commercial/institutional

$\%LU_{PRK}$ = percent of park/recreation

$\%LU_{OPR}$ = percent of open recreation

A = total area of watershed (acres)

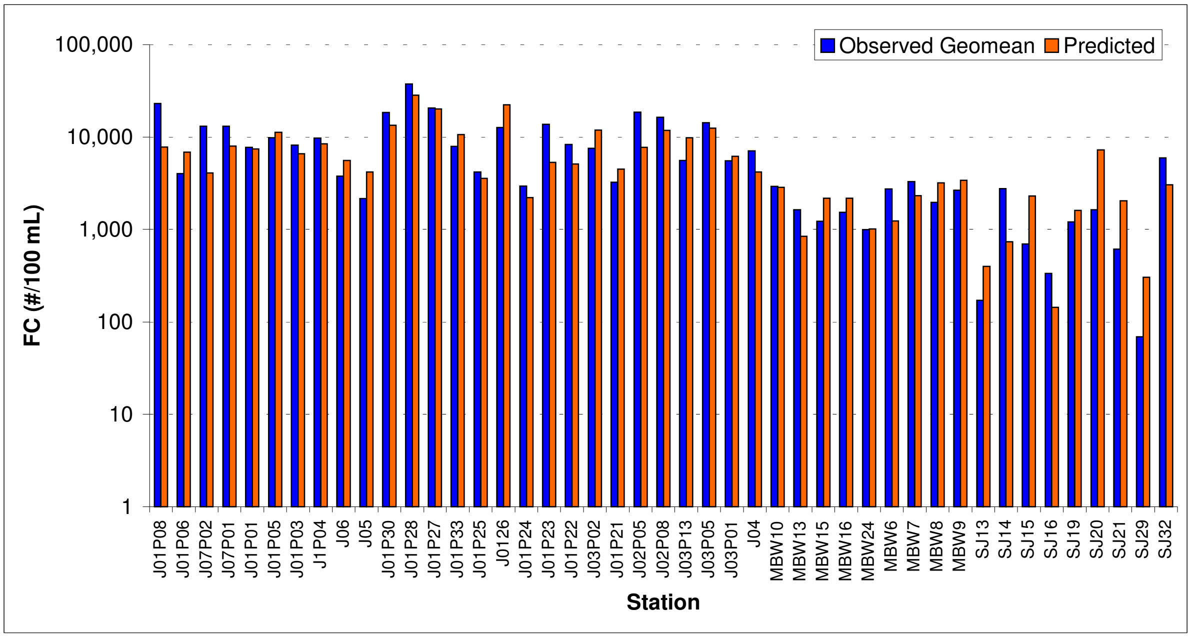

Figure H-4. Predicted versus observed fecal coliform concentrations.

The methodology for estimating FC concentrations was not as successful for prediction of total coliform (TC) and enteroccocus (ENT). Similar regression analyses were performed to determine whether there are relationships between TC and ENT and land use and subwatershed size, but no acceptable correlations were found. As a result, a separate approach was used for estimating TC and ENT concentrations in dry-weather runoff for each subwatershed. Analyses of geometric means of FC data collected at each station were performed on similar geometric means of TC and ENT data collected at those same stations. The analyses resulted in a single, normalized value of FC, TC and ENT at each station. Regression analyses were performed to determine whether there is a correlation between FC and levels of ENT and TC. Results showed a good correlation predicting TC and ENT as a function of FC (R^2=0.67 and R^2=0.77, respectively). The following are the resulting equations obtained (units of FC and TC/ENT are consistent):

$$\mathrm{TC} = 5.0324 \times \mathrm{FC} \quad \text{and} \quad \mathrm{ENT} = 0.8466 \times \mathrm{FC}$$

H.5 Model Calibration and Validation

The model was calibrated using data from Aliso Creek and Rose Creek. The calibration was completed by adjusting infiltration rates to reflect observed in-stream flow conditions and adjusting bacteria die-off rates to reflect observed in-stream bacteria concentrations. Following model calibration to in-stream flow and bacteria concentrations, a separate validation process was undertaken to verify the predictive capability of the model in other watersheds. Table H-1 lists the sampling locations used in calibration and validation, along with their corresponding watersheds. Figure H-7 shows the sampling locations in relation to the watersheds modeled for TMDL development (Appendix B, No. 4-6).

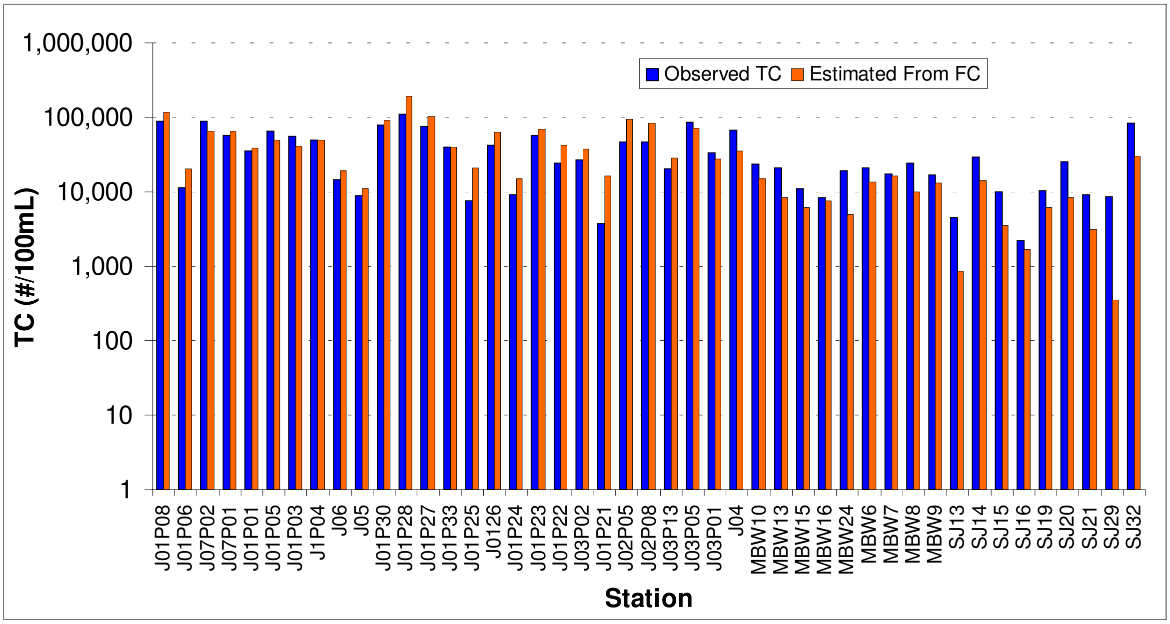

Figure H-5. Predicted versus observed total coliform concentrations

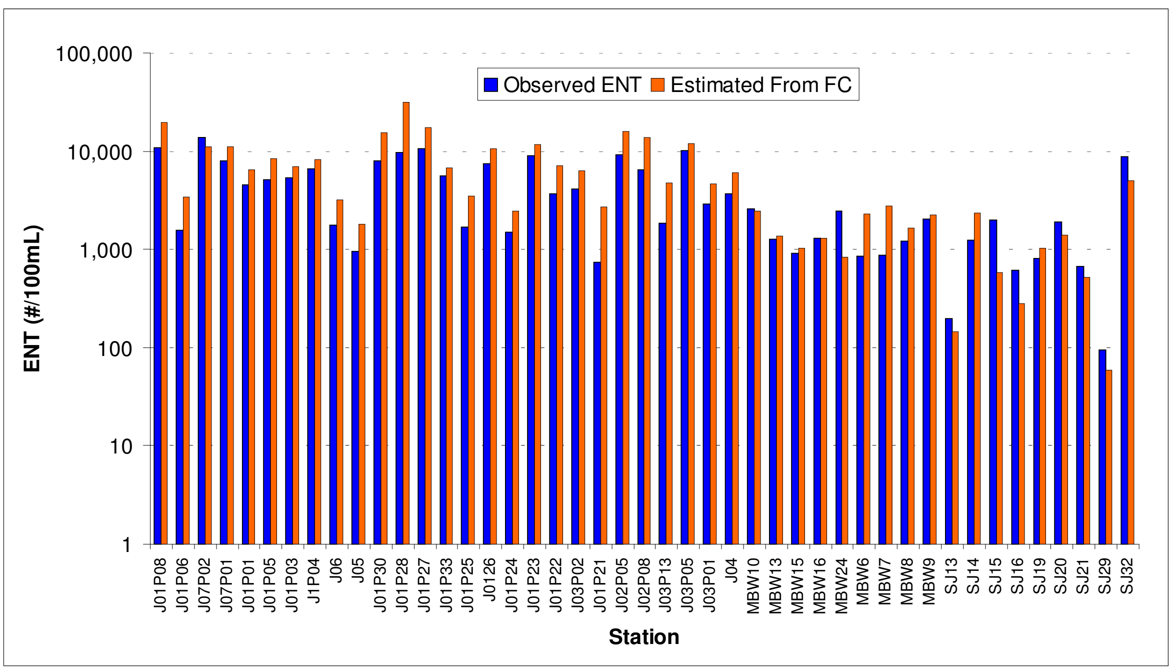

Figure H-6. Predicted versus observed enterococci concentrations

Table H-1. Calibration and Validation Sampling Locations

Calibration – Flow and Bacteria		Validation – Flow		Validation – Bacteria	
Watershed	Sampling Location	Watershed	Sampling Location	Watershed	Sampling Location
208	J01P22	403	USGS11047300	402	SJ04
209	J01P23	1701	MBW06	403	SJ05
210	J01P28	1702	MBW07	405	SJ18
211	J01P27	1703	MBW10	406	SJ24
212	J06	1704	MBW08	408	SJ1
213	J01P05	1705	MBW09	409	SJ29 & SJ17
214	J01P01			411	SJ06
215	J01TBN8			413	SJ08 & SJ07
219	J04			414	SJ30 & SJ09
220	J03P13			416	SJ15
221	J03P01			1701	MBW06
1601	MBW20			1702	MBW07
1602	MBW17			1703	MBW10
1603	MBW15			1704	MBW08
1605	MBW11			1705	MBW09
1606	MBW13				
1607	MBW24				

In the model, infiltration rates vary by soil type. Stream infiltration was calibrated by adjusting a single infiltration value, which was varied for each soil type by factors established from literature ranges (USEPA, 2000) of infiltration rates specific to each soil type. The goal of calibration was to minimize the difference between averages of observed streamflows and modeled flow at each station location (Figure H-7). Nine stations were used in calibrating the infiltration rate. The resulting infiltration rates were 1.368 in/hr (Soil Group A), 0.698 in/hr (Soil Group B), 0.209 in/hr (Soil Group C) and 0.084 in/hr (Soil Group D). The infiltration rates for Soil Groups B, C and D are within the infiltration range given in literature (Wanielisata et al., 1997). Soil Group A is below the range given in Wanielisata et al. (1997), however only one watershed in this TMDL is dominated by Soil Group A. Figure H-8 shows the results of the model calibration.

The modeled first-order die-off rate reflects the net effect on bacteria of various environmental conditions, such as solar radiation, temperature, dissolved oxygen, nutrients, regrowth, deposition, resuspension and toxins in the water. The die-off rates for FC, TC and ENT were used as calibration parameters to minimize the difference between observed in-stream bacteria levels and model predictions. Calibration results for FC, TC and ENT are presented in Figures I-9 through I-10. Die-off rates were determined for FC (0.137 1/d), TC (0.209 1/d) and ENT (0.145 1/d). These values are within the range of die-off rates used in various modeling studies as reported by the USEPA (1985). Sixteen stations were used in calibrating die-off rates.

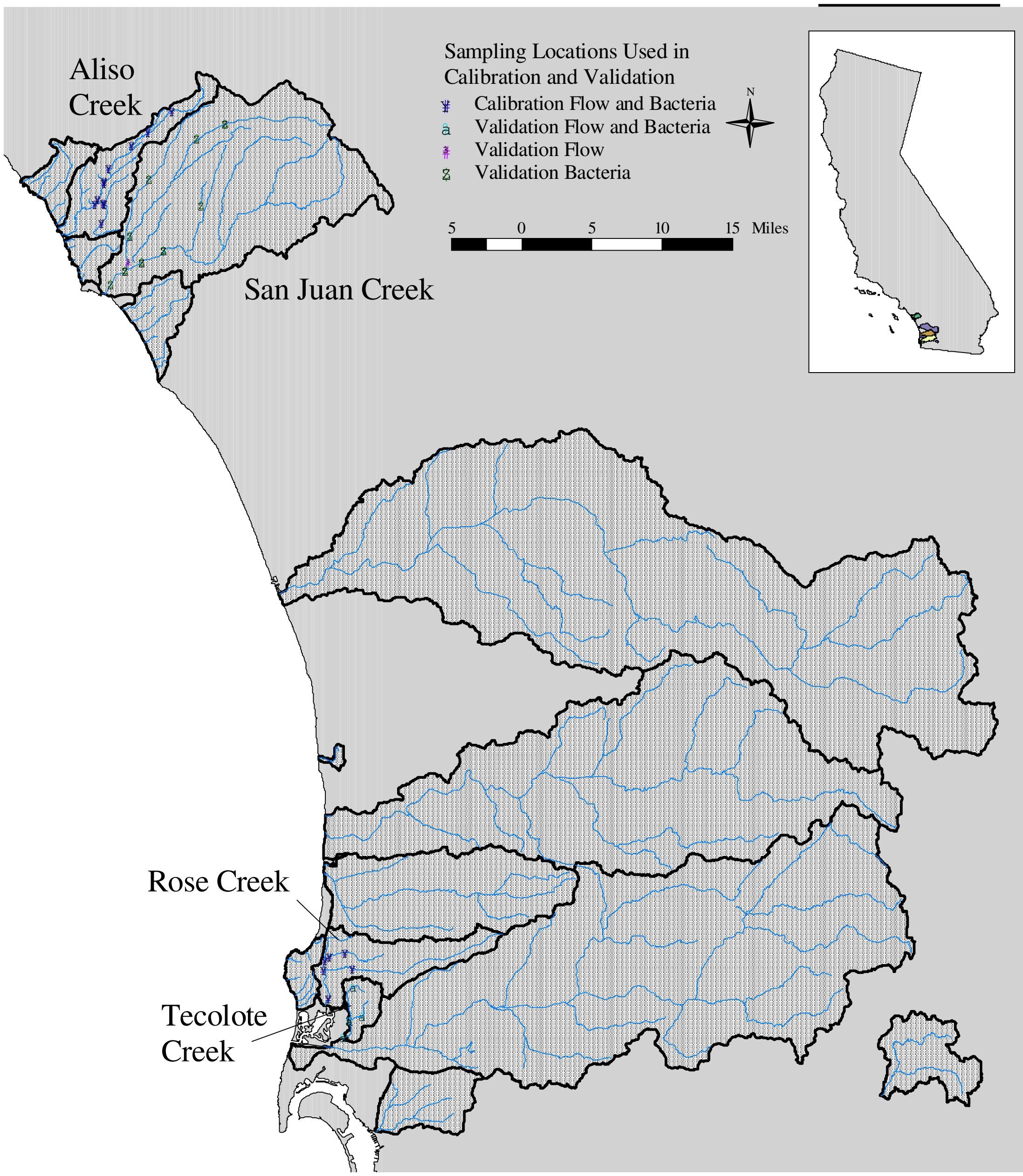

Figure H-7. Sampling locations used in model calibration and validation

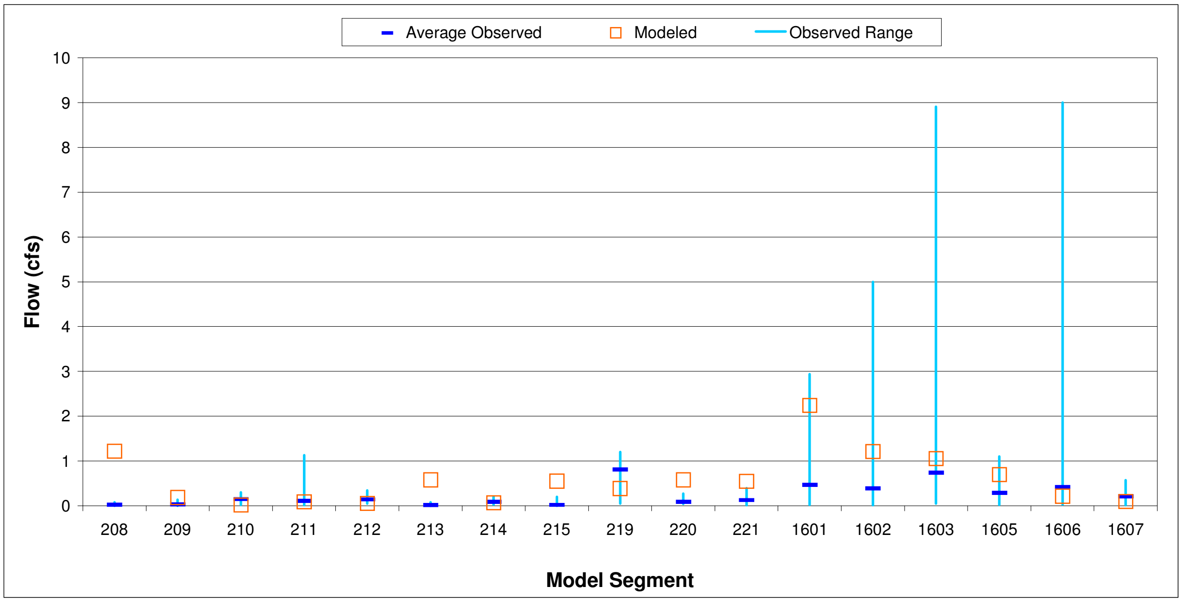

Figure H-8. Calibration modeled versus observed flows for Aliso Creek, Rose Creek and Tecolote Creek (Appendix B, No. 1 and 2)

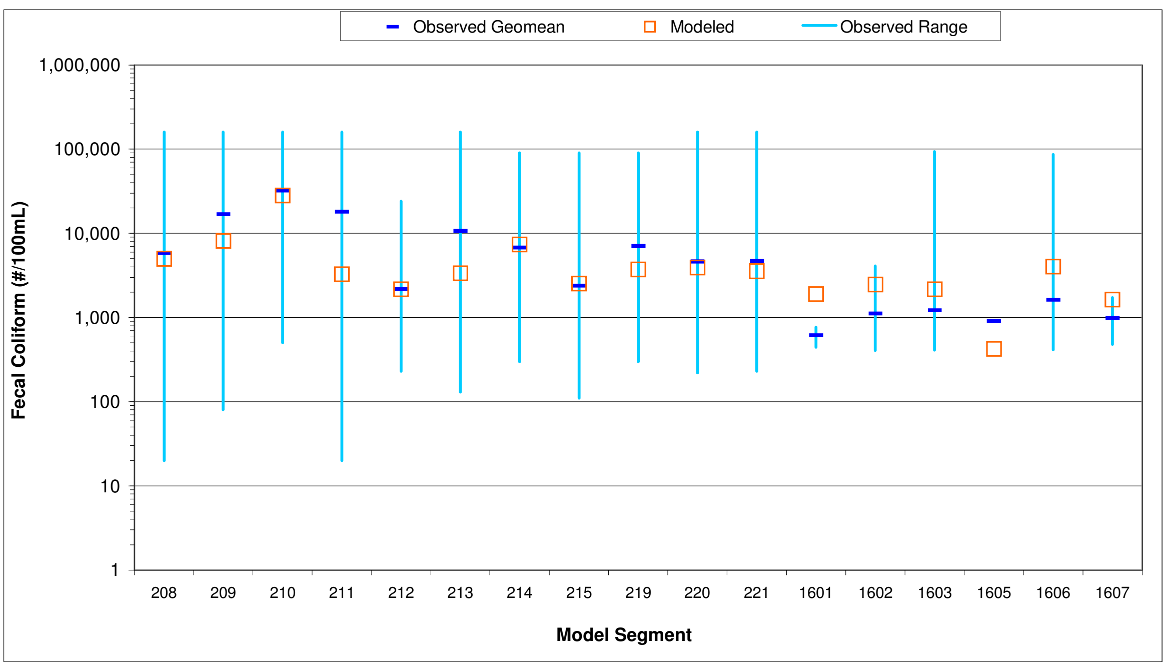

Figure H-9. Calibration modeled versus observed in-stream fecal coliform concentrations for Aliso Creek, Rose Creek and Tecolote Creek (Appendix B, No. 4 and 5)

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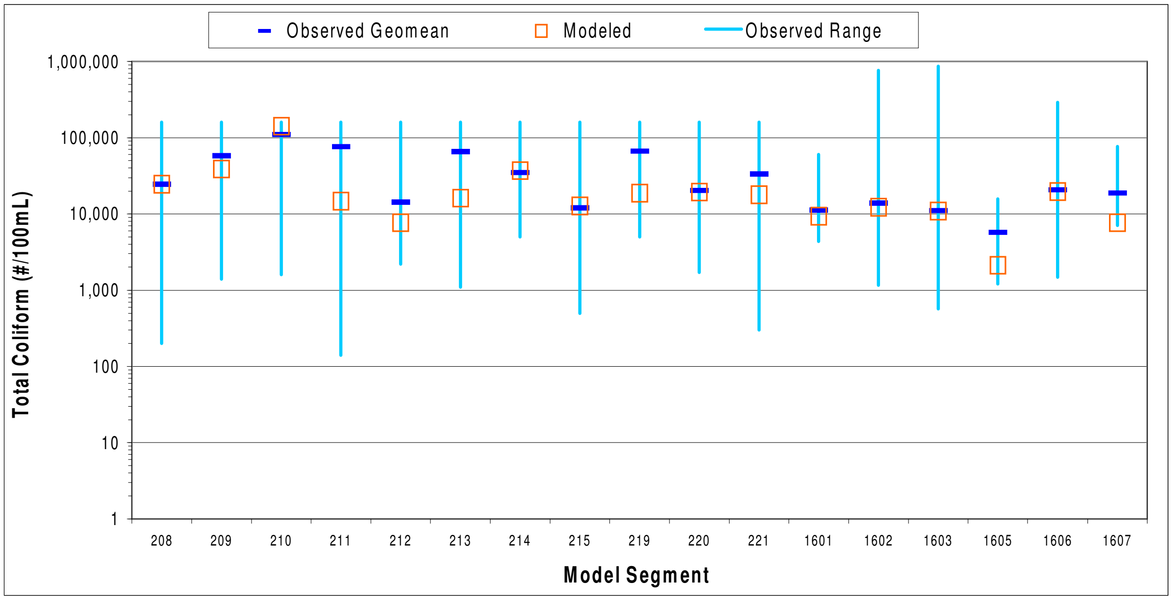

Figure H-10. Calibration modeled versus observed in-stream total coliform concentrations for Aliso Creek, Rose Creek and Tecolote Creek (Appendix B, No. 4 and 5)

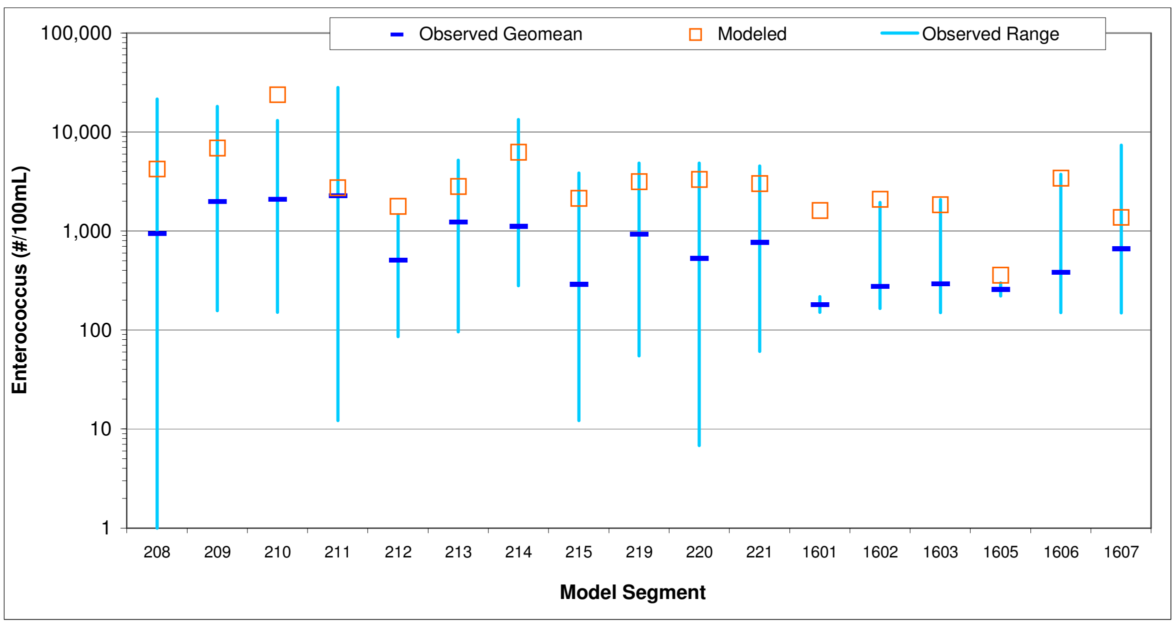

Figure H-11. Calibration modeled versus observed in-stream enterococci concentrations for Aliso Creek, Rose Creek and Tecolote Creek (Appendix B, No. 4 and 5)

The model was validated using six stations from San Juan Creek and Tecolote Creek (Appendix B, No. 2 and 3). The model-predicted flows were within the observed ranges of dry-weather flows (Figure H-12).

Model validation to in-stream water quality was provided using 15 stations on Tecolote Creek and San Juan Creek (Appendix B, No. 5 and 6). The results of the water quality validation are presented in Figures I-13 though I-15.

Figure H-12. Validation of modeled versus observed streamflow for San Juan Creek, Rose Creek and Tecolote Creek (Appendix B, No. 2 and 3)

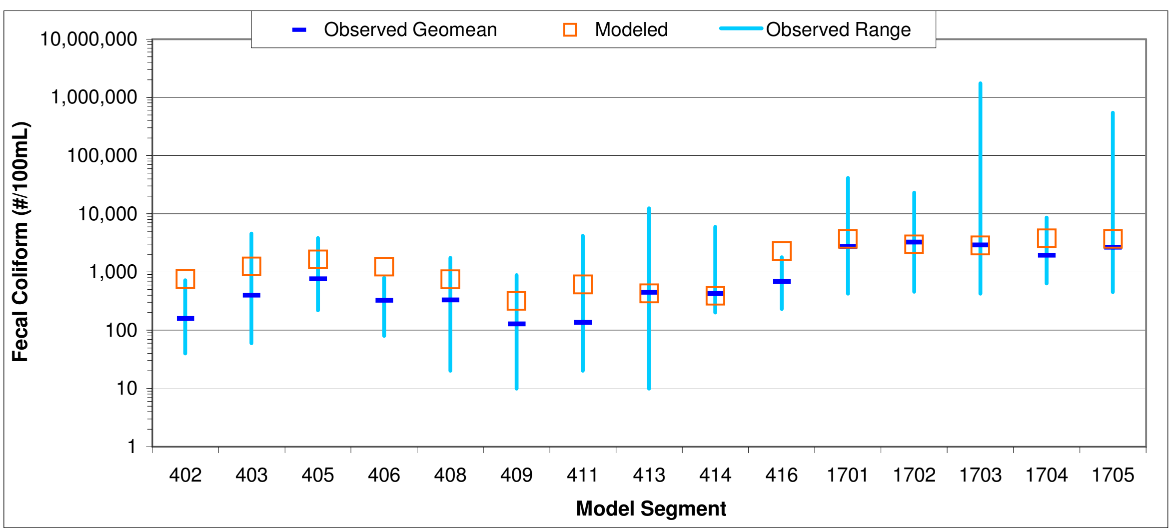

Figure H-13. Validation modeled versus observed fecal coliform concentration for San Juan Creek, Rose Creek and Tecolote Creek (Appendix B, No. 5 and 6)

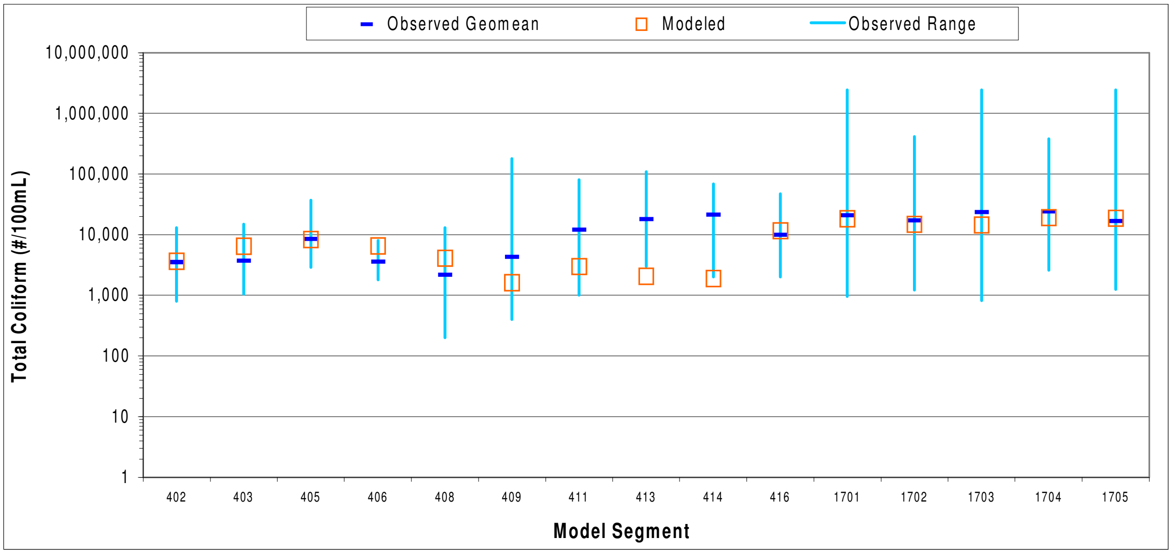

Figure H-14. Validation modeled versus observed total coliform concentration for San Juan Creek, Rose Creek and Tecolote Creek (Appendix B, No. 5 and 6)

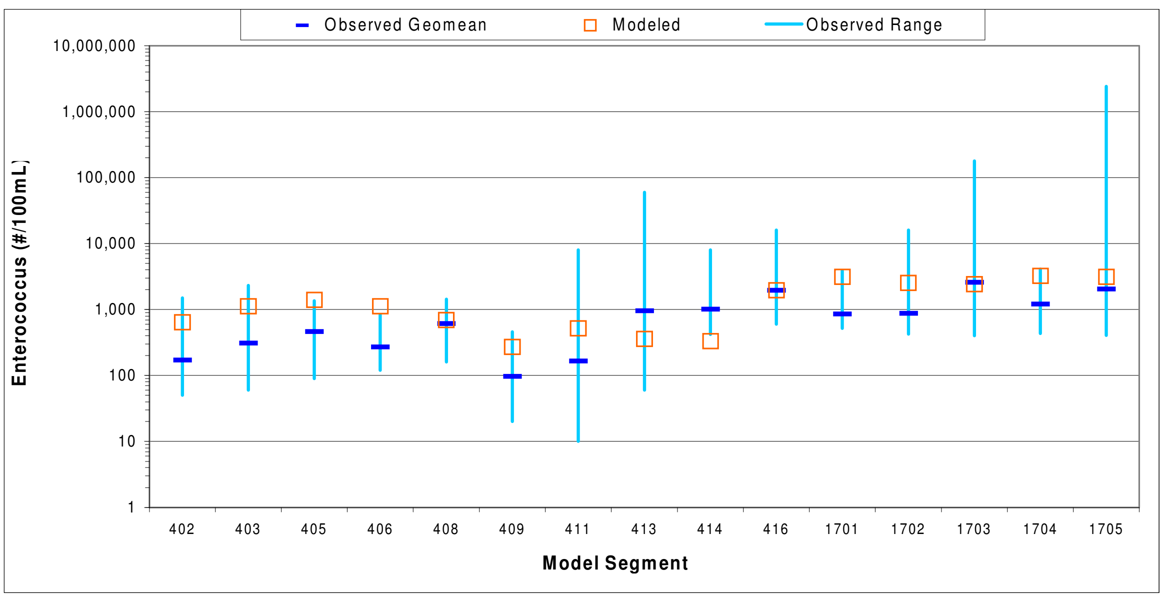

Figure H-15. Validation modeled versus observed enterococcus concentration for San Juan Creek, Rose Creek and Tecolote Creek (Appendix B, No. 5 and 6)

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Appendix I
Wet Weather Model Configuration, Calibration and Validation

Wet Weather Model

Wet weather sources of bacteria are generally associated with wash-off of loads accumulated on the land surface. During rainy periods, these bacteria loads are delivered to the waterbody through creeks and stormwater collection systems. Often, bacteria sources can be linked to specific land use types that have higher relative accumulation rates of bacteria, or are more likely to deliver bacteria to waterbodies due to delivery through stormwater collection systems. To assess the link between sources of bacteria and the impaired waters, a modeling system may be utilized that simulates the build-up and wash-off of bacteria and the hydrologic and hydraulic processes that affect delivery. Understanding and modeling of these processes provides the necessary decision support for TMDL development and allocation of loads to sources.

The wet weather TMDL calculation was based on a watershed model of the drainage area associated with each impaired waterbody. The USEPA's Loading Simulation Program in C++ (LSPC) was selected to simulate the hydrologic processes and bacteria loading to receiving waterbodies in the San Diego Region. LSPC is a component of the USEPA's TMDL Modeling Toolbox (Toolbox), which has been developed through a joint effort between the USEPA and Tetra Tech, Inc. It integrates a geographical information system (GIS), comprehensive data storage and management capabilities, a dynamic watershed model (a re-coded version of the USEPA's Hydrological Simulation Program – FORTRAN [HSPF]) and a data analysis/post-processing system into a convenient PC-based windows interface that dictates no software requirements.

An LSPC model was configured for many of the watersheds in the San Diego Region and was then used to simulate a series of hydraulically connected subwatersheds. Configuration of the model involved subdividing the watersheds within the San Diego Region into modeling units, followed by continuous simulation of flow and water quality for those units using meteorological, land use, soils, stream, point source and bacteria representation data. Development and application of the watershed model to address the project objectives involved a number of important steps:

1. Watershed Segmentation
2. Configuration of Key Model Components
3. Model Calibration and Validation

I.1 Watershed Segmentation

Watershed segmentation refers to the subdivision of all watersheds in the San Diego Region into smaller, discrete subwatersheds for modeling and analysis. This subdivision was primarily based on the stream networks and topographic variability and secondarily on the locations of flow and water quality monitoring stations, consistency of hydrologic factors, land use consistency and existing watershed boundaries (based on CALWTR 2.2 watershed boundaries). The San Diego Region was divided into sixteen basins for model configuration and subwatershed delineation—thirteen basins were modeled for assessment of bacteria loads to impaired waterbodies; three additional watersheds (Santa Margarita River, Tecolote Creek and Rose Creek) were configured for region-wide calibration, since data in these watersheds were plentiful. Basins and respective subwatershed delineations are presented in Appendix G.

I.2 Configuration of Key Model Components

Configuration of the watershed model involved consideration of four major components: meteorological data, land use representation, hydrologic and pollutant representation and waterbody representation. These components provided the basis for the model's ability to estimate flow and pollutant loadings. Meteorological data essentially drive the watershed model. Rainfall and other parameters are key inputs to LSPC's hydrologic algorithms. The land use representation provides the basis for distributing soils and pollutant loading characteristics throughout the basin. Hydrologic and pollutant representation refers to the LSPC modules or algorithms used to simulate hydrologic processes (e.g., surface runoff, evapotranspiration and infiltration) and pollutant loading processes (primarily accumulation and washoff). Waterbody representation refers to LSPC modules or algorithms used to simulate flow and pollutant transport through streams and rivers.

I.2.1 Meteorology

Meteorological data are a critical component of the watershed model. LSPC requires appropriate representation of precipitation and potential evapotranspiration. In general, hourly precipitation (or finer resolution) data are recommended for nonpoint source modeling. Therefore, only weather stations with hourly-recorded data were considered in the precipitation data selection process. Rainfall-runoff processes for each subwatershed were driven by precipitation data from the most representative station. These data provide necessary input to LSPC algorithms for hydrologic and water quality representation.

Meteorological data have been accessed from a number of sources in an effort to develop the most representative dataset for the San Diego Region. Hourly rainfall data were obtained from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA), the Automatic Local Evaluation in Real Time (ALERT) Flood Warning System managed by the County of San Diego and the California Irrigation Management Information System (CIMIS) (Appendix B, No. 21-23). The above data were reviewed based on geographic location, period of record and missing data to determine the most appropriate meteorological stations. Ultimately, meteorological data were utilized from 16 area weather stations for January 1990-September 2002 (Figure I-1).

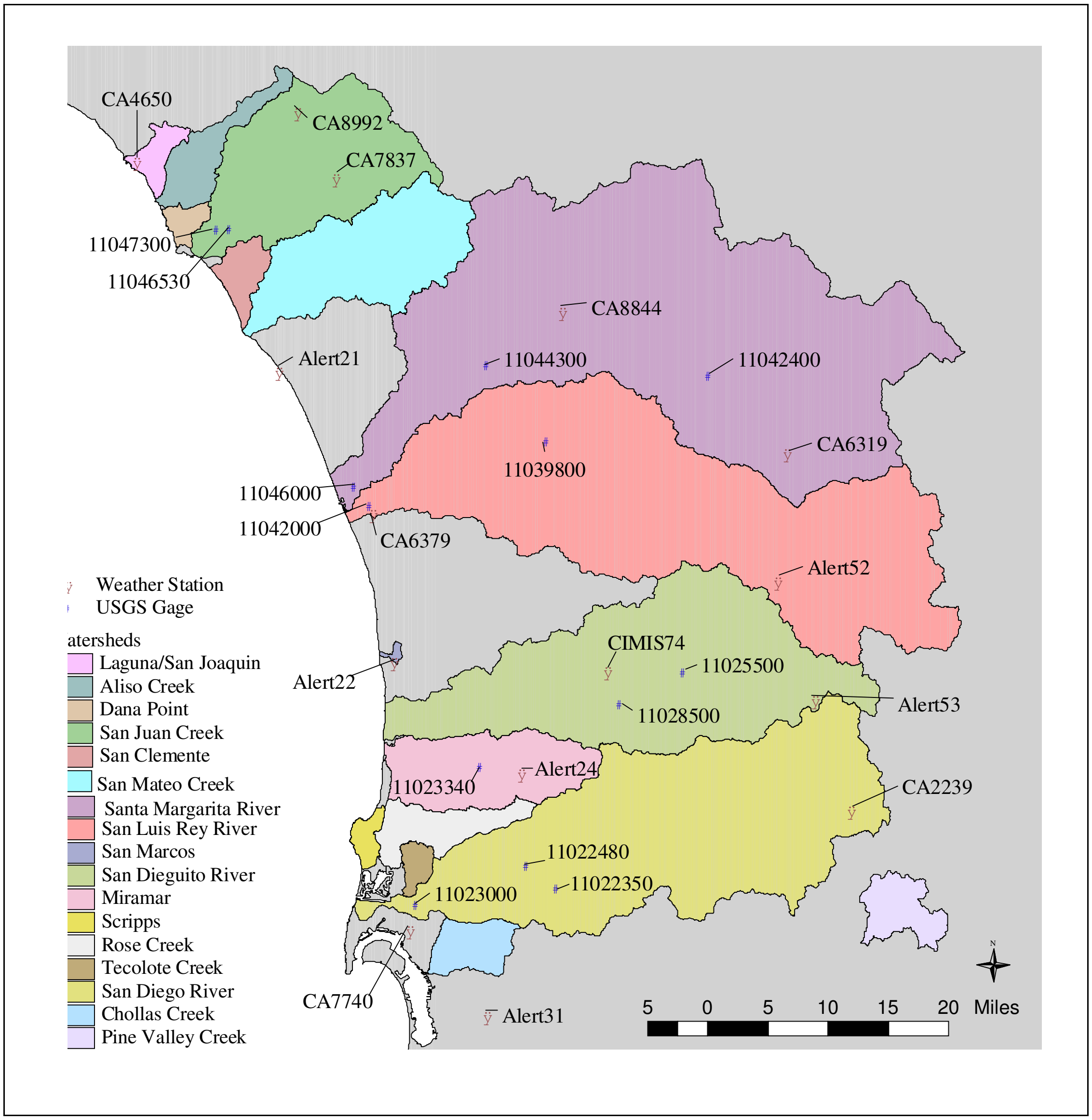

Figure I-1. Weather stations and flow gages utilized for wet weather modeling

Long-term hourly wind speed, cloud cover, temperature and dew point data are available for a number of weather stations in the San Diego Region. Data from Lindbergh Field, the San Diego Airport (COOP ID #047740), were obtained from NCDC for characterization of meteorology of the modeled watersheds (Appendix B, No. 21). Using this data, the METCMP utility, available from USGS, was used to calculate hourly potential evapotranspiration.

I.2.2 Land Use Representation

The watershed model requires a basis for distributing hydrologic and pollutant loading parameters. This is necessary to appropriately represent hydrologic variability throughout the basin, which is influenced by land surface and subsurface characteristics. It is also necessary to represent variability in pollutant loading, which is highly correlated to land practices. The basis for this distribution was provided by land use coverage of the entire watershed.

Three sources of land use data were used in this modeling effort. The primary source of data was the San Diego Association of Governments (SANDAG) 2000 land use dataset that covers San Diego County. This dataset was supplemented with land use data from the Southern California Association of Governments (SCAG) for Orange County and portions of Riverside County. A small area in Riverside County was not covered by either land use dataset. To obtain complete coverage, the 1993 USGS Multi-Resolution Land Characteristic data was used to fill this remaining data gap (Appendix B, No. 25).

Although the multiple categories in the land use coverage provide much detail regarding spatial representation of land practices in the watershed, such resolution is unnecessary for watershed modeling if many of the categories share hydrologic or pollutant loading characteristics. Therefore, many land use categories were grouped into similar classifications, resulting in a subset of 13 categories for modeling. Selection of these land use categories was based on the availability of monitoring data and literature values that could be used to characterize individual land use contributions and critical bacteria-contributing practices associated with different land uses. For example, multiple urban categories were represented independently (e.g., high density residential, low density residential and commercial/institutional), whereas forest and other natural categories were grouped. Table I-1 presents the land use distribution in each of the thirteen watersheds contributing to waterbody impairments.

LSPC algorithms require that land use categories be divided into separate pervious and impervious land units for modeling. This division was made for the appropriate land uses (primarily urban) to represent impervious and pervious areas separately. The division was based on typical impervious percentages associated with different land use types from the Soil Conservation Service's TR-55 Manual (Soil Conservation Service, 1986).
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Table I-1. Land use areas (square miles) of each impaired watershed

Watershed	Low Density Residential (1100)	High Density Residential (1200)	Commercial/ Institutional (1400)	Industrial/ Transportation (1500)	Military (1600)	Parks/ Recreation (1700)	Open Recreation (1800)	Agriculture (2000)	Dairy/ Intensive Live-stock (2400)	Horse Ranches (2700)	Open Space (4000)	Water (5000)	Transitional (7000)	Total
Laguna / San Joaquin	2.39	0.61	0.34	0.11	0.00	0.18	0.02	0.00	0.00	0.02	10.02	0.00	0.23	13.94
Aliso Creek	8.75	3.76	2.14	0.89	0.00	0.69	0.40	0.07	0.00	0.03	16.09	0.06	2.86	35.74
Dana Point	3.51	1.30	0.25	0.01	0.00	0.28	0.32	0.00	0.00	0.00	2.70	0.00	0.53	8.89
San Juan Creek	15.61	2.97	3.09	2.90	0.00	1.03	1.86	7.57	0.00	0.40	137.07	0.66	4.03	177.18
San Clemente	3.85	1.31	0.66	1.17	0.02	0.37	0.52	0.00	0.00	0.00	10.06	0.00	0.81	18.78
San Luis Rey River	42.86	4.22	3.24	4.92	15.31	1.65	2.56	123.49	8.51	0.00	350.46	2.56	0.63	560.42
San Marcos	0.34	0.17	0.19	0.05	0.00	0.04	0.10	0.06	0.25	0.00	0.13	0.01	0.10	1.43
San Dieguito River	43.58	2.26	5.33	2.22	0.00	1.19	3.19	61.72	5.71	0.00	215.96	2.72	2.34	346.22
Miramar	22.42	3.86	11.41	3.28	0.00	1.70	1.14	2.29	0.93	0.00	44.47	0.26	1.96	93.73
Scripps	5.21	1.32	0.86	0.05	0.00	0.13	0.20	0.00	0.00	0.00	0.94	0.01	0.03	8.75
San Diego River	65.65	10.61	16.36	10.07	3.07	2.73	2.06	9.46	0.87	0.00	308.67	6.44	0.50	436.48
Chollas Creek	14.75	2.87	3.79	1.61	0.02	0.38	0.52	0.00	0.00	0.00	2.73	0.03	0.09	26.80
Pine Valley Creek	0.13	0.00	0.03	0.00	0.00	0.11	0.00	0.03	0.00	0.00	29.10	0.13	0.00	29.53

I.2.3 Hydrology Representation

The LSPC PWATER (water budget simulation for pervious land segments) and IWATER (water budget simulation for impervious land segments) modules, which are identical to those in HSPF, were used to represent hydrology for all pervious and impervious land units (Bicknell et al., 1996). Designation of key hydrologic parameters in the PWATER and IWATER modules of LSPC were required. These parameters are associated with infiltration, groundwater flow and overland flow. USDA's STATSGO Soils Database served as a starting point for designation of infiltration and groundwater flow parameters (Appendix B, No. 26). For parameter values not easily derived from these sources, documentation on past HSPF applications were accessed, particularly the recent modeling studies performed for the San Jacinto River Watershed (Tetra Tech, Inc, 2003) and Santa Monica Bay (LARWQCB, 2002). Starting values were refined through the hydrologic calibration process (described in the next section).

I.2.4 Pollutant Representation

Loading processes for FC, TC and ENT were represented for each land unit using the LSPC PQUAL (simulation of quality constituents for pervious land segments) and IQUAL (simulation of quality constituents for impervious land segments) modules, which are identical to those in HSPF. These modules simulate the accumulation of pollutants during dry periods and the washoff of pollutants during storm events. Starting values for parameters relating to land-use-specific accumulation rates and buildup limits, were obtained from a study performed by the Southern California Coastal Water Research Project (SCCWRP) to support bacteria TMDL development of Santa Monica Bay (LARWQCB, 2002). These starting values served as baseline conditions for water quality calibration; the appropriateness of these values to the San Diego Region watershed was validated through comparison to local water quality data. Although atmospheric deposition may be an issue in the watersheds, it was not explicitly simulated in the watershed model. It was, however, represented implicitly in the model through use of the land use- and pollutant-specific accumulation rates.

There were six major inland dischargers during the simulation period and these were incorporated into the LSPC model as point sources of flow and bacteria. Each point source is located in the Santa Margarita River watershed – five at Camp Pendleton and one along Murrieta Creek (Santa Rosa Water Reclamation Facility). Although the Santa Margarita River watershed had no waterbodies impaired for bacteria, it was simulated in this wet weather modeling effort due to the availability of streamflow and bacteria monitoring data, which were used for hydrologic and water quality calibration and validation. It is important to note that all six major inland discharges were eliminated by 2002.

I.2.5 Waterbody Representation

Each delineated subwatershed was represented with a single stream assumed to be completely mixed, one-dimensional segments with a trapezoidal cross-section. The

National Hydrography Dataset (NHD) stream reach network for USGS hydrologic units 18070301 through 18070305 were used to determine the representative stream reach for each subwatershed. Once the representative reach was identified, slopes were calculated based on DEM data and stream lengths measured from the original NHD stream coverage (Appendix B, No. 24 and 27). In addition to stream slope and length, mean depths and channel widths are required to route flow and pollutants through the hydrologically connected subwatersheds. Mean stream depth and channel width were estimated using regression curves that relate upstream drainage area to stream dimensions. An estimated Manning's roughness coefficient of 0.2 was also applied to each representative stream reach.

In addition to the streams which route flow and transport pollutants through the watersheds, there were several reservoirs within the region that were large enough to impound a significant portion of flow during wet periods. To represent these reservoirs in the watershed model, the length, width, maximum depth, infiltration rate and spillway height and width were obtained for each reservoir. The reservoirs impounded all upstream flow until the water depth exceeded the spillway height, causing overflow and thus contributing to downstream flow and bacteria loading.

I.3 Model Calibration and Validation

After the model was configured, model calibration and validation were performed. This is generally a two-phase process, with hydrology calibration and validation completed before repeating the process for water quality. Upon completion of the calibration and validation at selected locations, a calibrated dataset containing parameter values for each modeled land use and pollutant was developed.

Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. The calibration was performed for different LSPC modules at multiple locations throughout the watershed. This approach ensured that heterogeneities were accurately represented. Subsequently, model validation was performed to test the calibrated parameters at different locations or for different time periods, without further adjustment. To ensure that the model results are as current as possible and to provide for a range of hydrologic conditions, January 1991 through September 2002 was selected as the time period for simulation.

I.3.1 Hydrology Calibration and Validation

Hydrology is the first model component calibrated because estimation of bacteria loading relies heavily on flow prediction. The hydrology calibration involves a comparison of model results to in-stream flow observations at selected locations. After comparing the results, key hydrologic parameters were adjusted and additional model simulations were performed. This iterative process was repeated until the simulated results closely represented the system and reproduced observed flow patterns and magnitudes.

Gaging stations representing diverse hydrologic regions of the San Diego Region were used for calibration, including eleven USGS streamflow gage stations (Table I-2 and Figure I-1) (Appendix B, No.3). These gaging stations were selected because they either had a robust historical record or they were in a strategic location (i.e. along a 303(d) listed waterbody, downstream of a reservoir, or along an otherwise unmonitored reach).

Table I-2. USGS stations used for hydrology calibration and validation

Station Number	Station Name	Historical Record	Selected Calibration Period	Selected Validation Period	Watershed and Model Subwatershed
11022480	San Diego River at Mast Road near Santee, CA	5/1/1912 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	San Diego River (1805)
11023000	San Diego River at Fashion Valley at San Diego, CA	1/18/1982 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	San Diego River (1801)
11023340	Los Penasquitos Creek near Poway, CA	10/1/1964 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	Miramar (1406)
11025500	Santa Ysabel Creek near Ramona, CA	2/1/1912 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	San Dieguito (1316)
11028500	Santa Maria Creek near Ramona, CA	12/1/1912 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	San Dieguito (1324)
11042000	San Luis Rey River at Oceanside, CA	10/1/1912 - 11/10/1997; 4/29/1998 - 9/30/2002	9/1/1993 - 8/31/1997	5/1/1998 - 4/30/0202	San Luis Rey (702)
11042400	Temecula Creek near Aguanga, CA	8/1/1957 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	Santa Margarita (658)
11044300	Santa Margarita River at FPUD Sump near Fallbrook, CA	10/1/1989 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	Santa Margarita (615)
11046000	Santa Margarita River at Ysidora, CA	3/1/1923 - 2/25/1999; 10/1/2001 - 9/30/2002	1/1/1991 - 12/31/1995	1/1/1996 - 12/31/1998	Santa Margarita (602)
11046530	San Juan Creek at La Novia Street Bridge near San Juan Capistrano, CA	10/1/1985 - 9/30/2002	1/1/1991 - 12/31/1996	1/1/1997 - 12/31/2001	San Juan (411)
11047300	Arroyo Trabuco near San Juan Capistrano, CA	10/1/1970 - 9/30/1989; 10/1/1995 - 9/30/2002	10/1/1995 - 4/30/1999	5/1/1999 - 4/30/2002	San Juan (403)
11022350	Forester Creek near El Cajon, CA	10/1/1993 - 9/30/2002	none (insufficient period of record)	1/1/1991 - 9/30/1993	San Diego River (1843)
11039800	San Luis Rey River at Couser Canyon Bridge near Pala, CA	10/1/1986 - 1/4/1993	none (insufficient period of record)	1/1/1991 - 12/31/1992	San Luis Rey (711)

The calibration years were selected based on annual precipitation variability and the availability of observation data to represent a continuum of hydrologic conditions: low, mean and high flow. Calibration for these conditions was necessary to ensure that the model would accurately predict a range of conditions over a longer period of time.

Key considerations in the hydrology calibration included the overall water balance, the high-flow/low-flow distribution, stormflows and seasonal variation. At least two criteria for goodness of fit were used for calibration: graphical comparison and the relative error method. Graphical comparisons were extremely useful for judging the results of model calibration; time-variable plots of observed versus modeled flow provided insight into the model's representation of storm hydrographs, baseflow recession, time distributions and other pertinent factors often overlooked by statistical comparisons. The model's accuracy was primarily assessed through interpretation of the time-variable plots. The relative error method was used to support the goodness of fit evaluation through a quantitative comparison.

After calibrating hydrology at the eleven locations, a validation of these hydrologic parameters was made through a comparison of model output to different time periods at the same gages as well as two additional gages (Table I-2). The validation essentially confirmed the applicability of the regional hydrologic parameters derived during the calibration process. Validation results were assessed in a similar manner to calibration: graphical comparison and the relative error method.

Hydrology calibration and validation results, including time series plots and relative error tables, are presented for each gage in Appendix M. The calibration results, which are presented first, include graphs to represent overall model fit, seasonal trends and two time series plots. These graphs are followed by a table that quantifies the model results and observed gage data. This table also provides relative errors between the modeled and observed values in the storm volumes and highest flows. The presentation of model validation results follows the calibration tables and graphs for each gage. Two additional gages that had a limited historical record were used as additional validation. Validation was assessed through a time series plot and a relative error table identical to the calibration table.

Overall, during model calibration the model predicted storm volumes and storm peaks well. Since the runoff and resulting streamflow is highly dependent on rainfall, occasional storms were over-predicted or under-predicted depending on the spatial variability of the meteorologic and gage stations. The validation results also showed a good fit between modeled and observed values, thus confirming the applicability of the calibrated hydrologic parameters to the San Diego Region.

I.3.2 Water Quality

After the model was calibrated and validated for hydrology, water quality simulations were performed. As described above, previously calibrated, land use specific accumulation and maximum build up rates for fecal coliforms, total coliforms and enterococci (LARWQCB, 2002) were used for the water quality simulations. Since these values have been successfully applied to recent bacteria models, including TMDLs, in southern California, they were considered to be sufficiently calibrated. Therefore, the water quality simulations were used to further validate these rates. The objective of the validation process was to best represent bacteria concentrations during storm events at monitoring stations throughout the region.

Only data from wet weather events (rainfall of 0.2 inches or greater and the following 72 hours) were used for comparison with model water quality output. This greatly reduced the availability of bacteria monitoring data for use in the validation process; however, it was important to differentiate between wet and dry periods due to the separate approaches utilized for this TMDL. There were 107 monitoring stations in the modeled subwatersheds with wet weather monitoring data that overlapped with the modeling period (Tables D-3 through D-5) (Appendix B, No. 7-14). The spatial variability of these locations was excellent (ranging from urban to open land uses); however, the temporal variability and total number of samples limited statistical analysis to basinwide summary statistics rather than comprehensive time series and relative error analyses at each monitoring location.

Table I-3. Basin-wide water quality data used for fecal coliform validation

Basin	Number of		Fecal Coliform (MPN/100mL)		
	Sites	Samples	Minimum	Mean	Maximum
Aliso Creek	59	217	2	11,142	160,000
San Juan Creek	7	9	200	4,222	26,000
Santa Margarita River	14	83	2	1,204	50,000
Rose Creek & Tecolote Creek	17	30	31	9,939	137,400
San Diego River	6	36	2	1,557	24,000

Table I-4. Basin-wide water quality data used for total coliform validation

Basin	Number of		Total Coliform (MPN/100mL)		
	Sites	Samples	Minimum	Mean	Maximum
Aliso Creek	56	206	2	32,246	160,000
San Juan Creek	7	9	680	16,356	70,000
Santa Margarita River	14	36	230	3,248	50,000
Rose Creek & Tecolote Creek	15	24	4,884	333,384	2,419,200
San Diego River	6	34	300	14,885	300,000

Table I-5. Basin-wide water quality data used for enterococcus validation

Basin	Number of		Enterococcus (MPN/100mL)		
	Sites	Samples	Minimum	Mean	Maximum
Aliso Creek	59	217	1	3,720	72,000
San Juan Creek	7	9	340	8,056	51,000
Rose Creek & Tecolote Creek	17	29	20	6,978	32,550
Pine Valley Creek	4	24	1	1,065	20,000

To assess model fit with available data, the time series model output was graphically compared to the observed data. Appendix N (Figures 1-11) presents time series graphs of modeled and observed data for downstream subwatersheds with a reasonable number of samples. Ensuring that the storm events were represented within the range of the data over time is the most practical and meaningful means of assessing the quality of the model output. The time series plots indicate that the model predicts the FC, TC and ENT concentrations within the range of observed data (ranges of observed data are presented in Tables D-3 through D-5) and at a similar frequency. This is especially evident in subwatersheds where there is a significant amount of data across a wide temporal range (see Appendix N, Figure 1).

To provide a side-by-side comparison of the available wet weather monitoring data with model output for the same day, data were grouped by basin to increase sample size. Graphs of concentration by percentile of unit area flow (inches/acre) are presented in Appendix N (Figures 12-25) for each pollutant in the basins where data were available. Presenting the data as a function of flow facilitates analysis of the results which are pertinent to the wet weather model. Specifically, the higher flows (larger percentiles) are likely associated with the actual precipitation event, rather than the assumed wet period of 72 hours following the storm. For lower flows, observed data that met the wet weather criterion (0.2 inches of rainfall and following 72 hours) may not be representative of true wet conditions, which explains the deviance between model predictions and ranges of observed water quality. However, dry periods are addressed in a separate approach in this TMDL with better accuracy.

Figures 12 through 25 in Appendix N depict the average and range for observed and modeled FC, TC and ENT concentrations in the basins identified above. These graphs indicate that the model compared well to observed data, especially for basins with larger sample sizes and in the larger unit area flow percentiles. Discrepancies may be due to small sample sizes, the variability in bacteria monitoring and analysis, or the range of time defined as a wet period (72 hours after a 0.2 inch or greater storm).

Analysis of the time series graphs and the unit area flow summary plots indicate that the previously calibrated bacteria accumulation and maximum build-up rates (LARWQCB, 2002) are applicable and therefore validated, for the San Diego region. Additional bacteriological data collection is likely to further support these findings considering that the model matched observed data extremely well for all three pollutants when an abundance of observed wet weather data was available (see Appendix N, Figures 12-14).

I.4 Application of Wet Weather Model

After completing model calibration and validation for hydrology and water quality, the model was applied to obtain hourly output for the critical period described in Section 6.1.1. The maximum hourly FC, TC and ENT concentrations were obtained for each wet day in the critical period (1993) for all subwatersheds associated with a 303(d) listed segment. These concentrations, along with their associated average daily flow, were used to generate TMDL load duration curves (Appendices K and L). The overall load capacity was incorporated into the load duration curves. Predicted loads that fell above the load capacity are exceedances and were then divided by the total existing load to calculate the percent reduction required to achieve the beneficial use of the receiving waterbody.

Appendix J
Assumptions

Wet-Weather Modeling Assumptions

The watershed modeling system developed to represent wet-weather conditions is reported in Appendices I, K, and L of the draft Technical TMDL report. The following assumptions are relevant to the LSPC model developed to simulate wet-weather sources of bacteria in the region.

- *General LSPC/HSPF Model Assumptions* - Many model assumptions are inherent in the algorithms used by the LSPC watershed model and are reported extensively in Bicknell et al. (1996).
- *Land Use* - A combination of SCAG, SANDAG and MRLC land use GIS datasets is assumed representative of the current land use areas. For areas where significant changes in land use have occurred since the creation of these datasets, model predictions may not be representative of observed conditions.
- *Stream Representation* - Each delineated subwatershed was represented with a single stream assumed to be a completely mixed, one-dimensional segment with a trapezoidal cross-section.
- *Hydrologic Modeling Parameters* - Hydrologic modeling parameters were developed during previous modeling studies in Southern CA (e.g., LA River, San Jacinto River) and refined through calibration to streamflow data collected in the San Diego region. Through the calibration and validation process (reported in Appendix I of the draft Report), a set of modeling parameters were obtained specific to land use and hydrologic soil groups. These parameters are assumed to be representative of the hydrology of other watersheds in the San Diego region that are presently ungaged and therefore unverified.
- *Water Quality Modeling Parameters* - Dynamic models require a substantial amount of information regarding input parameters and data for calibration purposes. All sources of indicator bacteria from watersheds are represented in the LSPC model as build-up/wash-off from specific land use types. Limited data are currently available in the San Diego region to allow development of unique modeling parameters for simulation of build-up/wash-off, so parameters were obtained from a similar study performed in the Los Angeles region. These build-up/wash-off modeling parameters were originally developed by SCCWRP for a watershed model of the Santa Monica Bay Beaches (LARWQCB, 2002) and are assumed representative of land use sources in the San Diego region. This assumption was validated through evaluation of model results with local data. Results of model validation are reported in Appendix I of the TMDL Report.
- *Lumped Parameter Model Characteristic* - LSPC is a lumped-parameter model and is assumed to be sufficient for modeling transport of flows and bacteria loads from watersheds in the region. For lumped parameter models, transport of flows and bacteria loads to the streams within a given model subwatershed cannot consider relative distances of land use activities and topography that may enhance or impede time of travel over the land surface. Although this limitation could result in mistiming of peak flows or under-prediction of bacteria die-off because overland losses are not simulated, impacts are assumed minimal.

- *First-order Bacteria Die-off* - Each stream is modeled assuming first-order die-off of bacteria. Bacteria die-off rates for wet weather are assumed as 0.8/day, based on sensitivity analyses performed by SCCWRP (LARWQCB, 2002).
- *In-stream Bacteria Re-growth* - The LSPC model assumes no in-stream regrowth of bacteria. No data or literature were located to provide indication that such sources are significant during wet weather or could be estimated for model input.

Dry Weather Modeling Assumptions

The watershed modeling system developed for simulation of steady-state dry-weather flows and sources of bacteria are reported in Appendix H of the TMDL Report. The following assumptions are relevant to that discussion.

- *Channel Geometry* - Channel geometry during low-flow, dry-weather conditions is assumed to be represented appropriately using equations derived from flows and physical data collected at 53 USGS stream gages in southern CA.
- *Steady-state Model Configuration* - Although it is understood that dry-weather flows and bacteria densities vary over time for any given stream, for prediction of average conditions in the stream, flows and concentrations are assumed as steady state.
- *Plug Flow Model Configuration* - Plug flow reaction kinetics are assumed sufficient in modeling dry-weather, steady-state stream routing and bacteria die-off (with first-order die-off).
- *Sources for Characterization of Dry-weather Conditions* - Data used for characterization of dry-weather flows and water quality are assumed representative of conditions throughout the region.
- *Methods for Characterization of Dry-weather Conditions* - The equations derived through multivariable regression analyses are assumed sufficient to represent the dry-weather flows and water quality as functions of land use and watershed size. This assumption was verified through model calibration and validation reported in Appendix H of the TMDL Report.
- *First-order Bacteria Die-off* - Each stream is modeled assuming first-order die-off of bacteria. First-order rates were obtained through model calibration and verified as consistent with ranges reported by USEPA (1985). These values were determined for FC, TC and ENT as 0.137/day, 0.209/day and 0.145/day, respectively. These die-off rates are assumed representative of all streams studied in the region.
- *Bacteria Re-growth* - The dry-weather model assumes no in-stream sources or regrowth of bacteria. No data or literature were located to provide indication that such sources are significant during wet weather or could be estimated for model input
- *Stream Infiltration* - Losses of volume through stream infiltration were modeled assuming infiltration rates were constant for each of the four hydrologic soil groups (A, B, C and D). Infiltration rates were based on literature vales and refined through model calibration and validation reported in Appendix H of the

TMDL Report. The resulting infiltration rates were 1.368 in/hr (Soil Group A), 0.698 in/hr (Soil Group B), 0.209 in/hr (Soil Group C) and 0.084 in/hr (Soil Group D). These infiltration rates are within the range of values given in literature (Wanielisata et al., 1997). These infiltration rates are assumed representative for all streams studied in the region within each hydrologic soil group.

Assumptions for TMDL Calculation

Calculation of TMDLs, load allocations and recommended load reductions were reported in Section 8 of the TMDL Report. The following assumptions are applicable to this discussion.

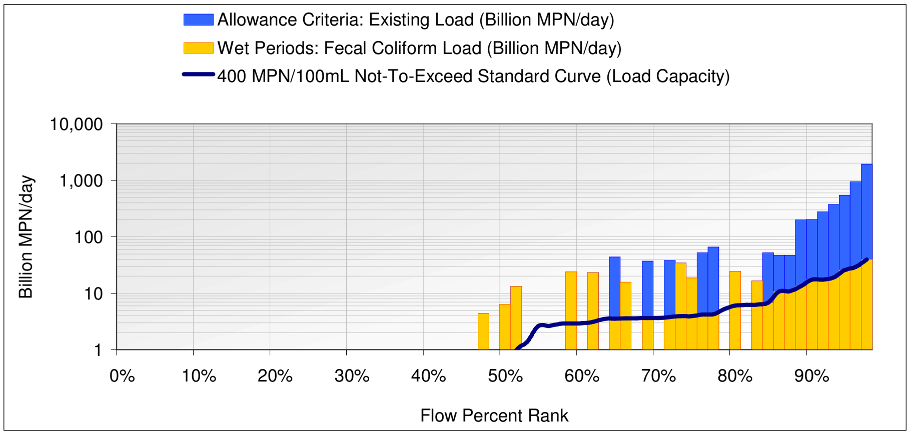
- *Critical Point for Loading Assessments* - For TMDL calculation, the water quality at a *critical point* or location in an impaired waterbody is often compared to TMDL targets for assessment of reductions of pollutant loads to meet TMDLs. This critical point is a conservative location for assessment of water quality conditions and is therefore selected based on high bacteria loads predicted at that location. Although this critical point for water quality assessment is utilized for TMDL analysis, compliance to WQOs must be assessed and maintained for all segments of a waterbody to ensure that impairments of beneficial uses are not observed. For beaches, the critical points for meeting numeric targets are at the mouths of the watersheds that contribute to the impairment of the waterbodies. Therefore, surf zone mixing and dilution of discharges from creeks and storm drains to the beach were not considered. Because beneficial uses of the beach are to be maintained at all locations, including the discharge point of creeks, the conservative approach was to attain numeric targets at those discharge points where bacterial densities are assumed to be greatest. For development of TMDLs for impaired creeks, critical points were also selected at the mouths of the impaired creek segments. This approach provides an implicit margin of safety to ensure protection of the beneficial uses of the beaches and creeks under critical conditions.
- *TMDL Numeric Targets* – Separate numeric targets are used for wet- and dry-weather TMDL calculations. For wet-weather, the single-sample water quality objectives were used to assess exceedance of the TMDL. For dry-weather, the 30-day geometric mean was used to assess exceedances. For each condition, selection of the applicable numeric target provides assurance of the protection of beneficial uses in the impaired waterbodies and is consistent with state and federal guidance.
- *Wet-weather Critical Condition* – The critical wet condition was selected based on identification of the 92nd percentile of annual rainfalls observed over the past 12 years (1990 through 2002) at multiple rainfall gages in the San Diego region. This resulted in selection of 1993 as the critical wet year for assessment of wet weather loading conditions. This condition was consistent with studies performed by SCCWRP, where a 90th percentile year was selected based on rainfall data for

the Los Angeles Airport (LAX) from 1947 to 2000, also resulting in selection of 1993 as the critical year (LARWQCB, 2002).

- *Dry-weather Critical Condition* - The critical dry period was based on predictions of steady-state flows based on results of analysis of average dry-weather flows observed in Aliso Creek, Rose Creek and Tecolote Creek. Dry-weather days were selected based on the criterion that less than 0.2 inch of rainfall was observed on each of the previous 3 days.

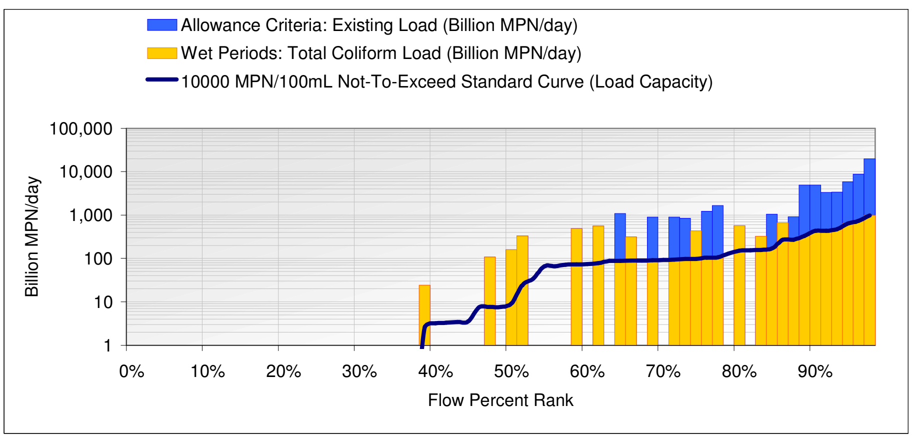
Appendix K
Wet Weather
Interim Period Results

Table K-1. Fecal coliform load duration curve and TMDL results for subwatershed 101 – Interim Period



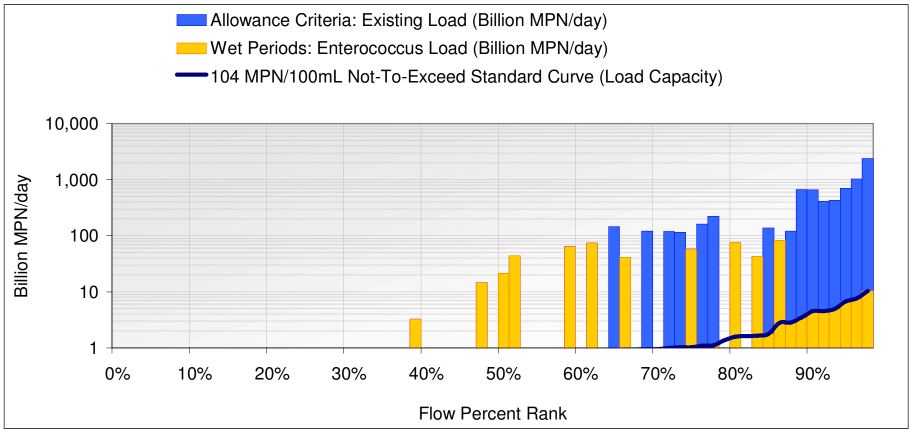
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	309	Billion MPN/Year
Total Load for Existing Condition	5,179	Billion MPN/Year
Total Load Using Allowance Criteria	528	Billion MPN/Year
Non-allowable Exceedance Load	272	Billion MPN/Year
Required Annual Load Reduction	51.6%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-2. Total coliform load duration curve and TMDL results for subwatershed 101 – Interim Period



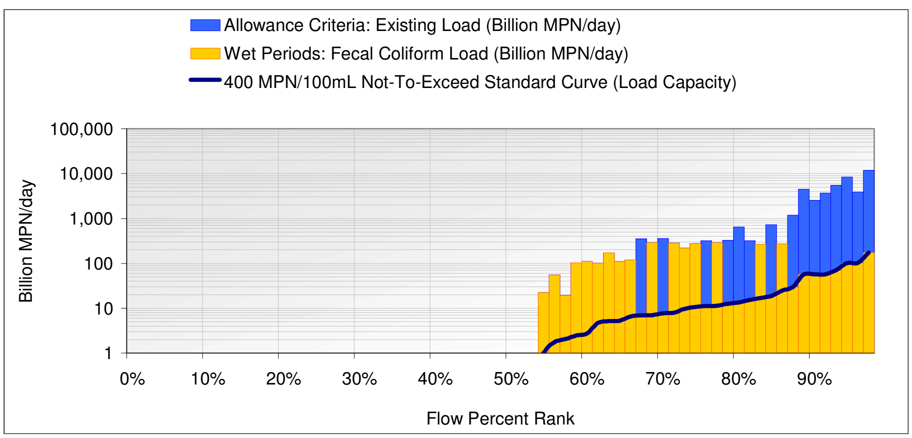
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	7,716	Billion MPN/Year
Total Load for Existing Condition	67,350	Billion MPN/Year
Total Load Using Allowance Criteria	12,396	Billion MPN/Year
Non-allowable Exceedance Load	6,010	Billion MPN/Year
Required Annual Load Reduction	48.5%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-3. Enterococcus load duration curve and TMDL results for subwatershed 101 – Interim Period



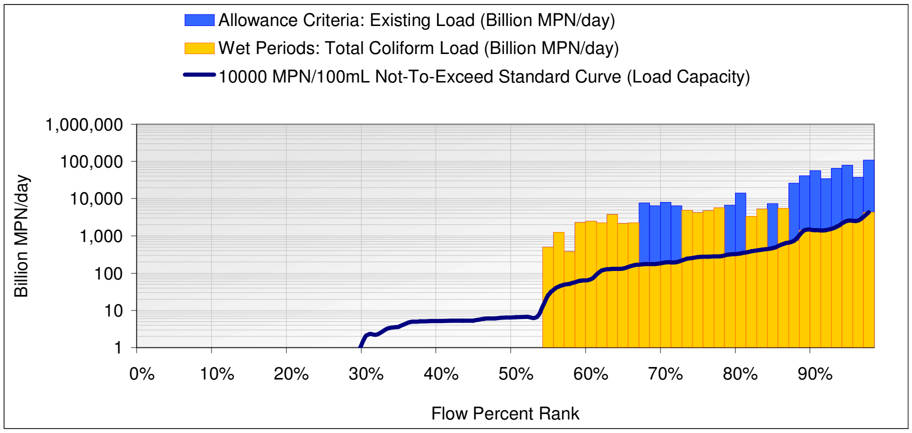
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	80	Billion MPN/Year
Total Load for Existing Condition	8,374	Billion MPN/Year
Total Load Using Allowance Criteria	1,018	Billion MPN/Year
Non-allowable Exceedance Load	952	Billion MPN/Year
Required Annual Load Reduction	93.5%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-4. Fecal coliform load duration curve and TMDL results for subwatershed 103 – Interim Period



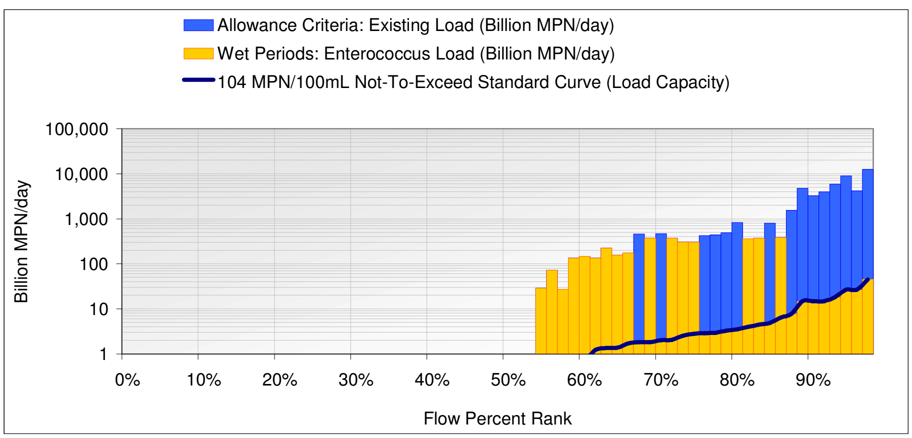
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	872	Billion MPN/Year
Total Load for Existing Condition	47,497	Billion MPN/Year
Total Load Using Allowance Criteria	3,794	Billion MPN/Year
Non-allowable Exceedance Load	2,930	Billion MPN/Year
Required Annual Load Reduction	77.2%	Percentage
Wet Day Exceedances	36	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	21	None

Table K-5. Total coliform load duration curve and TMDL results for subwatershed 103 – Interim Period



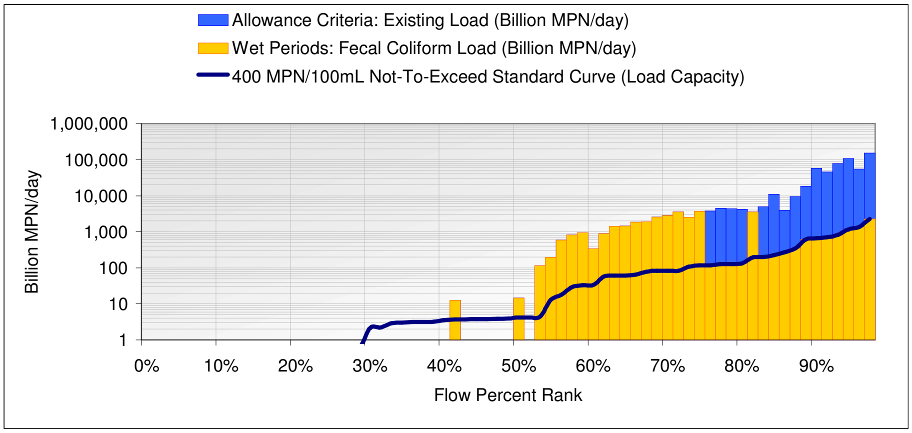
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	21,804	Billion MPN/Year
Total Load for Existing Condition	561,319	Billion MPN/Year
Total Load Using Allowance Criteria	76,658	Billion MPN/Year
Non-allowable Exceedance Load	55,048	Billion MPN/Year
Required Annual Load Reduction	71.8%	Percentage
Wet Day Exceedances	36	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	21	None

Table K-6. Enterococcus load duration curve and TMDL results for subwatershed 103 – Interim Period



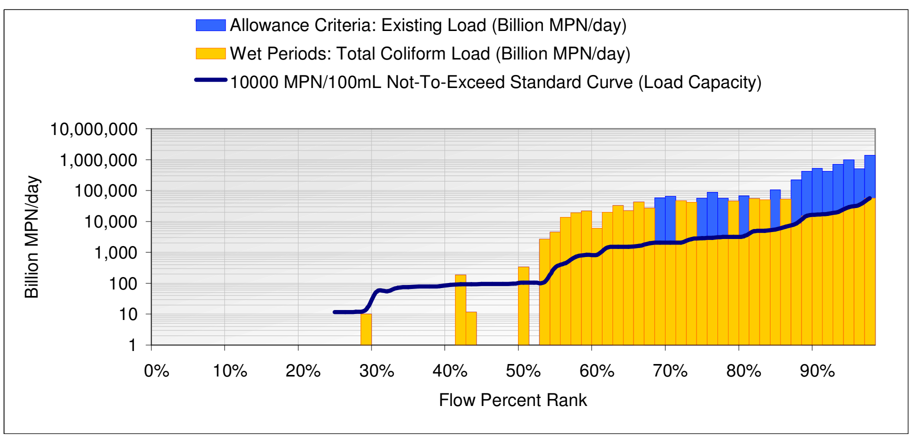
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	227	Billion MPN/Year
Total Load for Existing Condition	52,977	Billion MPN/Year
Total Load Using Allowance Criteria	4,205	Billion MPN/Year
Non-allowable Exceedance Load	3,980	Billion MPN/Year
Required Annual Load Reduction	94.7%	Percentage
Wet Day Exceedances	37	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	22	None

Table K-7. Fecal coliform load duration curve and TMDL results for subwatershed 104 – Interim Period



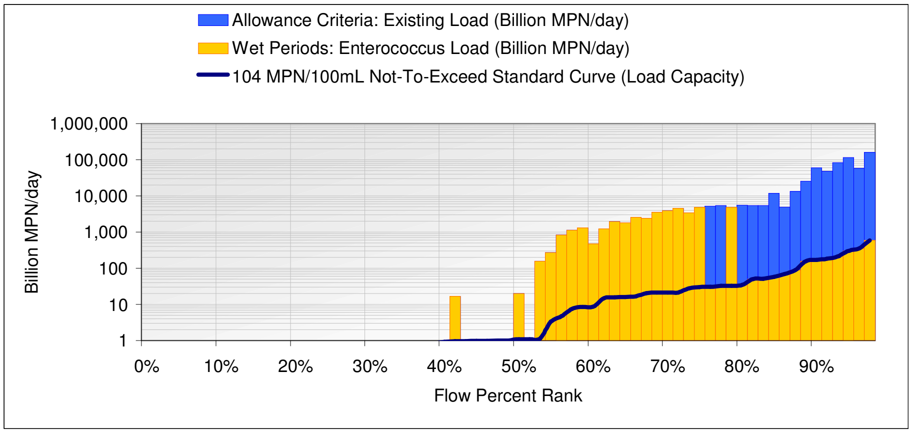
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	10,505	Billion MPN/Year
Total Load for Existing Condition	592,496	Billion MPN/Year
Total Load Using Allowance Criteria	41,126	Billion MPN/Year
Non-allowable Exceedance Load	30,709	Billion MPN/Year
Required Annual Load Reduction	74.7%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	28	None

Table K-8. Total coliform load duration curve and TMDL results for subwatershed 104 – Interim Period



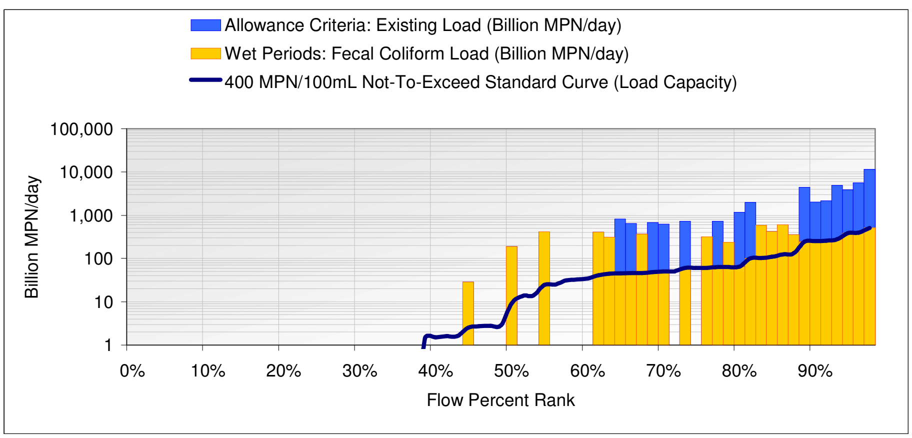
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	262,616	Billion MPN/Year
Total Load for Existing Condition	6,278,214	Billion MPN/Year
Total Load Using Allowance Criteria	788,241	Billion MPN/Year
Non-allowable Exceedance Load	527,845	Billion MPN/Year
Required Annual Load Reduction	67.0%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	28	None

Table K-9. Enterococcus load duration curve and TMDL results for subwatershed 104 – Interim Period



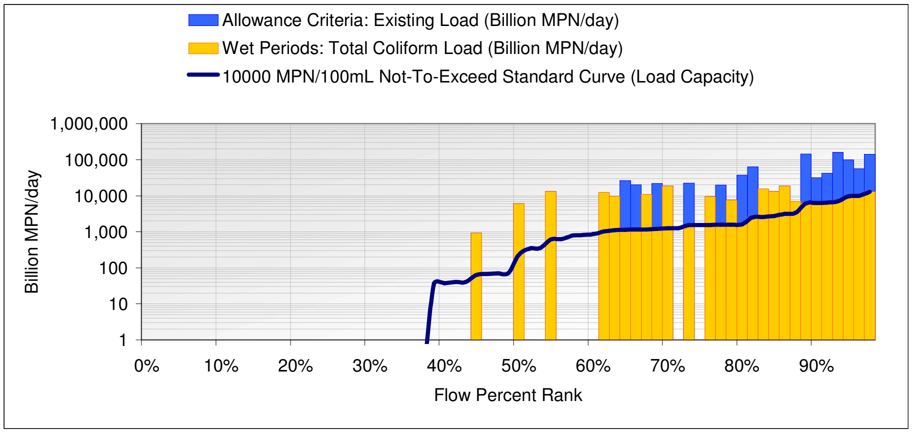
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,731	Billion MPN/Year
Total Load for Existing Condition	650,651	Billion MPN/Year
Total Load Using Allowance Criteria	45,423	Billion MPN/Year
Non-allowable Exceedance Load	42,711	Billion MPN/Year
Required Annual Load Reduction	94.0%	Percentage
Wet Day Exceedances	44	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	29	None

Table K-10. Fecal coliform load duration curve and TMDL results for subwatershed 105 – Interim Period



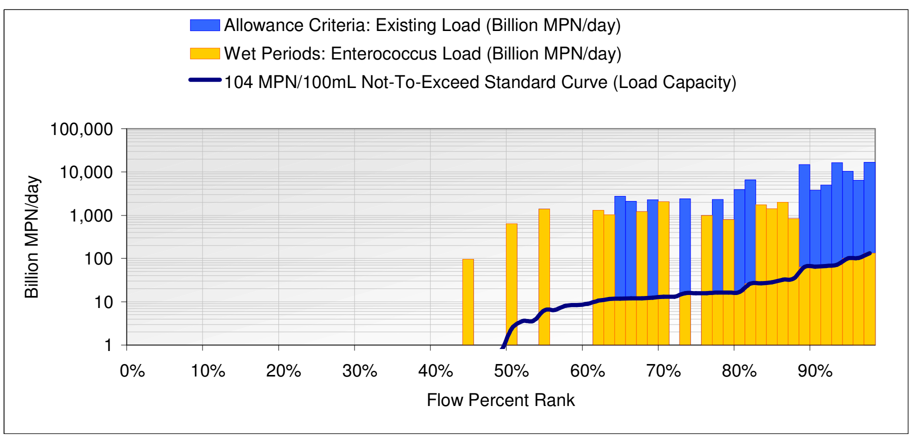
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	4,174	Billion MPN/Year
Total Load for Existing Condition	47,842	Billion MPN/Year
Total Load Using Allowance Criteria	8,717	Billion MPN/Year
Non-allowable Exceedance Load	5,029	Billion MPN/Year
Required Annual Load Reduction	57.7%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-11. Total coliform load duration curve and TMDL results for subwatershed 105 – Interim Period



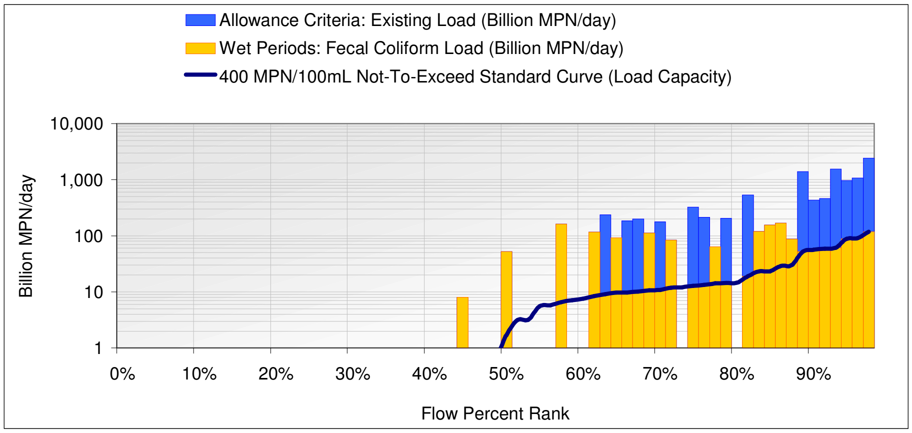
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	104,355	Billion MPN/Year
Total Load for Existing Condition	1,076,489	Billion MPN/Year
Total Load Using Allowance Criteria	246,505	Billion MPN/Year
Non-allowable Exceedance Load	154,294	Billion MPN/Year
Required Annual Load Reduction	62.6%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-12. Enterococcus load duration curve and TMDL results for subwatershed 105 – Interim Period



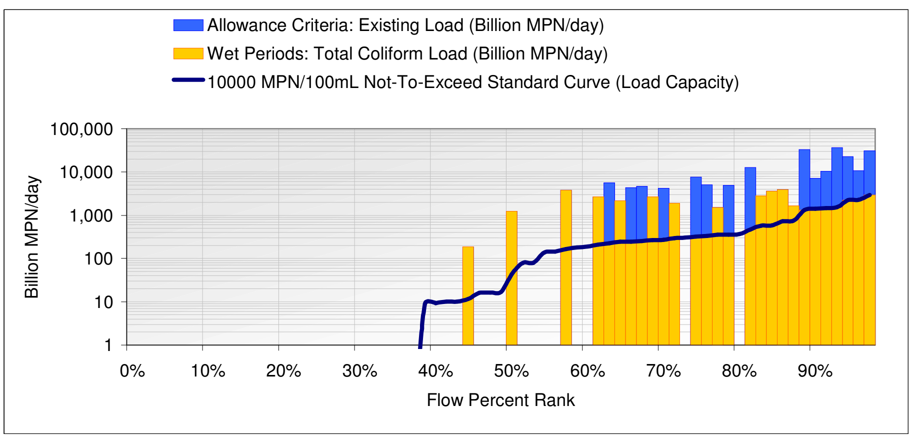
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,085	Billion MPN/Year
Total Load for Existing Condition	117,393	Billion MPN/Year
Total Load Using Allowance Criteria	19,669	Billion MPN/Year
Non-allowable Exceedance Load	18,710	Billion MPN/Year
Required Annual Load Reduction	95.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-13. Fecal coliform load duration curve and TMDL results for subwatershed 106 – Interim Period



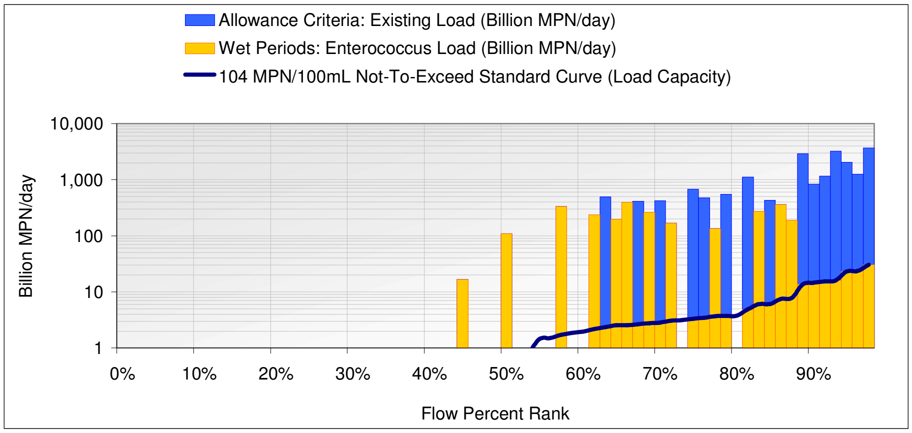
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	932	Billion MPN/Year
Total Load for Existing Condition	12,001	Billion MPN/Year
Total Load Using Allowance Criteria	2,259	Billion MPN/Year
Non-allowable Exceedance Load	1,441	Billion MPN/Year
Required Annual Load Reduction	63.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-14. Total coliform load duration curve and TMDL results for subwatershed 106 – Interim Period



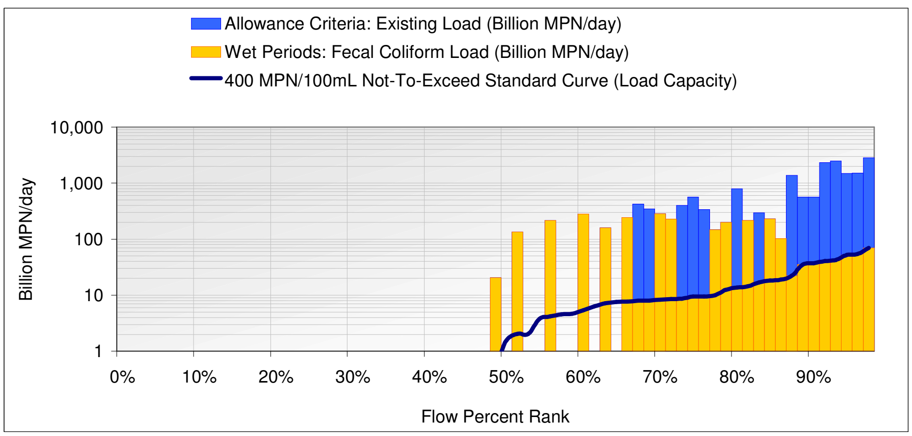
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	23,295	Billion MPN/Year
Total Load for Existing Condition	238,530	Billion MPN/Year
Total Load Using Allowance Criteria	53,501	Billion MPN/Year
Non-allowable Exceedance Load	33,055	Billion MPN/Year
Required Annual Load Reduction	61.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-15. Enterococcus load duration curve and TMDL results for subwatershed 106 – Interim Period



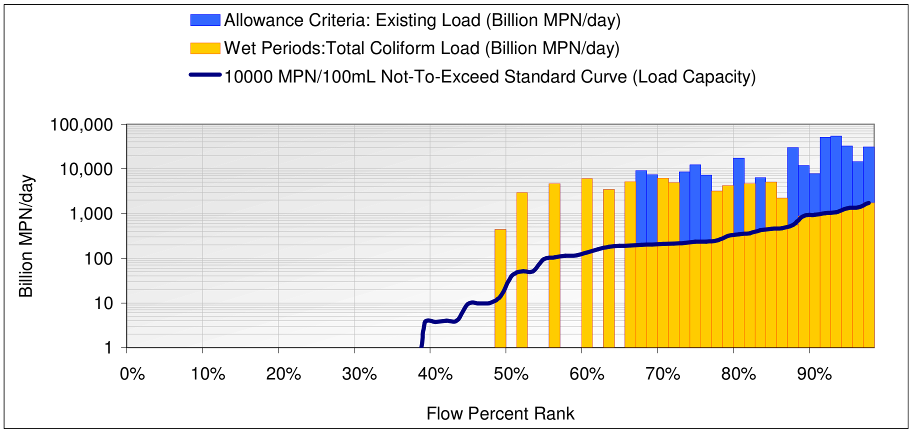
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	242	Billion MPN/Year
Total Load for Existing Condition	23,254	Billion MPN/Year
Total Load Using Allowance Criteria	3,709	Billion MPN/Year
Non-allowable Exceedance Load	3,496	Billion MPN/Year
Required Annual Load Reduction	94.3%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-16. Fecal coliform load duration curve and TMDL results for subwatershed 201 – Interim Period



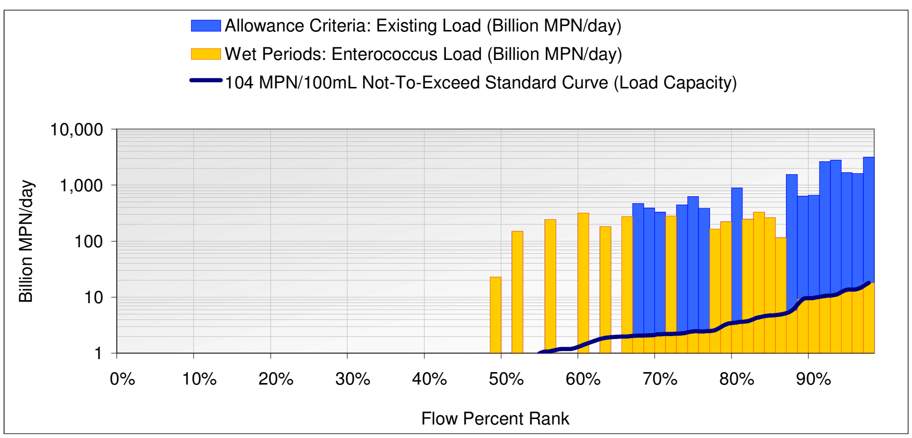
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	630	Billion MPN/Year
Total Load for Existing Condition	19,386	Billion MPN/Year
Total Load Using Allowance Criteria	3,470	Billion MPN/Year
Non-allowable Exceedance Load	2,907	Billion MPN/Year
Required Annual Load Reduction	83.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-17. Total coliform load duration curve and TMDL results for subwatershed 201 – Interim Period



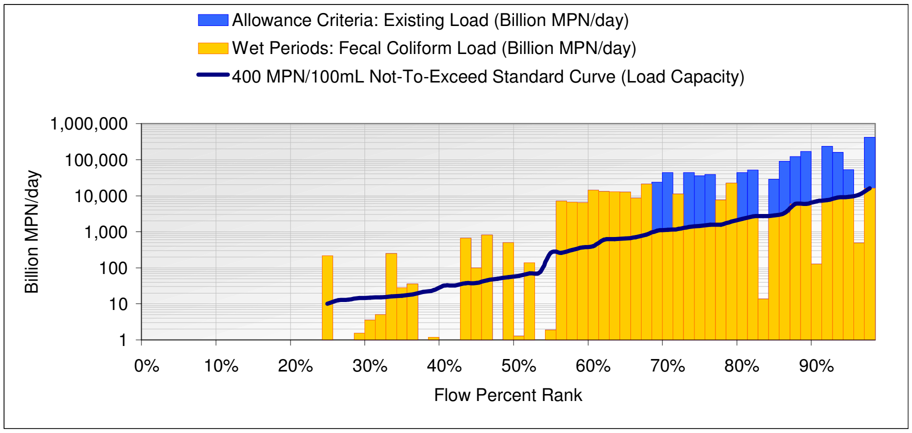
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	15,761	Billion MPN/Year
Total Load for Existing Condition	364,715	Billion MPN/Year
Total Load Using Allowance Criteria	75,877	Billion MPN/Year
Non-allowable Exceedance Load	61,796	Billion MPN/Year
Required Annual Load Reduction	81.4%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-18. Enterococcus load duration curve and TMDL results for subwatershed 201 – Interim Period



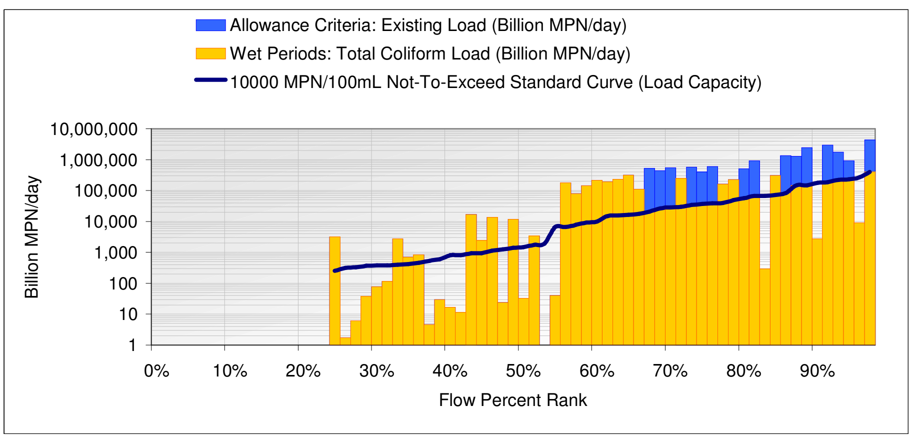
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	164	Billion MPN/Year
Total Load for Existing Condition	21,646	Billion MPN/Year
Total Load Using Allowance Criteria	3,553	Billion MPN/Year
Non-allowable Exceedance Load	3,407	Billion MPN/Year
Required Annual Load Reduction	95.9%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-19. Fecal coliform load duration curve and TMDL results for subwatershed 202 – Interim Period



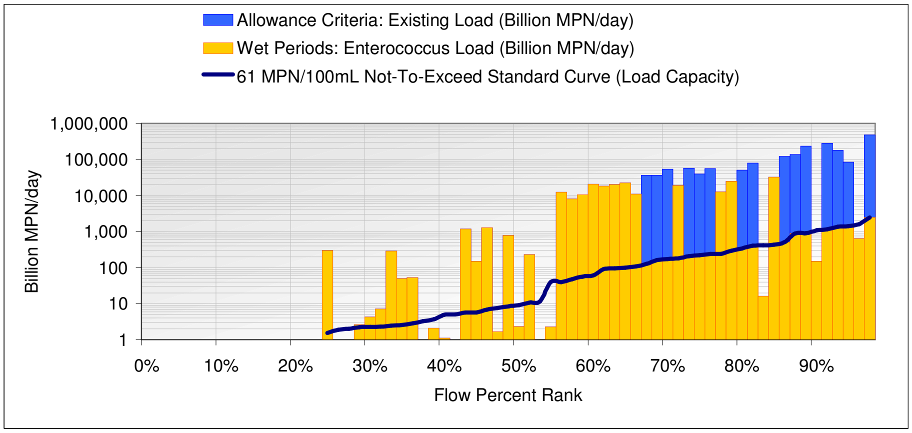
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	104,792	Billion MPN/Year
Total Load for Existing Condition	1,732,709	Billion MPN/Year
Total Load Using Allowance Criteria	254,114	Billion MPN/Year
Non-allowable Exceedance Load	170,116	Billion MPN/Year
Required Annual Load Reduction	66.9%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	34	None

Table K-20. Total coliform load duration curve and TMDL results for subwatershed 202 – Interim Period



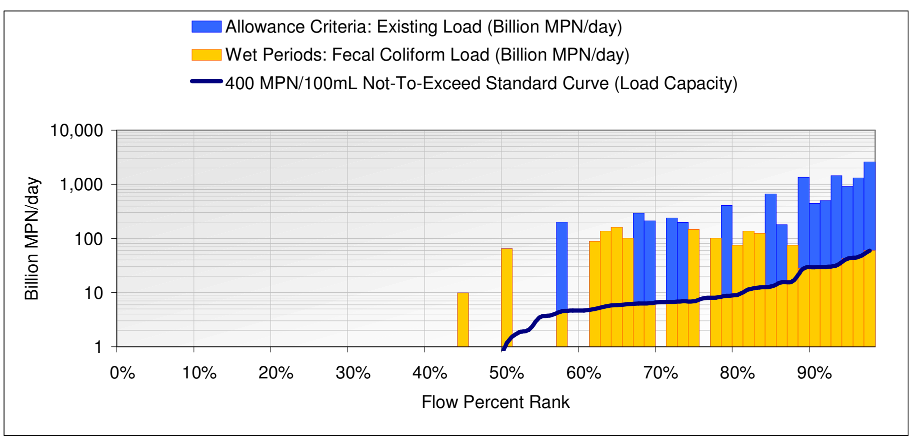
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,619,796	Billion MPN/Year
Total Load for Existing Condition	22,846,059	Billion MPN/Year
Total Load Using Allowance Criteria	5,053,699	Billion MPN/Year
Non-allowable Exceedance Load	2,958,180	Billion MPN/Year
Required Annual Load Reduction	58.5%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	34	None

Table K-21. Enterococcus load duration curve and TMDL results for subwatershed 202 – Interim Period (based on numeric target for inland surface waters)



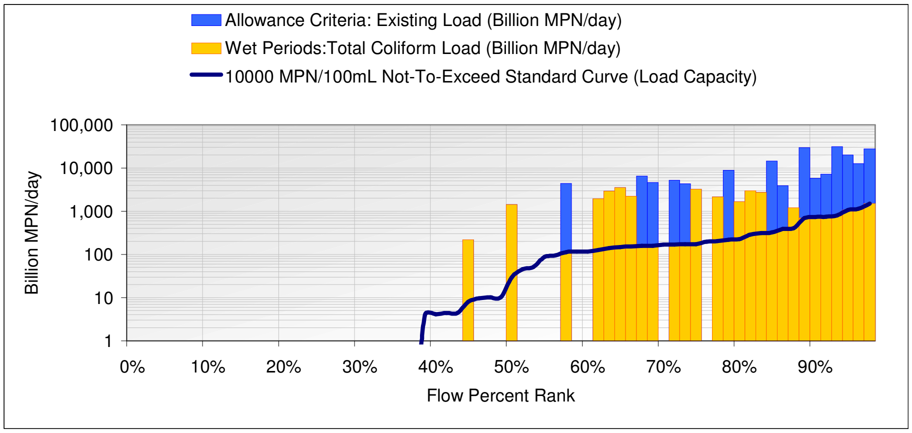
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	15,981	Billion MPN/Year
Total Load for Existing Condition	2,208,560	Billion MPN/Year
Total Load Using Allowance Criteria	289,377	Billion MPN/Year
Non-allowable Exceedance Load	275,820	Billion MPN/Year
Required Annual Load Reduction	95.3%	Percentage
Wet Day Exceedances	53	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	38	None

Table K-22. Fecal coliform load duration curve and TMDL results for subwatershed 301 – Interim Period



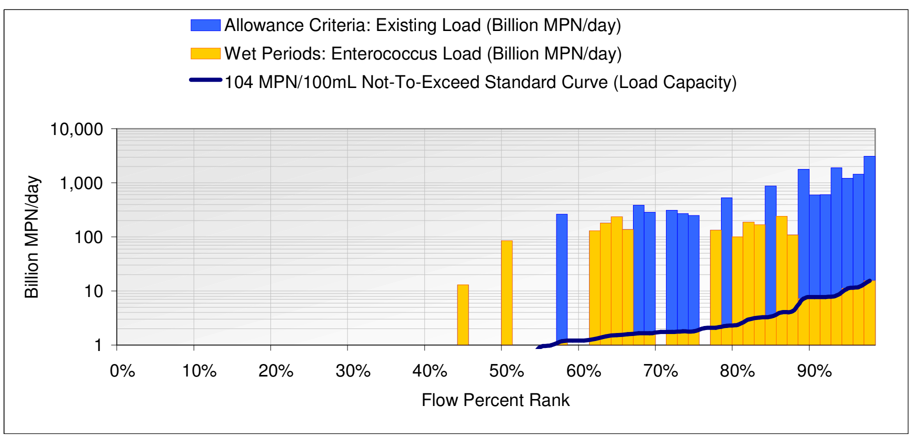
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	507	Billion MPN/Year
Total Load for Existing Condition	12,677	Billion MPN/Year
Total Load Using Allowance Criteria	2,062	Billion MPN/Year
Non-allowable Exceedance Load	1,624	Billion MPN/Year
Required Annual Load Reduction	78.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-23. Total coliform load duration curve and TMDL results for subwatershed 301 – Interim Period



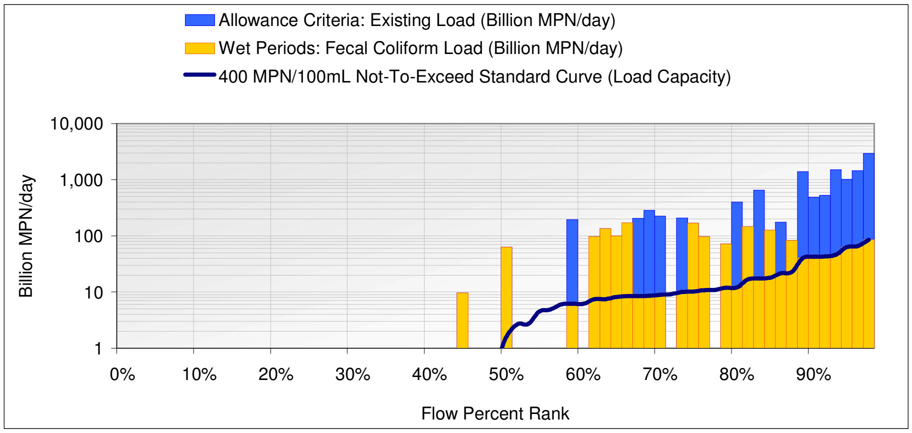
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	12,680	Billion MPN/Year
Total Load for Existing Condition	224,286	Billion MPN/Year
Total Load Using Allowance Criteria	45,593	Billion MPN/Year
Non-allowable Exceedance Load	34,640	Billion MPN/Year
Required Annual Load Reduction	76.0%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-24 Enterococcus load duration curve and TMDL results for subwatershed 301 – Interim Period



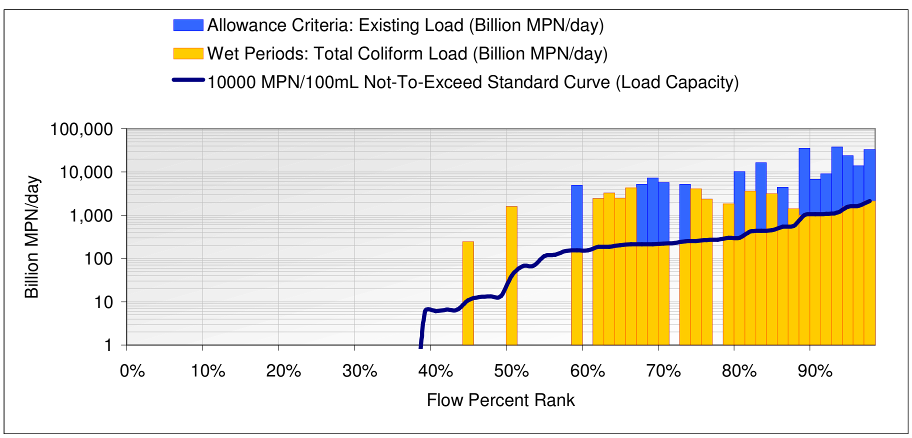
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	132	Billion MPN/Year
Total Load for Existing Condition	16,137	Billion MPN/Year
Total Load Using Allowance Criteria	2,458	Billion MPN/Year
Non-allowable Exceedance Load	2,344	Billion MPN/Year
Required Annual Load Reduction	95.4%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-25. Fecal coliform load duration curve and TMDL results for subwatershed 302 – Interim Period



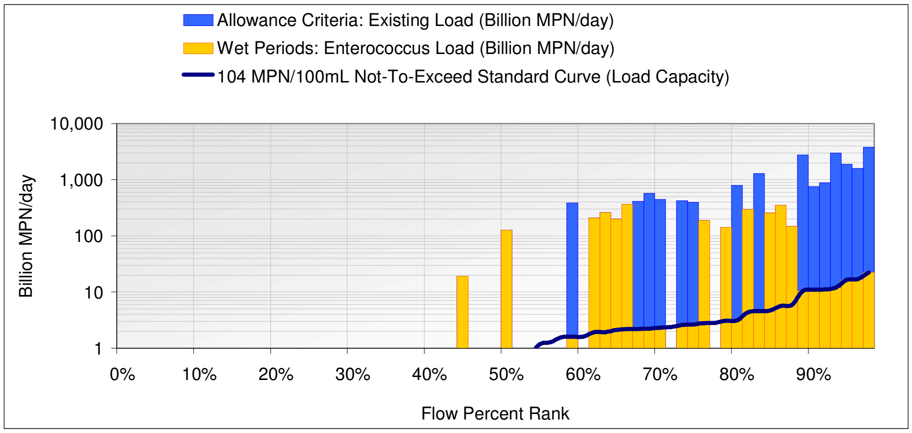
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	715	Billion MPN/Year
Total Load for Existing Condition	13,426	Billion MPN/Year
Total Load Using Allowance Criteria	2,233	Billion MPN/Year
Non-allowable Exceedance Load	1,610	Billion MPN/Year
Required Annual Load Reduction	72.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-26. Total coliform load duration curve and TMDL results for subwatershed 302 – Interim Period



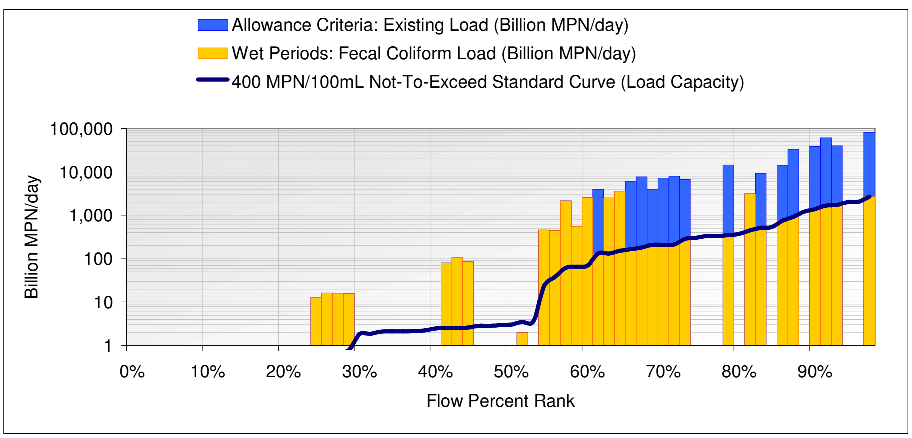
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	17,868	Billion MPN/Year
Total Load for Existing Condition	261,979	Billion MPN/Year
Total Load Using Allowance Criteria	54,930	Billion MPN/Year
Non-allowable Exceedance Load	39,353	Billion MPN/Year
Required Annual Load Reduction	71.6%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-27. Enterococcus load duration curve and TMDL results for subwatershed 302 – Interim Period



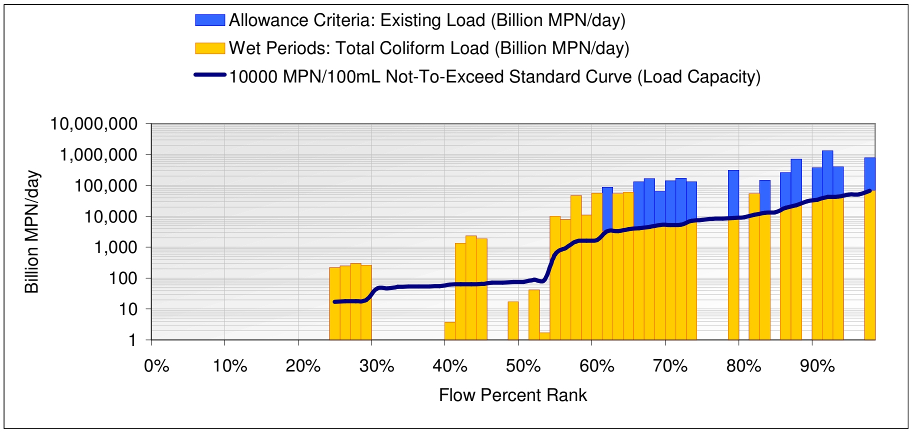
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	186	Billion MPN/Year
Total Load for Existing Condition	22,871	Billion MPN/Year
Total Load Using Allowance Criteria	3,635	Billion MPN/Year
Non-allowable Exceedance Load	3,473	Billion MPN/Year
Required Annual Load Reduction	95.5%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-28. Fecal coliform load duration curve and TMDL results for subwatershed 304 – Interim Period



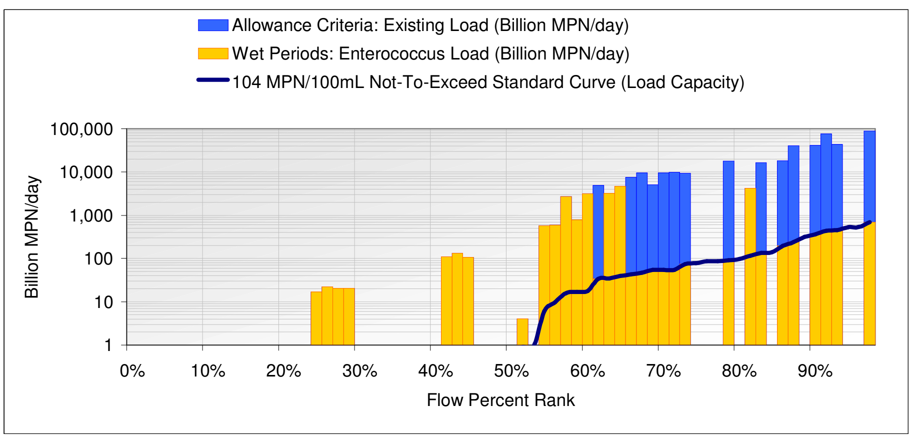
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	19,885	Billion MPN/Year
Total Load for Existing Condition	356,926	Billion MPN/Year
Total Load Using Allowance Criteria	33,073	Billion MPN/Year
Non-allowable Exceedance Load	20,416	Billion MPN/Year
Required Annual Load Reduction	61.7%	Percentage
Wet Day Exceedances	39	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	24	None

Table K-29. Total coliform load duration curve and TMDL results for subwatershed 304 – Interim Period



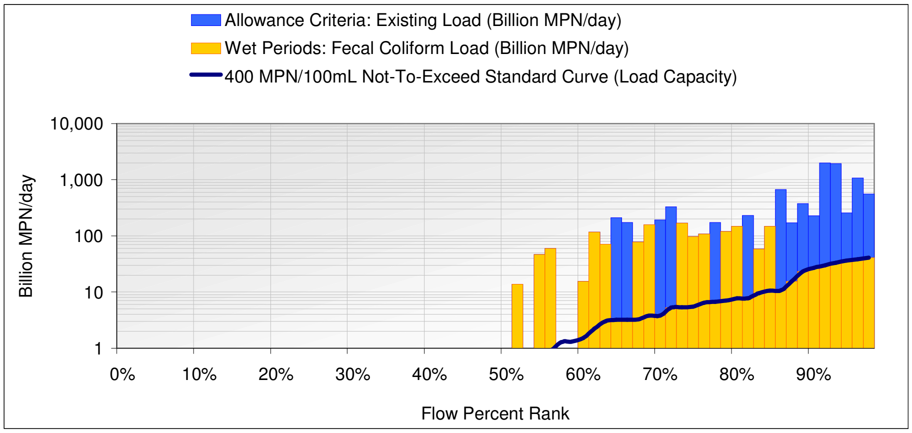
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	497,130	Billion MPN/Year
Total Load for Existing Condition	5,599,516	Billion MPN/Year
Total Load Using Allowance Criteria	693,037	Billion MPN/Year
Non-allowable Exceedance Load	376,642	Billion MPN/Year
Required Annual Load Reduction	54.3%	Percentage
Wet Day Exceedances	39	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	24	None

Table K-30. Enterococcus load duration curve and TMDL results for subwatershed 304 – Interim Period



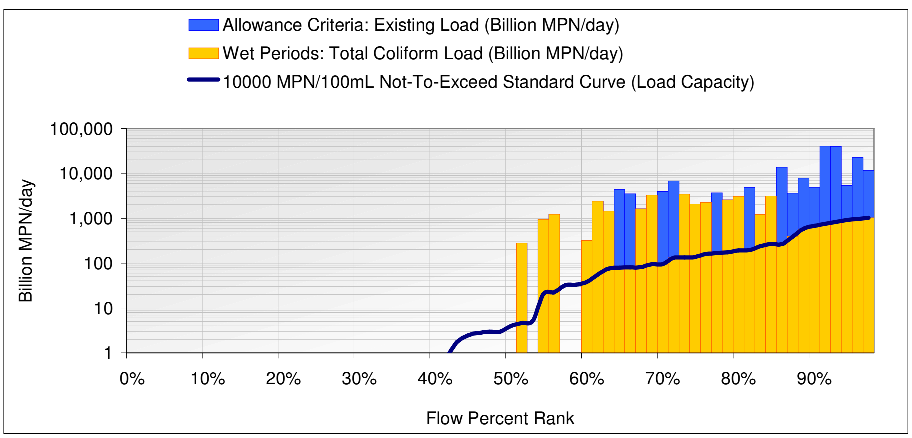
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	5,170	Billion MPN/Year
Total Load for Existing Condition	428,285	Billion MPN/Year
Total Load Using Allowance Criteria	31,314	Billion MPN/Year
Non-allowable Exceedance Load	28,020	Billion MPN/Year
Required Annual Load Reduction	89.5%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	27	None

Table K-31. Fecal coliform load duration curve and TMDL results for subwatershed 305 – Interim Period



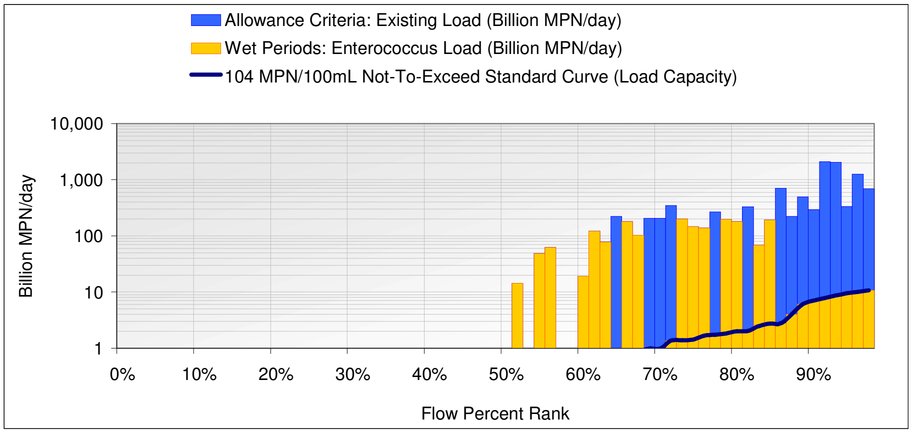
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	367	Billion MPN/Year
Total Load for Existing Condition	10,149	Billion MPN/Year
Total Load Using Allowance Criteria	1,843	Billion MPN/Year
Non-allowable Exceedance Load	1,486	Billion MPN/Year
Required Annual Load Reduction	80.6%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-32. Total coliform load duration curve and TMDL results for subwatershed 305 – Interim Period



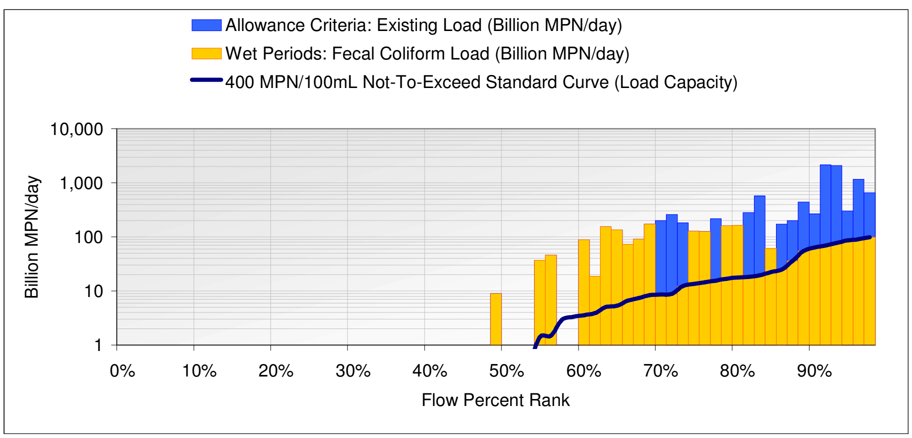
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	9,164	Billion MPN/Year
Total Load for Existing Condition	209,193	Billion MPN/Year
Total Load Using Allowance Criteria	39,553	Billion MPN/Year
Non-allowable Exceedance Load	30,630	Billion MPN/Year
Required Annual Load Reduction	77.4%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-33. Enterococcus load duration curve and TMDL results for subwatershed 305 – Interim Period



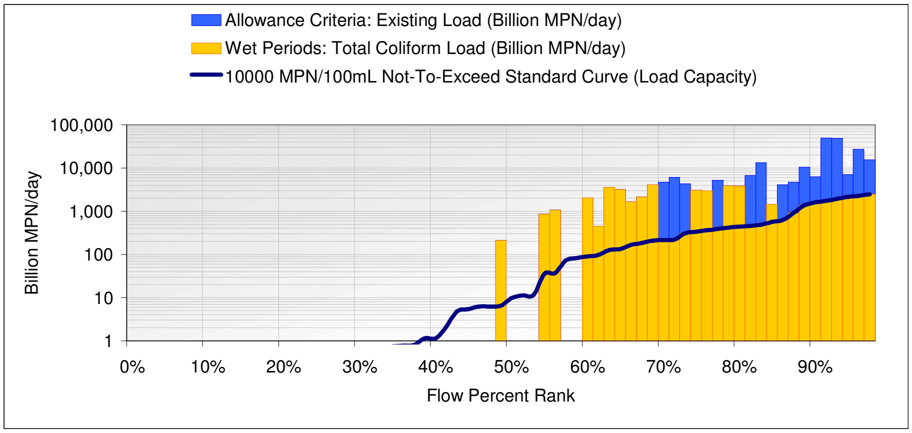
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	95	Billion MPN/Year
Total Load for Existing Condition	11,603	Billion MPN/Year
Total Load Using Allowance Criteria	1,985	Billion MPN/Year
Non-allowable Exceedance Load	1,892	Billion MPN/Year
Required Annual Load Reduction	95.3%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-34. Fecal coliform load duration curve and TMDL results for subwatershed 306 – Interim Period



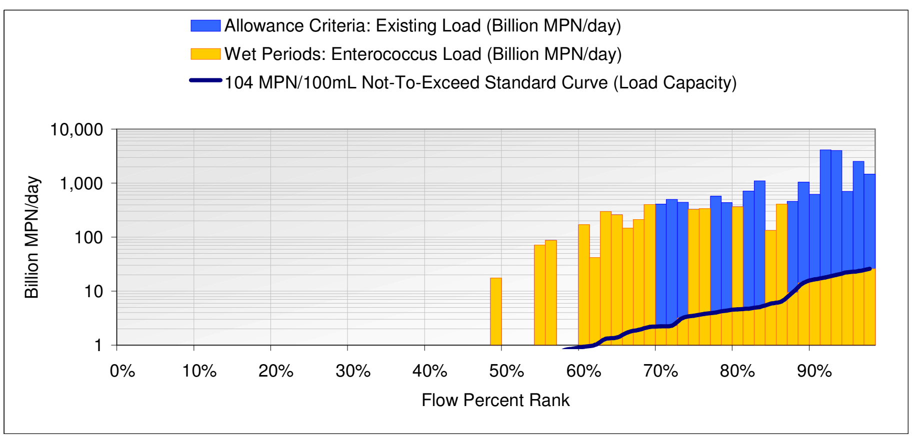
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	843	Billion MPN/Year
Total Load for Existing Condition	10,733	Billion MPN/Year
Total Load Using Allowance Criteria	2,280	Billion MPN/Year
Non-allowable Exceedance Load	1,461	Billion MPN/Year
Required Annual Load Reduction	64.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-35. Total coliform load duration curve and TMDL results for subwatershed 306 – Interim Period



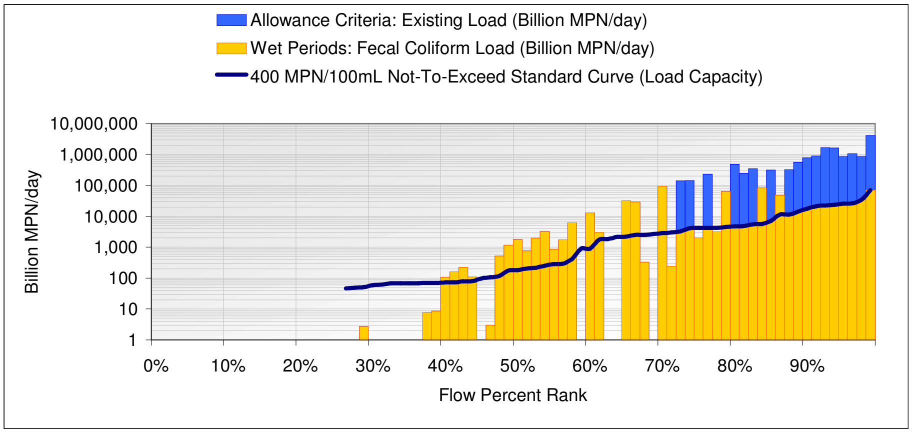
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	21,068	Billion MPN/Year
Total Load for Existing Condition	251,988	Billion MPN/Year
Total Load Using Allowance Criteria	54,706	Billion MPN/Year
Non-allowable Exceedance Load	34,225	Billion MPN/Year
Required Annual Load Reduction	62.6%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-36. Enterococcus load duration curve and TMDL results for subwatershed 306 – Interim Period



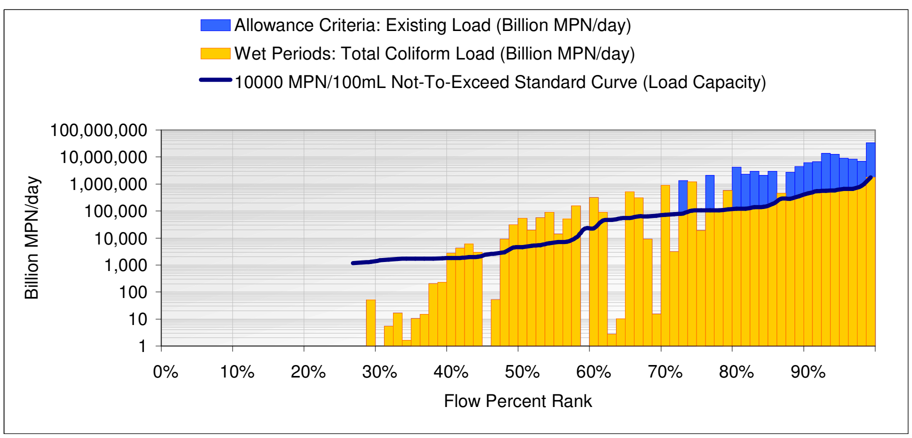
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	219	Billion MPN/Year
Total Load for Existing Condition	22,629	Billion MPN/Year
Total Load Using Allowance Criteria	3,702	Billion MPN/Year
Non-allowable Exceedance Load	3,489	Billion MPN/Year
Required Annual Load Reduction	94.2%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	15	None
Excess Wet Day Exceedances	18	None

Table K-37. Fecal coliform load duration curve and TMDL results for subwatershed 401 – Interim Period



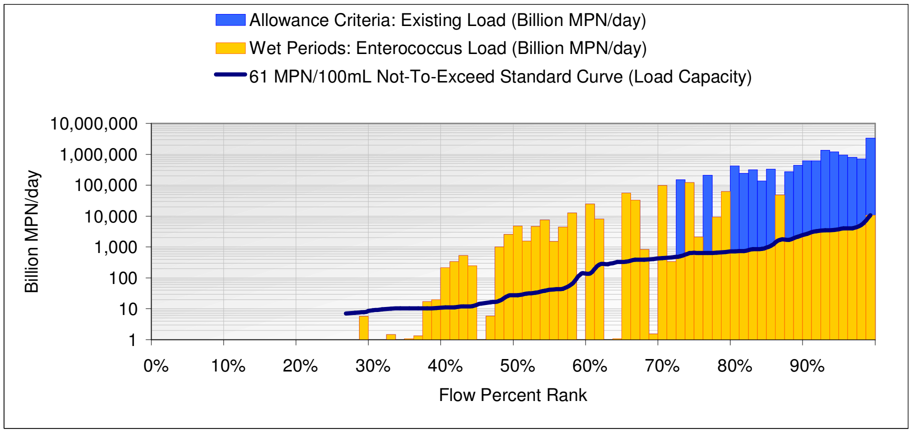
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	381,639	Billion MPN/Year
Total Load for Existing Condition	15,304,790	Billion MPN/Year
Total Load Using Allowance Criteria	948,367	Billion MPN/Year
Non-allowable Exceedance Load	589,958	Billion MPN/Year
Required Annual Load Reduction	62.2%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	17	None
Excess Wet Day Exceedances	33	None

Table K-38. Total coliform load duration curve and TMDL results for subwatershed 401 – Interim Period



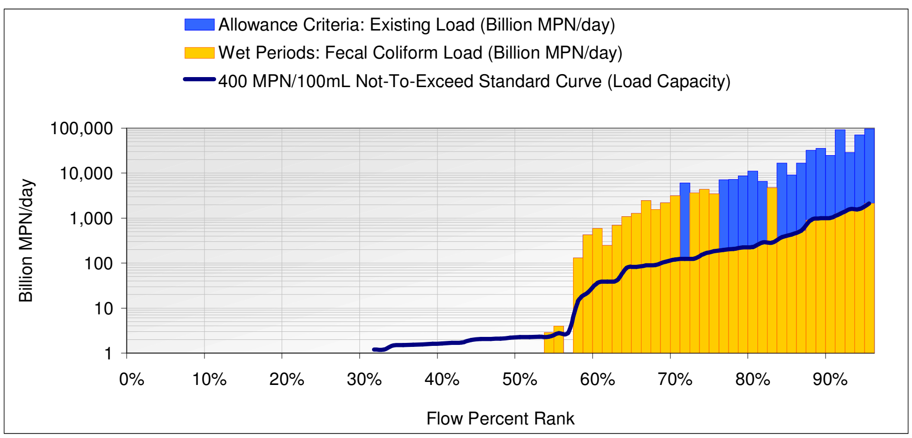
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	9,540,977	Billion MPN/Year
Total Load for Existing Condition	130,258,863	Billion MPN/Year
Total Load Using Allowance Criteria	16,326,787	Billion MPN/Year
Non-allowable Exceedance Load	7,379,673	Billion MPN/Year
Required Annual Load Reduction	45.2%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	17	None
Excess Wet Day Exceedances	33	None

Table K-39. Enterococcus load duration curve and TMDL results for subwatershed 401 – Interim Period (based on numeric target for inland surface waters)



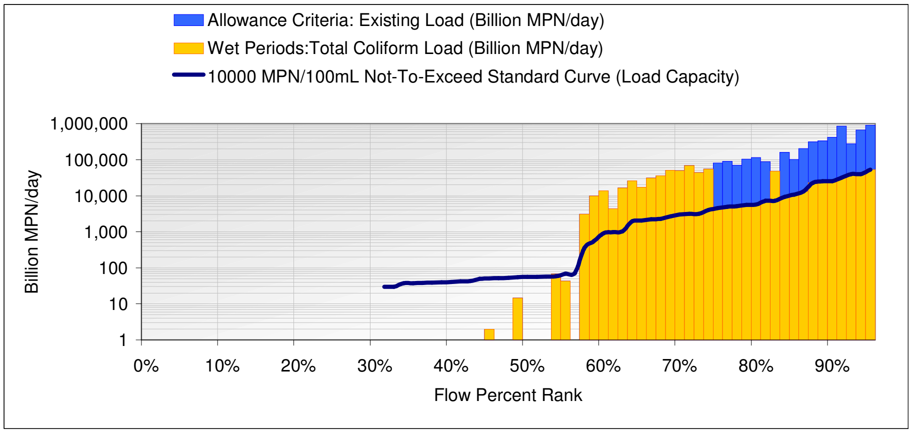
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	58,200	Billion MPN/Year
Total Load for Existing Condition	12,980,098	Billion MPN/Year
Total Load Using Allowance Criteria	883,771	Billion MPN/Year
Non-allowable Exceedance Load	827,652	Billion MPN/Year
Required Annual Load Reduction	93.7%	Percentage
Wet Day Exceedances	56	None
Allowable Wet Day Exceedances	17	None
Excess Wet Day Exceedances	39	None

Table K-40. Fecal coliform load duration curve and TMDL results for subwatershed 501 – Interim Period



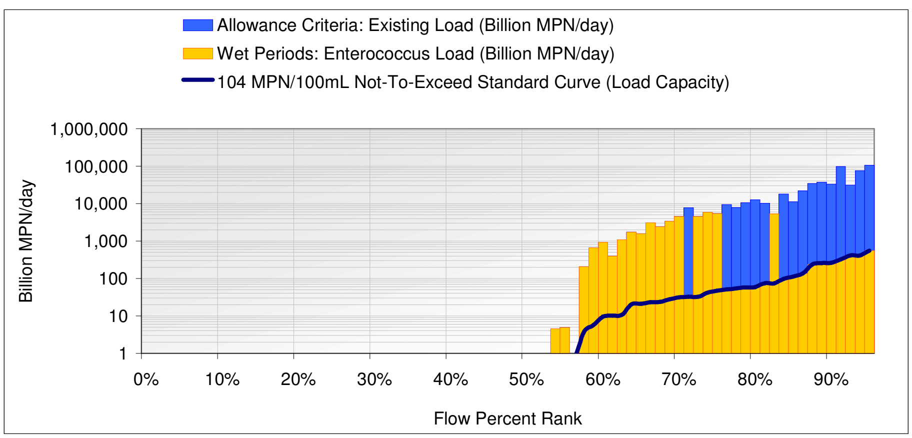
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	13,761	Billion MPN/Year
Total Load for Existing Condition	503,463	Billion MPN/Year
Total Load Using Allowance Criteria	44,180	Billion MPN/Year
Non-allowable Exceedance Load	30,474	Billion MPN/Year
Required Annual Load Reduction	69.0%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	26	None

Table K-41. Total coliform load duration curve and TMDL results for subwatershed 501 – Interim Period



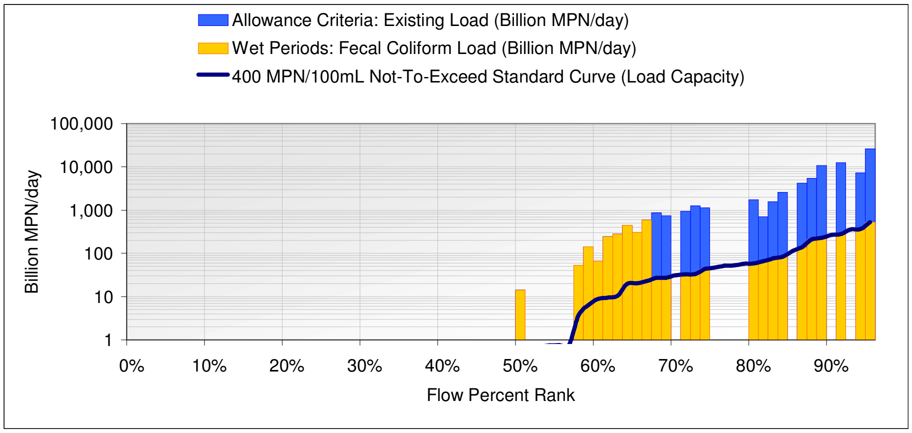
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	344,015	Billion MPN/Year
Total Load for Existing Condition	5,276,541	Billion MPN/Year
Total Load Using Allowance Criteria	825,515	Billion MPN/Year
Non-allowable Exceedance Load	482,899	Billion MPN/Year
Required Annual Load Reduction	58.5%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	25	None

Table K-42. Enterococcus load duration curve and TMDL results for subwatershed 501 – Interim Period



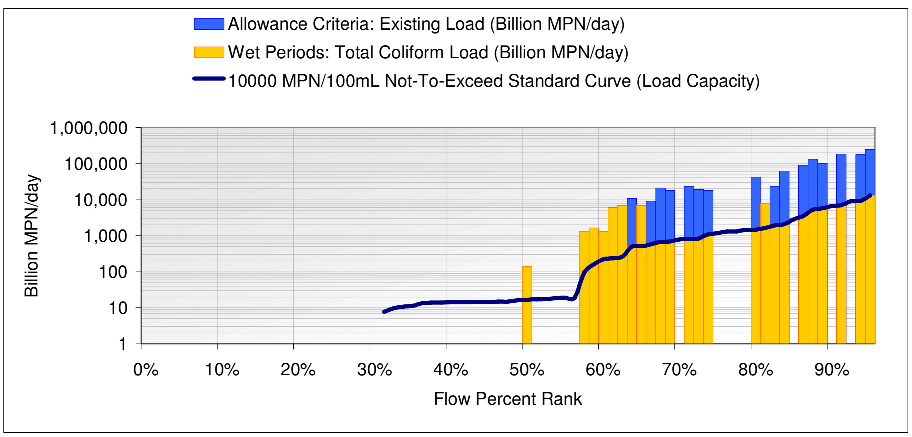
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	3,578	Billion MPN/Year
Total Load for Existing Condition	570,531	Billion MPN/Year
Total Load Using Allowance Criteria	47,716	Billion MPN/Year
Non-allowable Exceedance Load	44,151	Billion MPN/Year
Required Annual Load Reduction	92.5%	Percentage
Wet Day Exceedances	44	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	28	None

Table K-43. Fecal coliform load duration curve and TMDL results for subwatershed 502 – Interim Period



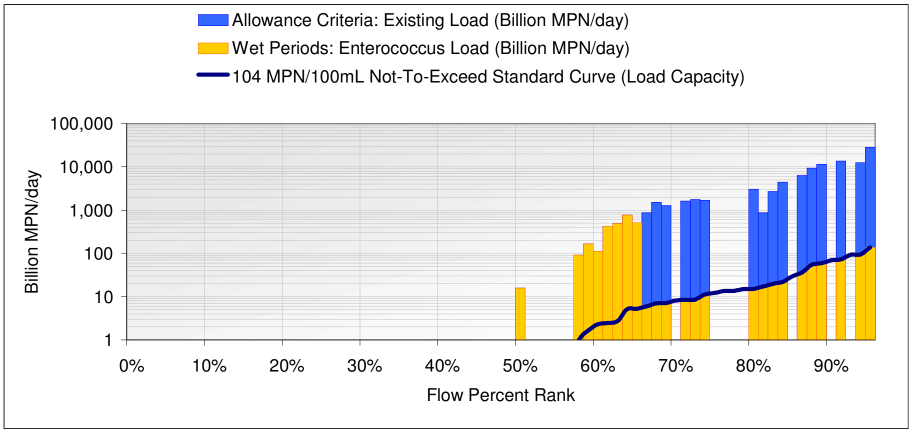
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	3,342	Billion MPN/Year
Total Load for Existing Condition	81,333	Billion MPN/Year
Total Load Using Allowance Criteria	4,898	Billion MPN/Year
Non-allowable Exceedance Load	2,559	Billion MPN/Year
Required Annual Load Reduction	52.2%	Percentage
Wet Day Exceedances	30	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	14	None

Table K-44. Total coliform load duration curve and TMDL results for subwatershed 502 – Interim Period



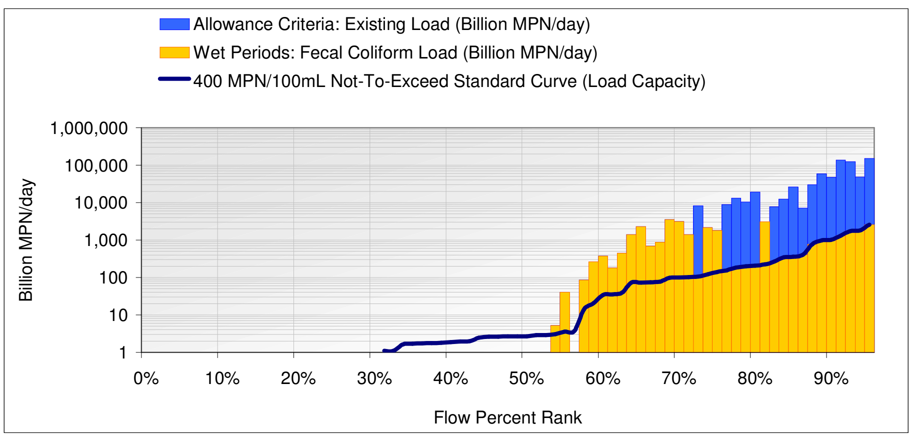
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	83,546	Billion MPN/Year
Total Load for Existing Condition	1,216,982	Billion MPN/Year
Total Load Using Allowance Criteria	101,345	Billion MPN/Year
Non-allowable Exceedance Load	42,858	Billion MPN/Year
Required Annual Load Reduction	42.3%	Percentage
Wet Day Exceedances	30	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	14	None

Table K-45. Enterococcus load duration curve and TMDL results for subwatershed 502 – Interim Period



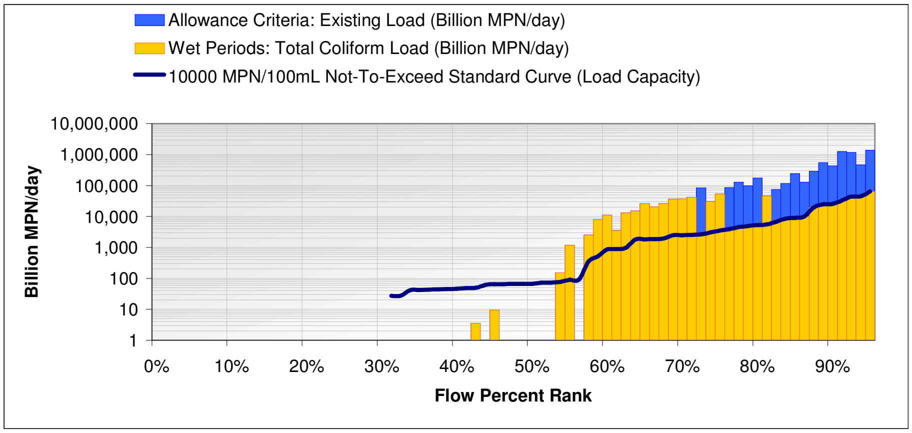
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	869	Billion MPN/Year
Total Load for Existing Condition	105,718	Billion MPN/Year
Total Load Using Allowance Criteria	4,629	Billion MPN/Year
Non-allowable Exceedance Load	4,020	Billion MPN/Year
Required Annual Load Reduction	86.9%	Percentage
Wet Day Exceedances	31	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	15	None

Table K-46. Fecal coliform load duration curve and TMDL results for subwatershed 503 – Interim Period



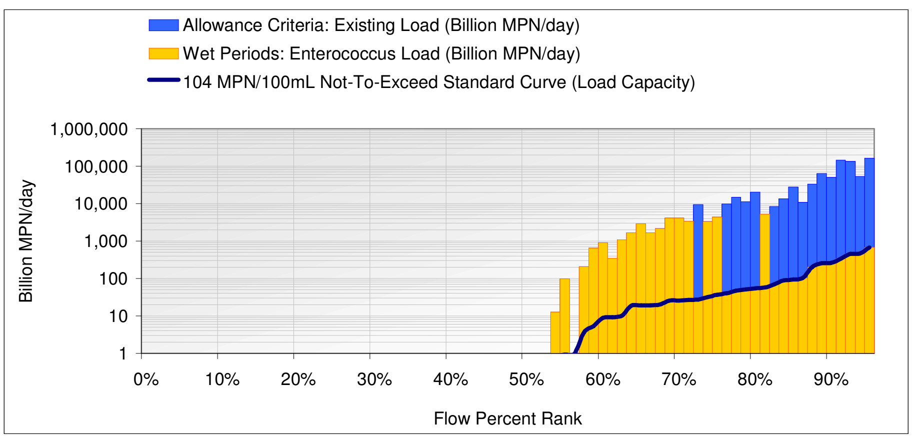
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	13,867	Billion MPN/Year
Total Load for Existing Condition	736,628	Billion MPN/Year
Total Load Using Allowance Criteria	35,618	Billion MPN/Year
Non-allowable Exceedance Load	21,816	Billion MPN/Year
Required Annual Load Reduction	61.3%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	26	None

Table K-47 Total coliform load duration curve and TMDL results for subwatershed 503 – Interim Period



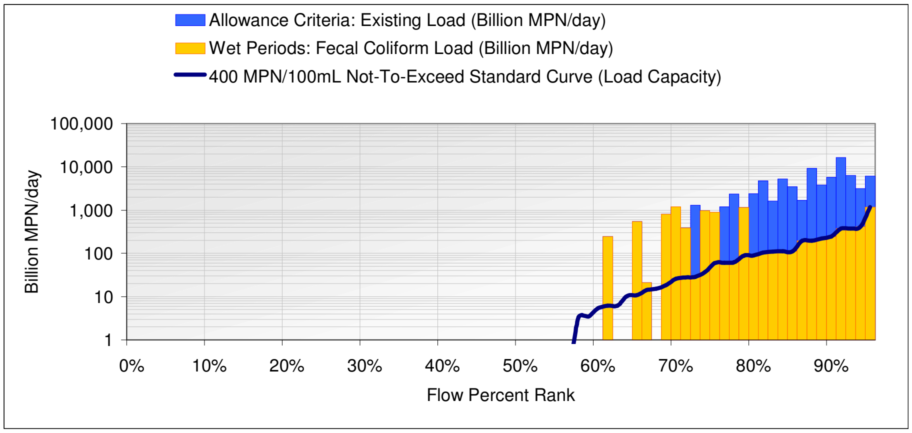
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	346,674	Billion MPN/Year
Total Load for Existing Condition	7,101,860	Billion MPN/Year
Total Load Using Allowance Criteria	723,031	Billion MPN/Year
Non-allowable Exceedance Load	377,971	Billion MPN/Year
Required Annual Load Reduction	52.3%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	26	None

Table K-48. Enterococcus load duration curve and TMDL results for subwatershed 503 – Interim Period



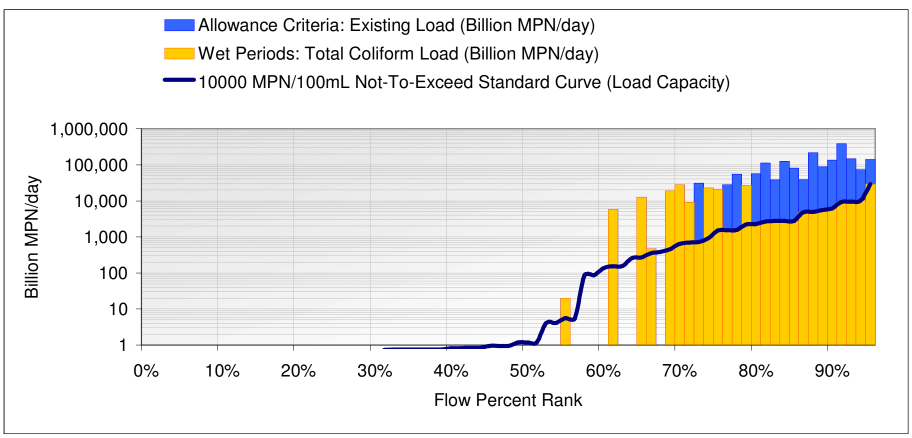
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	3,605	Billion MPN/Year
Total Load for Existing Condition	806,852	Billion MPN/Year
Total Load Using Allowance Criteria	42,859	Billion MPN/Year
Non-allowable Exceedance Load	39,266	Billion MPN/Year
Required Annual Load Reduction	91.6%	Percentage
Wet Day Exceedances	46	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	30	None

Table K-49. Fecal coliform load duration curve and TMDL results for subwatershed 504 – Interim Period



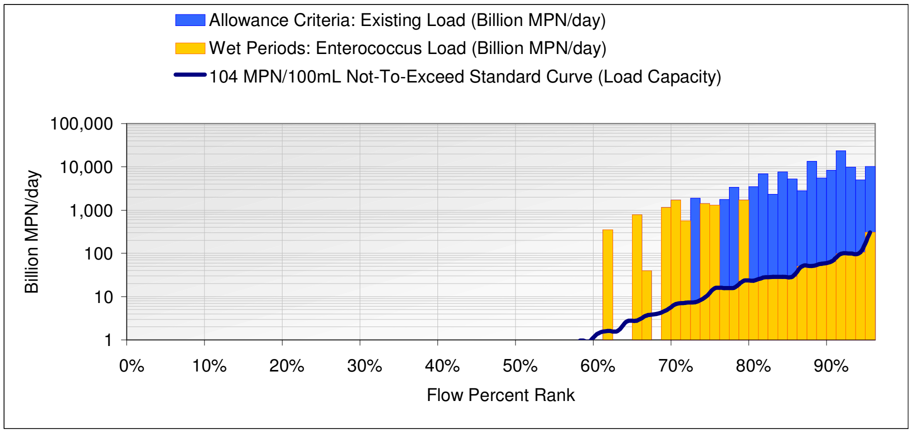
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	4,235	Billion MPN/Year
Total Load for Existing Condition	81,576	Billion MPN/Year
Total Load Using Allowance Criteria	10,554	Billion MPN/Year
Non-allowable Exceedance Load	6,382	Billion MPN/Year
Required Annual Load Reduction	60.5%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	12	None

Table K-50. Total coliform load duration curve and TMDL results for subwatershed 504 – Interim Period



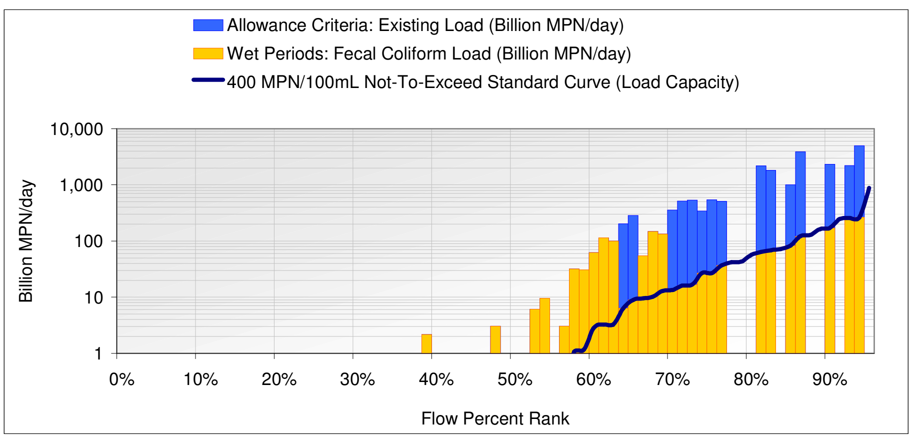
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	105,876	Billion MPN/Year
Total Load for Existing Condition	1,903,632	Billion MPN/Year
Total Load Using Allowance Criteria	253,115	Billion MPN/Year
Non-allowable Exceedance Load	148,817	Billion MPN/Year
Required Annual Load Reduction	58.8%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	12	None

Table K-51. Enterococcus load duration curve and TMDL results for subwatershed 504 – Interim Period



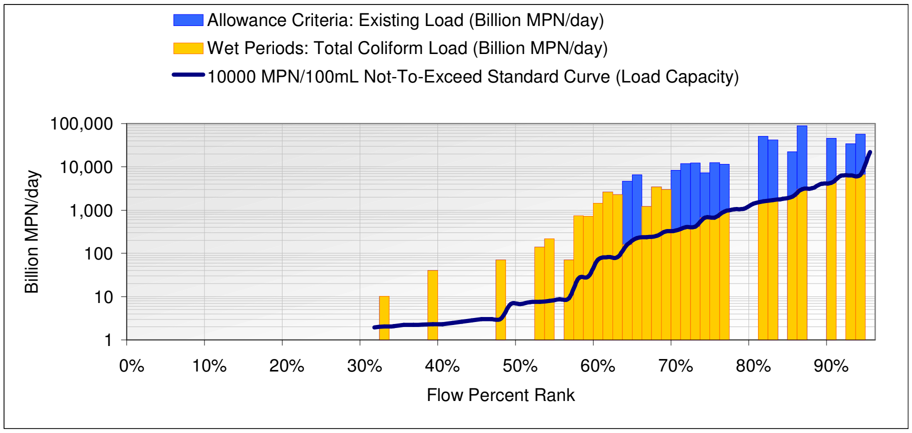
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,101	Billion MPN/Year
Total Load for Existing Condition	120,842	Billion MPN/Year
Total Load Using Allowance Criteria	10,694	Billion MPN/Year
Non-allowable Exceedance Load	9,609	Billion MPN/Year
Required Annual Load Reduction	89.9%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	12	None

Table K-52. Fecal coliform load duration curve and TMDL results for subwatershed 505 – Interim Period



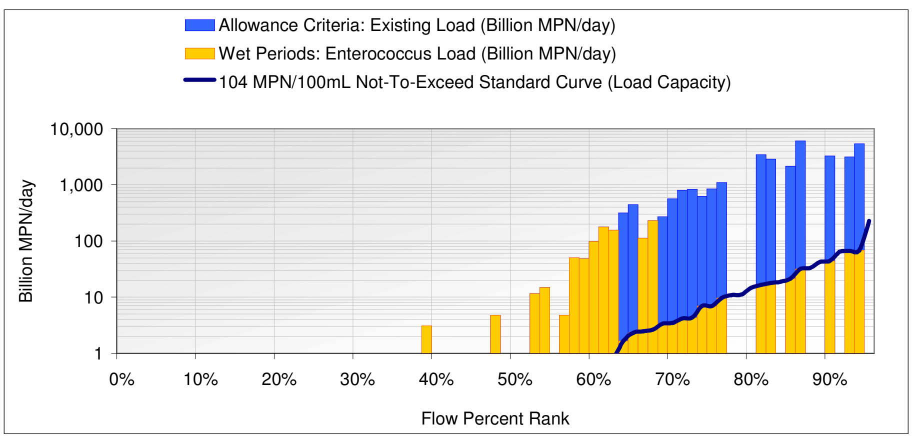
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,875	Billion MPN/Year
Total Load for Existing Condition	22,705	Billion MPN/Year
Total Load Using Allowance Criteria	2,015	Billion MPN/Year
Non-allowable Exceedance Load	780	Billion MPN/Year
Required Annual Load Reduction	38.7%	Percentage
Wet Day Exceedances	35	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	19	None

Table K-53. Total coliform load duration curve and TMDL results for subwatershed 505 – Interim Period



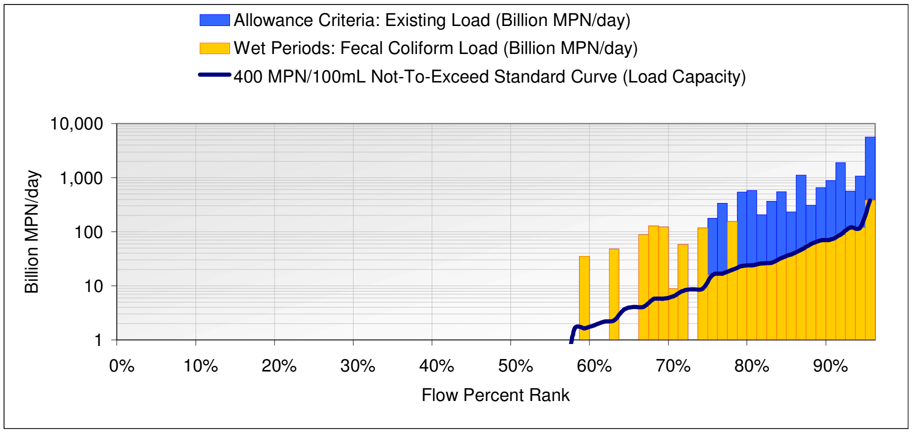
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	71,873	Billion MPN/Year
Total Load for Existing Condition	439,306	Billion MPN/Year
Total Load Using Allowance Criteria	48,615	Billion MPN/Year
Non-allowable Exceedance Load	17,751	Billion MPN/Year
Required Annual Load Reduction	36.5%	Percentage
Wet Day Exceedances	35	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	19	None

Table K-54. Enterococcus load duration curve and TMDL results for subwatershed 505 – Interim Period



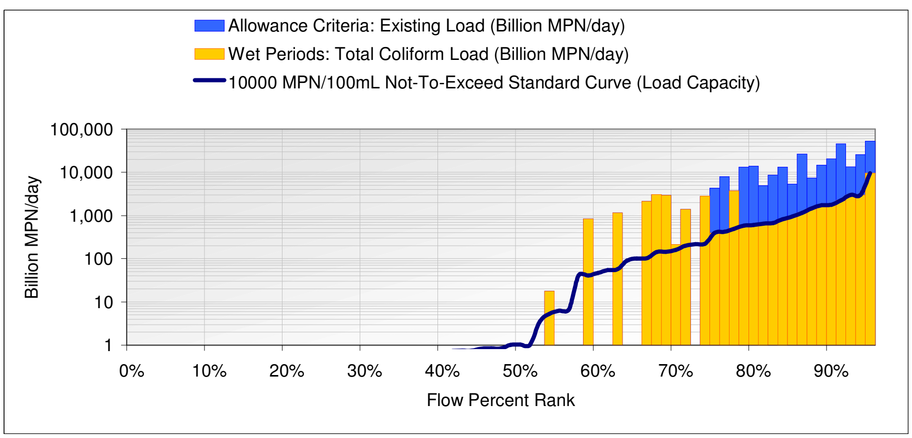
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	747	Billion MPN/Year
Total Load for Existing Condition	33,570	Billion MPN/Year
Total Load Using Allowance Criteria	1,695	Billion MPN/Year
Non-allowable Exceedance Load	1,374	Billion MPN/Year
Required Annual Load Reduction	81.1%	Percentage
Wet Day Exceedances	35	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	19	None

Table K-55. Fecal coliform load duration curve and TMDL results for subwatershed 506 – Interim Period



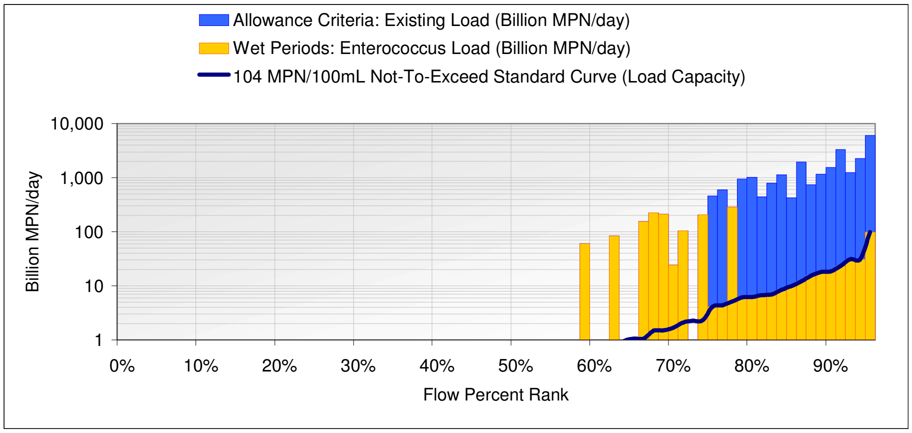
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,259	Billion MPN/Year
Total Load for Existing Condition	16,014	Billion MPN/Year
Total Load Using Allowance Criteria	2,005	Billion MPN/Year
Non-allowable Exceedance Load	779	Billion MPN/Year
Required Annual Load Reduction	38.8%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	12	None

Table K-56. Total coliform load duration curve and TMDL results for subwatershed 506 – Interim Period



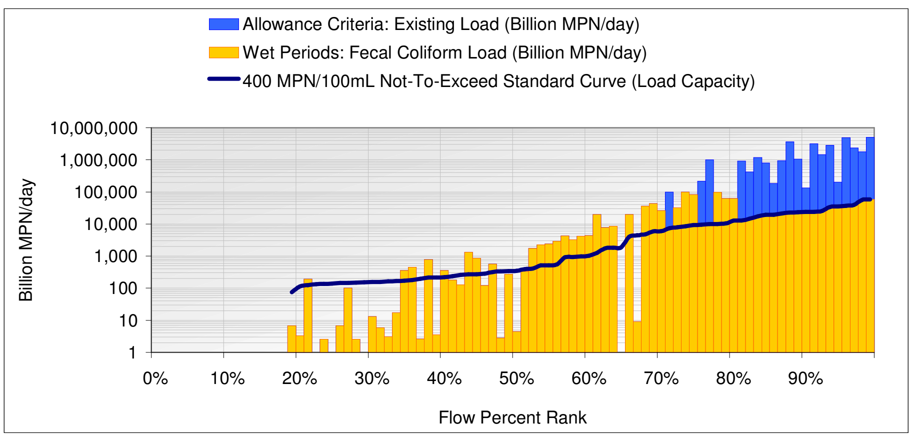
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	31,485	Billion MPN/Year
Total Load for Existing Condition	298,219	Billion MPN/Year
Total Load Using Allowance Criteria	49,310	Billion MPN/Year
Non-allowable Exceedance Load	18,652	Billion MPN/Year
Required Annual Load Reduction	37.8%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	12	None

Table K-57. Enterococcus load duration curve and TMDL results for subwatershed 506 – Interim Period



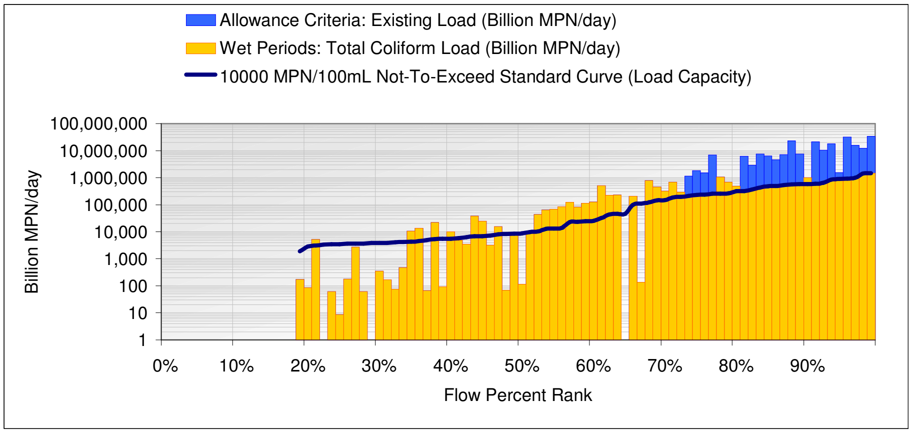
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	327	Billion MPN/Year
Total Load for Existing Condition	25,580	Billion MPN/Year
Total Load Using Allowance Criteria	1,806	Billion MPN/Year
Non-allowable Exceedance Load	1,487	Billion MPN/Year
Required Annual Load Reduction	82.3%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	16	None
Excess Wet Day Exceedances	12	None

Table K-58. Fecal coliform load duration curve and TMDL results for subwatershed 701 – Interim Period



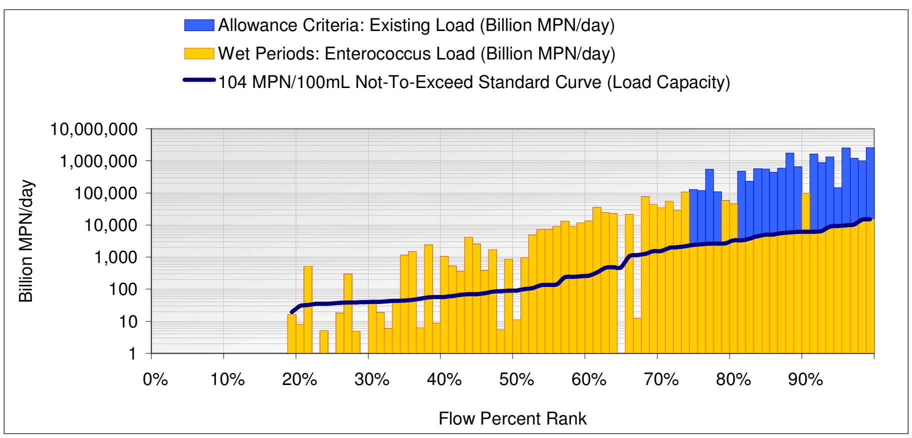
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	662,782	Billion MPN/Year
Total Load for Existing Condition	33,120,012	Billion MPN/Year
Total Load Using Allowance Criteria	1,316,365	Billion MPN/Year
Non-allowable Exceedance Load	674,542	Billion MPN/Year
Required Annual Load Reduction	51.2%	Percentage
Wet Day Exceedances	56	None
Allowable Wet Day Exceedances	20	None
Excess Wet Day Exceedances	36	None

Table K-59. Total coliform load duration curve and TMDL results for subwatershed 701 – Interim Period



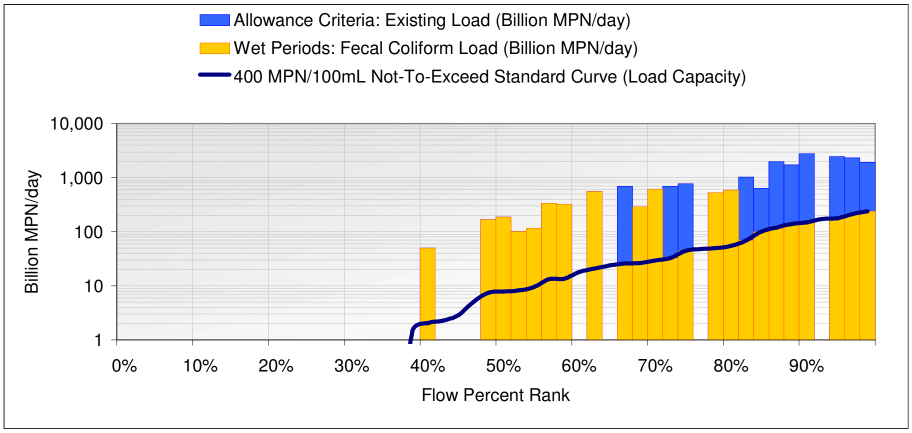
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	16,569,557	Billion MPN/Year
Total Load for Existing Condition	231,598,677	Billion MPN/Year
Total Load Using Allowance Criteria	23,441,526	Billion MPN/Year
Non-allowable Exceedance Load	7,409,521	Billion MPN/Year
Required Annual Load Reduction	31.6%	Percentage
Wet Day Exceedances	54	None
Allowable Wet Day Exceedances	20	None
Excess Wet Day Exceedances	34	None

Table K-60. Enterococcus load duration curve and TMDL results for subwatershed 701 – Interim Period



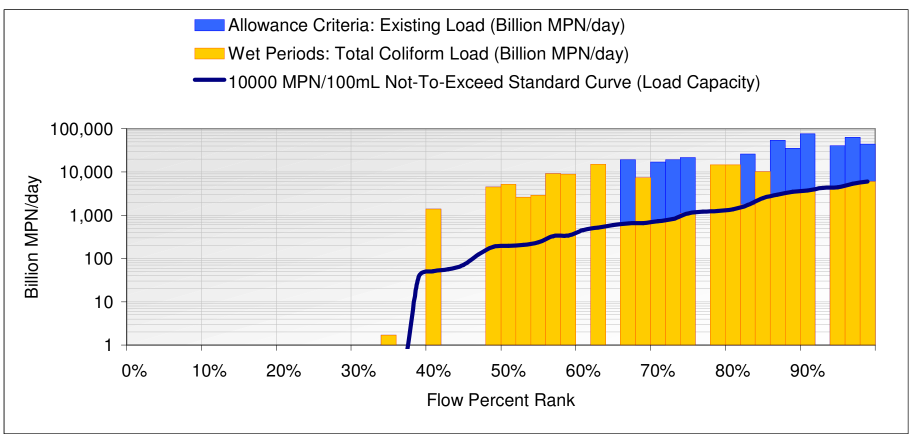
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	172,323	Billion MPN/Year
Total Load for Existing Condition	18,439,920	Billion MPN/Year
Total Load Using Allowance Criteria	1,143,454	Billion MPN/Year
Non-allowable Exceedance Load	969,233	Billion MPN/Year
Required Annual Load Reduction	84.8%	Percentage
Wet Day Exceedances	60	None
Allowable Wet Day Exceedances	20	None
Excess Wet Day Exceedances	40	None

Table K-61. Fecal coliform load duration curve and TMDL results for subwatershed 1101 – Interim Period



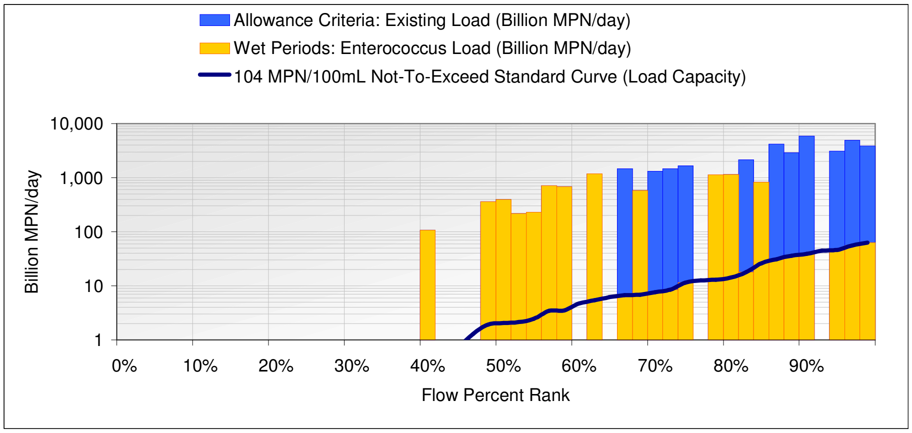
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,845	Billion MPN/Year
Total Load for Existing Condition	20,886	Billion MPN/Year
Total Load Using Allowance Criteria	5,221	Billion MPN/Year
Non-allowable Exceedance Load	3,662	Billion MPN/Year
Required Annual Load Reduction	70.1%	Percentage
Wet Day Exceedances	48	None
Allowable Wet Day Exceedances	11	None
Excess Wet Day Exceedances	37	None

Table K-62. Total coliform load duration curve and TMDL results for subwatershed 1101 – Interim Period



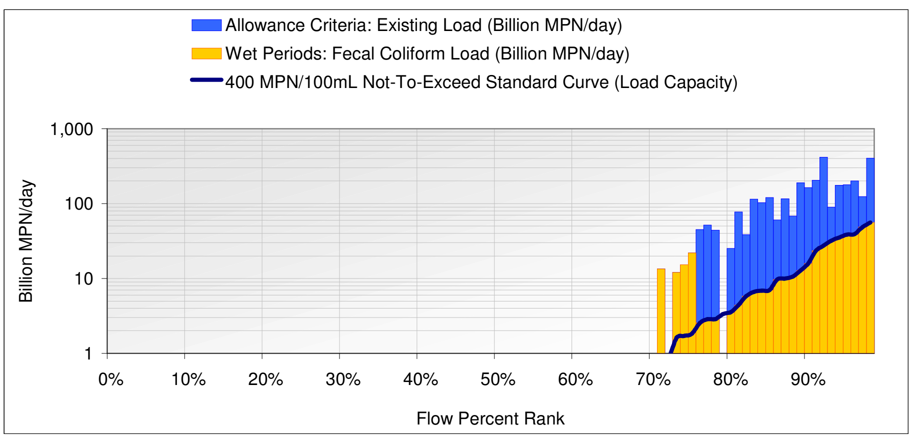
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	46,114	Billion MPN/Year
Total Load for Existing Condition	515,278	Billion MPN/Year
Total Load Using Allowance Criteria	129,179	Billion MPN/Year
Non-allowable Exceedance Load	90,196	Billion MPN/Year
Required Annual Load Reduction	69.8%	Percentage
Wet Day Exceedances	48	None
Allowable Wet Day Exceedances	11	None
Excess Wet Day Exceedances	37	None

Table K-63. Enterococcus load duration curve and TMDL results for subwatershed 1101 – Interim Period



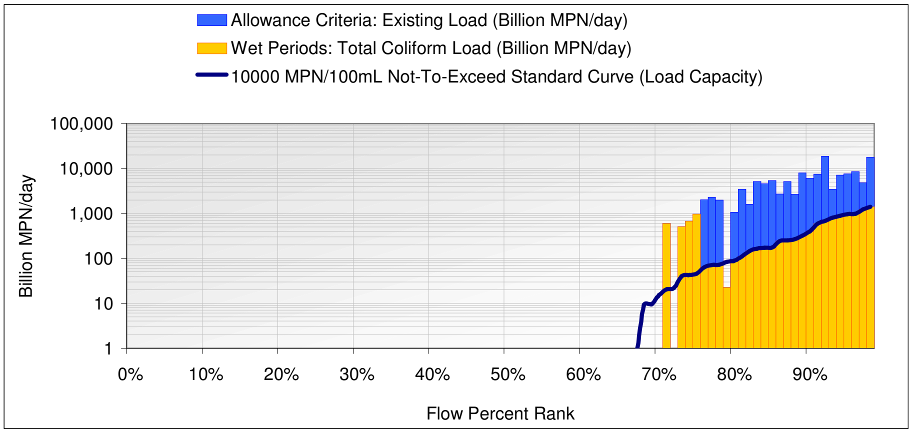
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	480	Billion MPN/Year
Total Load for Existing Condition	40,558	Billion MPN/Year
Total Load Using Allowance Criteria	7,999	Billion MPN/Year
Non-allowable Exceedance Load	7,592	Billion MPN/Year
Required Annual Load Reduction	94.9%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	11	None
Excess Wet Day Exceedances	38	None

Table K-64. Fecal coliform load duration curve and TMDL results for subwatershed 1301 – Interim Period



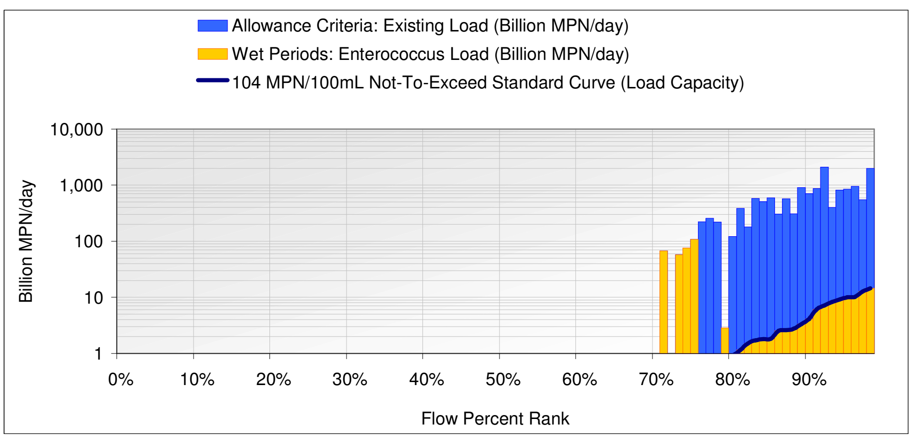
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	418	Billion MPN/Year
Total Load for Existing Condition	3,081	Billion MPN/Year
Total Load Using Allowance Criteria	473	Billion MPN/Year
Non-allowable Exceedance Load	63	Billion MPN/Year
Required Annual Load Reduction	13.3%	Percentage
Wet Day Exceedances	27	None
Allowable Wet Day Exceedances	22	None
Excess Wet Day Exceedances	5	None

Table K-65. Total coliform load duration curve and TMDL results for subwatershed 1301 – Interim Period



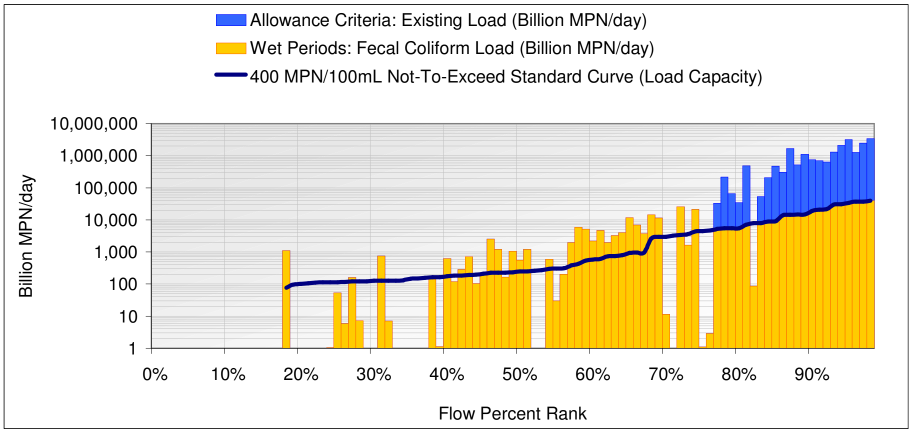
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	10,447	Billion MPN/Year
Total Load for Existing Condition	130,532	Billion MPN/Year
Total Load Using Allowance Criteria	13,146	Billion MPN/Year
Non-allowable Exceedance Load	2,900	Billion MPN/Year
Required Annual Load Reduction	22.1%	Percentage
Wet Day Exceedances	27	None
Allowable Wet Day Exceedances	22	None
Excess Wet Day Exceedances	5	None

Table K-66. Enterococcus load duration curve and TMDL results for subwatershed 1301 – Interim Period



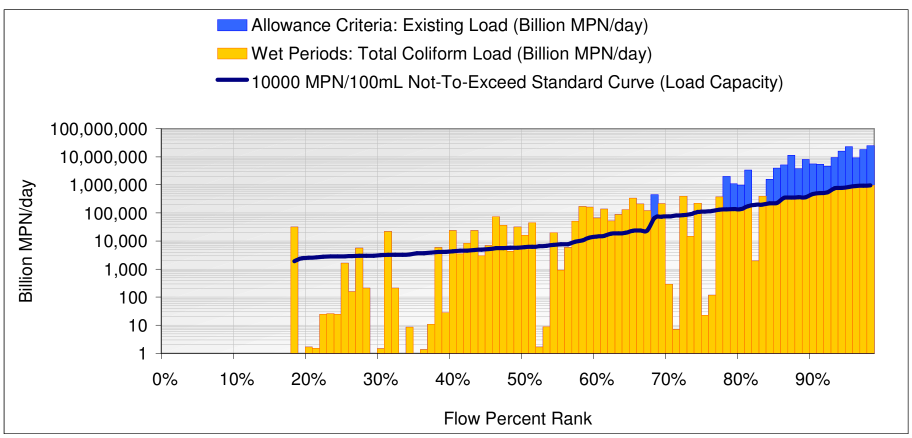
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	109	Billion MPN/Year
Total Load for Existing Condition	14,763	Billion MPN/Year
Total Load Using Allowance Criteria	451	Billion MPN/Year
Non-allowable Exceedance Load	344	Billion MPN/Year
Required Annual Load Reduction	76.2%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	22	None
Excess Wet Day Exceedances	6	None

Table K-67. Fecal coliform load duration curve and TMDL results for subwatershed 1302 – Interim Period



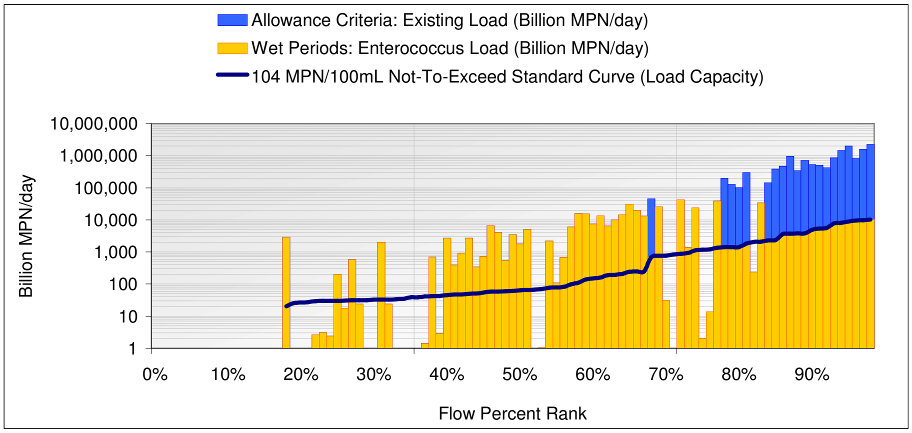
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	467,420	Billion MPN/Year
Total Load for Existing Condition	21,283,828	Billion MPN/Year
Total Load Using Allowance Criteria	610,757	Billion MPN/Year
Non-allowable Exceedance Load	180,163	Billion MPN/Year
Required Annual Load Reduction	29.5%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	22	None
Excess Wet Day Exceedances	28	None

Table K-68. Total coliform load duration curve and TMDL results for subwatershed 1302 – Interim Period



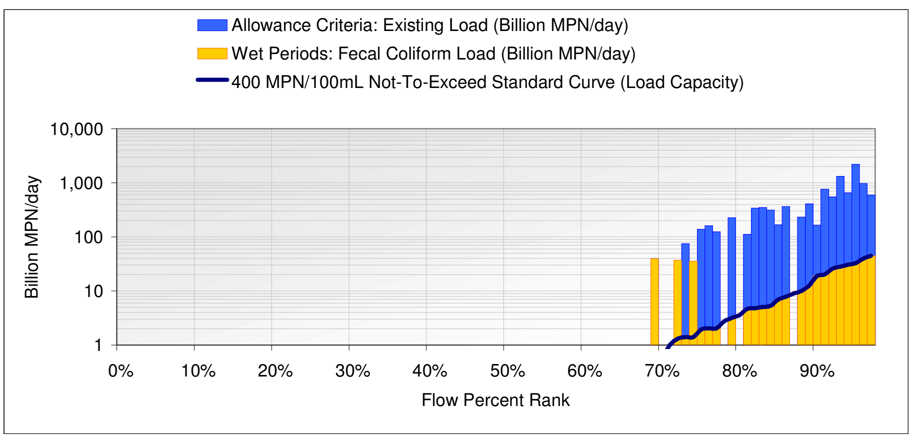
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	11,685,511	Billion MPN/Year
Total Load for Existing Condition	163,410,600	Billion MPN/Year
Total Load Using Allowance Criteria	14,351,028	Billion MPN/Year
Non-allowable Exceedance Load	3,559,560	Billion MPN/Year
Required Annual Load Reduction	24.8%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	22	None
Excess Wet Day Exceedances	28	None

Table K-69. Enterococcus load duration curve and TMDL results for subwatershed 1302 – Interim Period



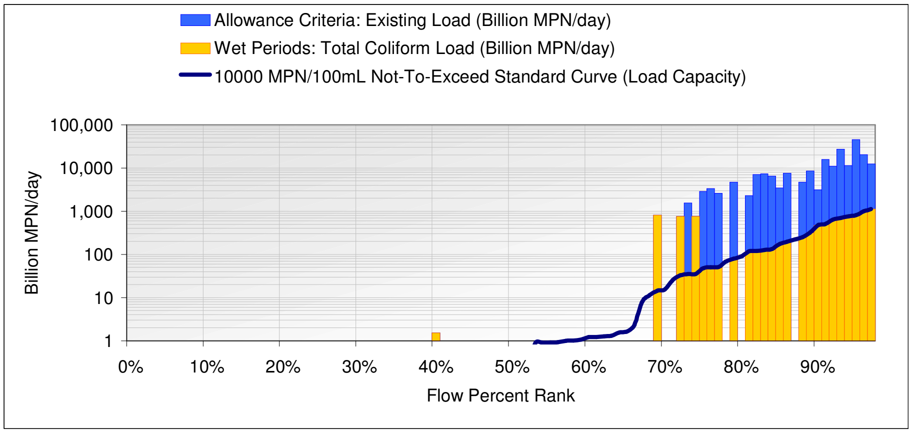
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	121,529	Billion MPN/Year
Total Load for Existing Condition	14,781,447	Billion MPN/Year
Total Load Using Allowance Criteria	601,925	Billion MPN/Year
Non-allowable Exceedance Load	468,501	Billion MPN/Year
Required Annual Load Reduction	77.8%	Percentage
Wet Day Exceedances	57	None
Allowable Wet Day Exceedances	22	None
Excess Wet Day Exceedances	35	None

Table K-70. Fecal coliform load duration curve and TMDL results for subwatershed 1401 – Interim Period



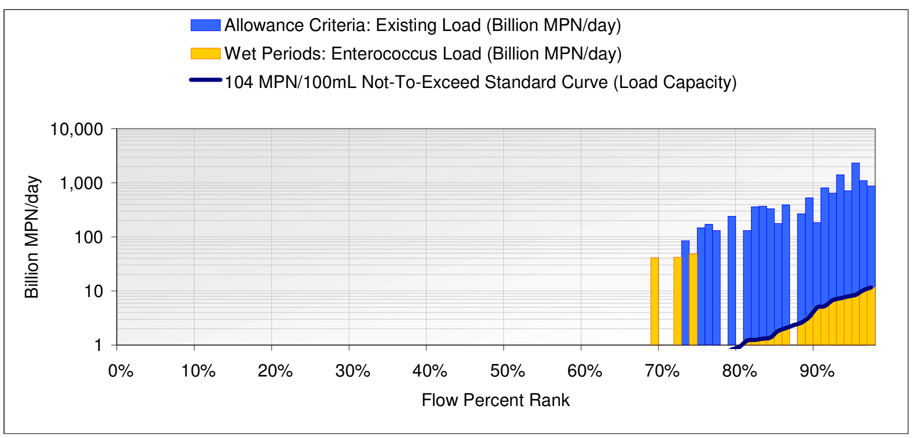
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	335	Billion MPN/Year
Total Load for Existing Condition	10,392	Billion MPN/Year
Total Load Using Allowance Criteria	448	Billion MPN/Year
Non-allowable Exceedance Load	136	Billion MPN/Year
Required Annual Load Reduction	30.3%	Percentage
Wet Day Exceedances	26	None
Allowable Wet Day Exceedances	21	None
Excess Wet Day Exceedances	5	None

Table K-71. Total coliform load duration curve and TMDL results for subwatershed 1401 – Interim Period



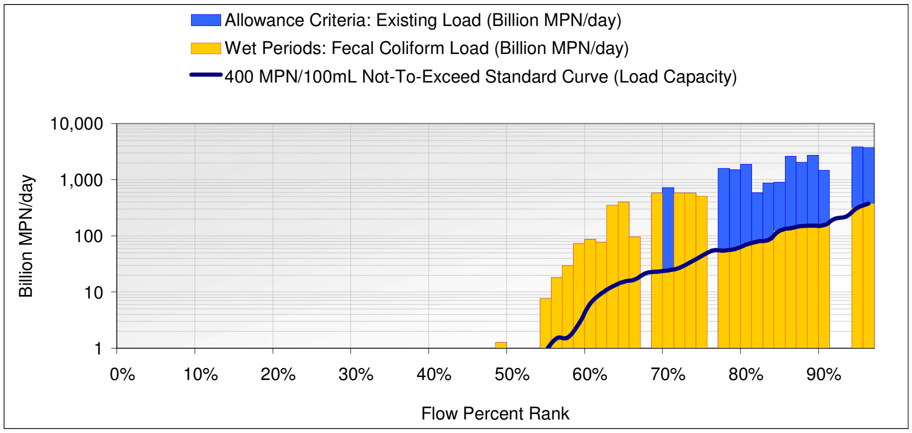
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	8,363	Billion MPN/Year
Total Load for Existing Condition	212,986	Billion MPN/Year
Total Load Using Allowance Criteria	10,616	Billion MPN/Year
Non-allowable Exceedance Load	2,805	Billion MPN/Year
Required Annual Load Reduction	26.4%	Percentage
Wet Day Exceedances	26	None
Allowable Wet Day Exceedances	21	None
Excess Wet Day Exceedances	5	None

Table K-72. Enterococcus load duration curve and TMDL results for subwatershed 1401 – Interim Period



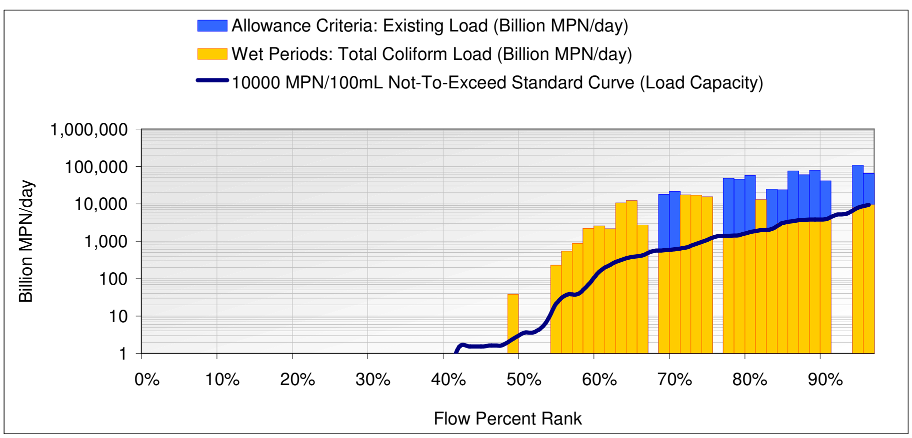
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	87	Billion MPN/Year
Total Load for Existing Condition	11,564	Billion MPN/Year
Total Load Using Allowance Criteria	241	Billion MPN/Year
Non-allowable Exceedance Load	160	Billion MPN/Year
Required Annual Load Reduction	66.3%	Percentage
Wet Day Exceedances	26	None
Allowable Wet Day Exceedances	21	None
Excess Wet Day Exceedances	5	None

Table K-73. Fecal coliform load duration curve and TMDL results for subwatershed 1501 – Interim Period



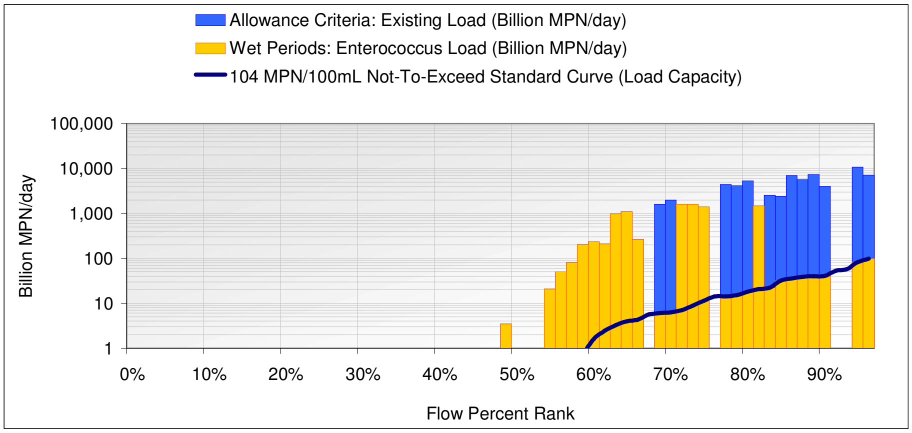
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,487	Billion MPN/Year
Total Load for Existing Condition	28,044	Billion MPN/Year
Total Load Using Allowance Criteria	5,295	Billion MPN/Year
Non-allowable Exceedance Load	3,312	Billion MPN/Year
Required Annual Load Reduction	62.6%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	28	None

Table K-74. Total coliform load duration curve and TMDL results for subwatershed 1501 – Interim Period



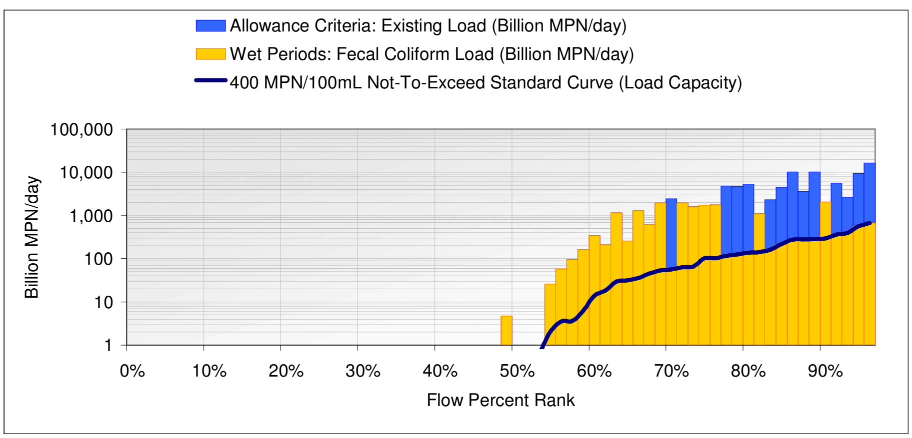
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	62,173	Billion MPN/Year
Total Load for Existing Condition	768,912	Billion MPN/Year
Total Load Using Allowance Criteria	143,323	Billion MPN/Year
Non-allowable Exceedance Load	93,756	Billion MPN/Year
Required Annual Load Reduction	65.4%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	28	None

Table K-75. Enterococcus load duration curve and TMDL results for subwatershed 1501 – Interim Period



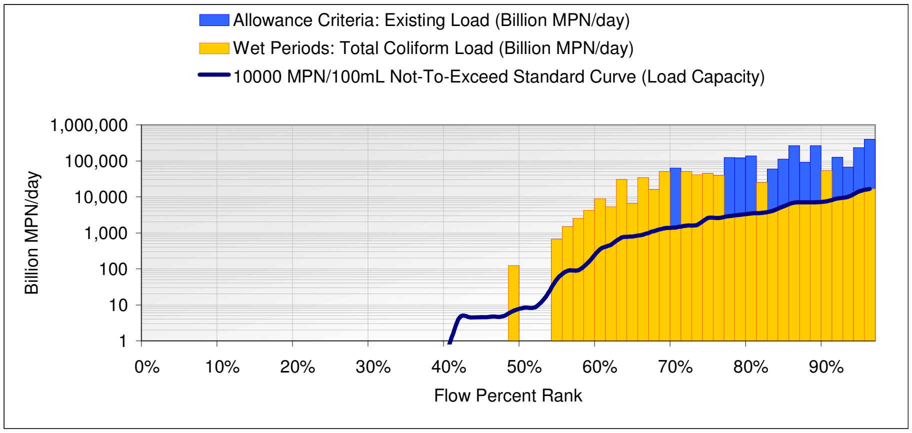
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	647	Billion MPN/Year
Total Load for Existing Condition	74,057	Billion MPN/Year
Total Load Using Allowance Criteria	9,998	Billion MPN/Year
Non-allowable Exceedance Load	9,483	Billion MPN/Year
Required Annual Load Reduction	94.8%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	28	None

Table K-76. Fecal coliform load duration curve and TMDL results for subwatershed 1503 – Interim Period



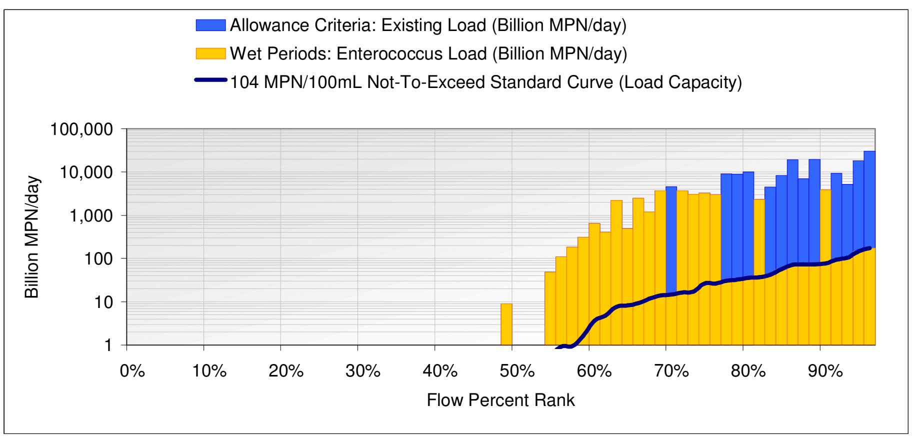
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	4,692	Billion MPN/Year
Total Load for Existing Condition	98,955	Billion MPN/Year
Total Load Using Allowance Criteria	20,424	Billion MPN/Year
Non-allowable Exceedance Load	15,740	Billion MPN/Year
Required Annual Load Reduction	77.1%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	32	None

Table K-77. Total coliform load duration curve and TMDL results for subwatershed 1503 – Interim Period



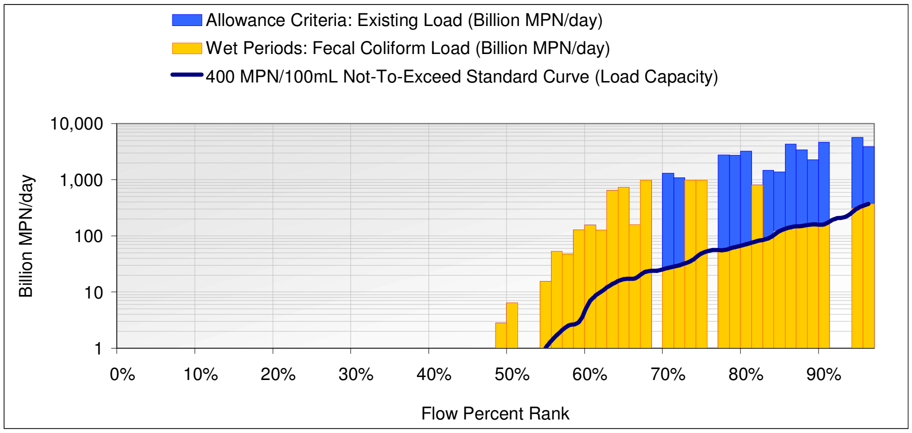
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	117,295	Billion MPN/Year
Total Load for Existing Condition	2,485,458	Billion MPN/Year
Total Load Using Allowance Criteria	514,239	Billion MPN/Year
Non-allowable Exceedance Load	397,159	Billion MPN/Year
Required Annual Load Reduction	77.2%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	32	None

Table K-78. Enterococcus load duration curve and TMDL results for subwatershed 1503 – Interim Period



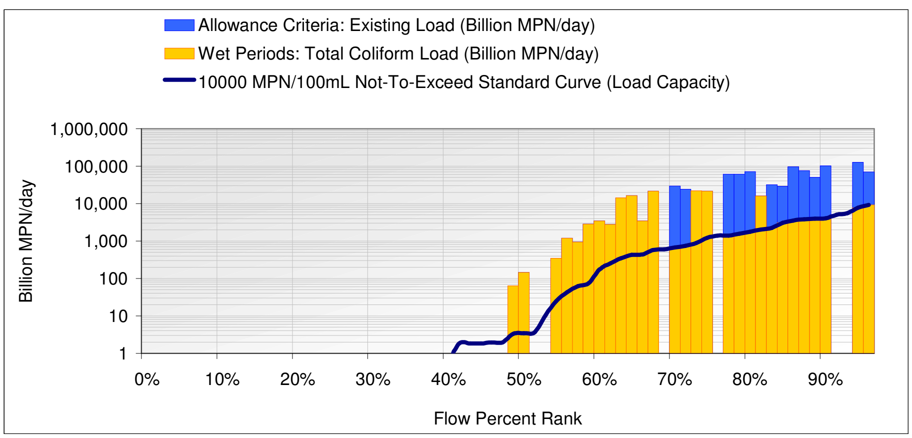
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,220	Billion MPN/Year
Total Load for Existing Condition	185,674	Billion MPN/Year
Total Load Using Allowance Criteria	32,615	Billion MPN/Year
Non-allowable Exceedance Load	31,398	Billion MPN/Year
Required Annual Load Reduction	96.3%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	32	None

Table K-79. Fecal coliform load duration curve and TMDL results for subwatershed 1505 – Interim Period



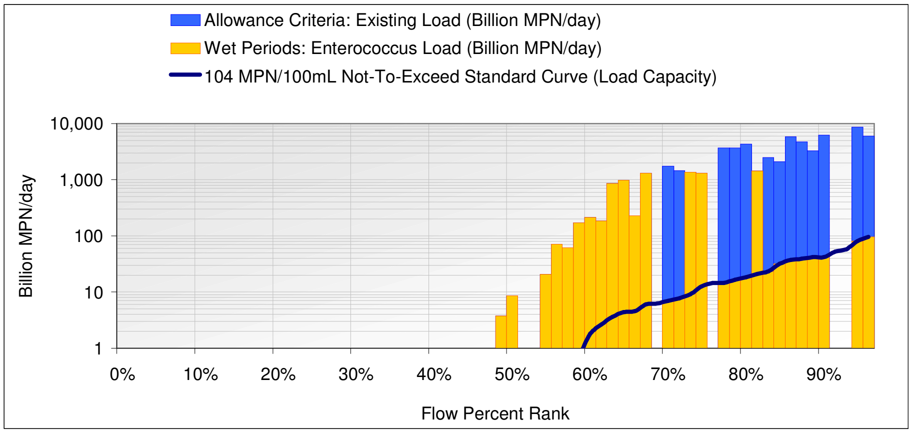
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,530	Billion MPN/Year
Total Load for Existing Condition	44,212	Billion MPN/Year
Total Load Using Allowance Criteria	7,780	Billion MPN/Year
Non-allowable Exceedance Load	5,757	Billion MPN/Year
Required Annual Load Reduction	74.0%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	29	None

Table K-80. Total coliform load duration curve and TMDL results for subwatershed 1505 – Interim Period



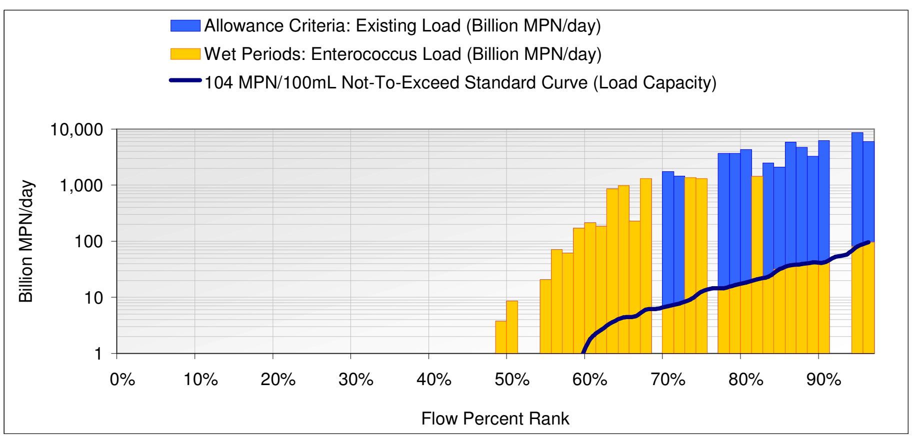
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	63,238	Billion MPN/Year
Total Load for Existing Condition	958,988	Billion MPN/Year
Total Load Using Allowance Criteria	175,850	Billion MPN/Year
Non-allowable Exceedance Load	125,279	Billion MPN/Year
Required Annual Load Reduction	71.2%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	29	None

Table K-81. Enterococcus load duration curve and TMDL results for subwatershed 1505 – Interim Period



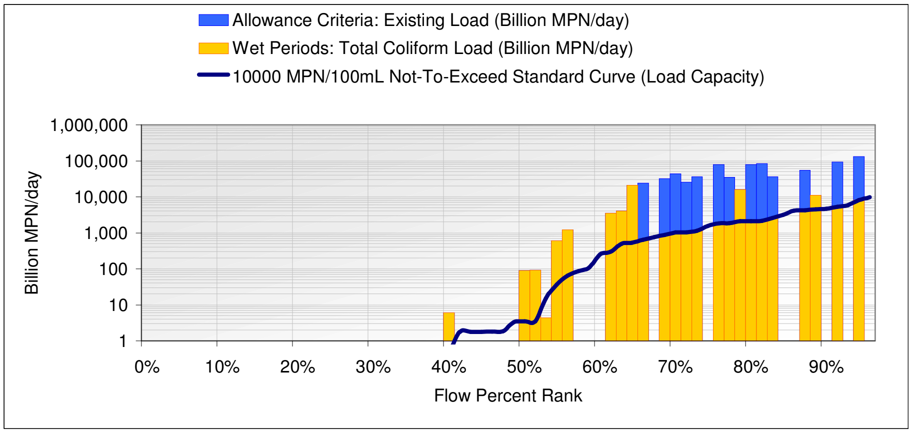
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	658	Billion MPN/Year
Total Load for Existing Condition	62,646	Billion MPN/Year
Total Load Using Allowance Criteria	8,946	Billion MPN/Year
Non-allowable Exceedance Load	8,420	Billion MPN/Year
Required Annual Load Reduction	94.1%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	29	None

Table K-82. Fecal coliform load duration curve and TMDL results for subwatershed 1507 – Interim Period



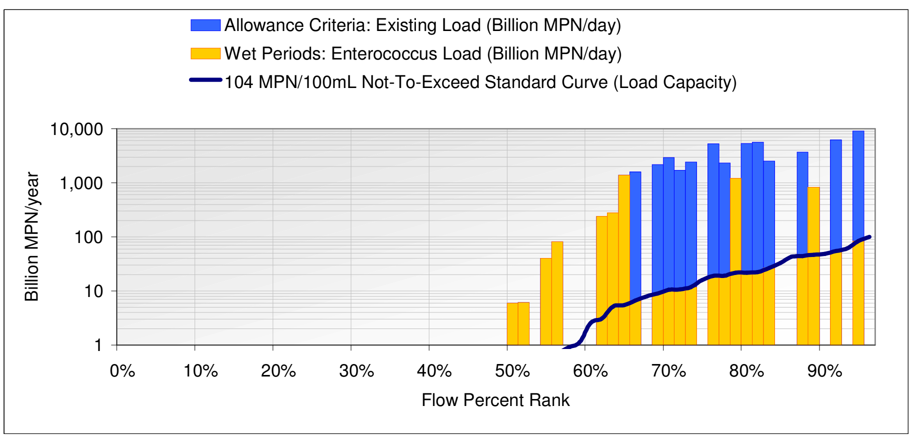
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	658	Billion MPN/Year
Total Load for Existing Condition	62,646	Billion MPN/Year
Total Load Using Allowance Criteria	8,946	Billion MPN/Year
Non-allowable Exceedance Load	8,420	Billion MPN/Year
Required Annual Load Reduction	94.1%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	29	None

Table K-83. Total coliform load duration curve and TMDL results for subwatershed 1507 – Interim Period



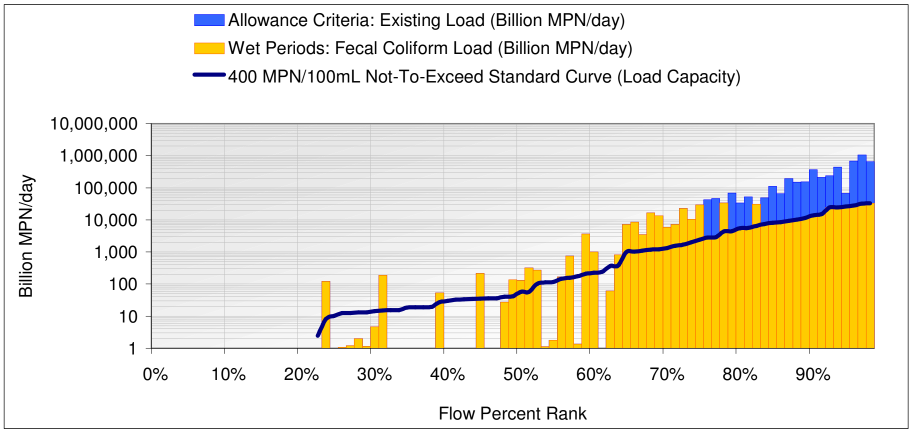
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	71,305	Billion MPN/Year
Total Load for Existing Condition	816,160	Billion MPN/Year
Total Load Using Allowance Criteria	97,361	Billion MPN/Year
Non-allowable Exceedance Load	56,351	Billion MPN/Year
Required Annual Load Reduction	57.9%	Percentage
Wet Day Exceedances	38	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	25	None

Table K-84. Enterococcus load duration curve and TMDL results for subwatershed 1507 – Interim Period



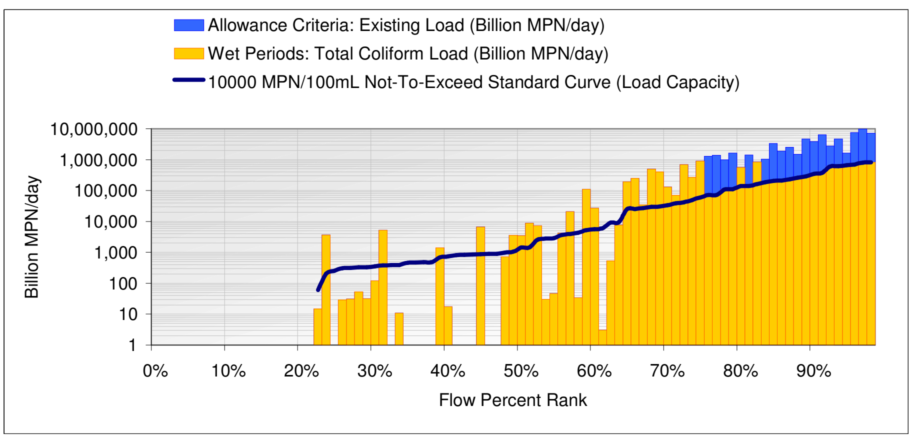
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	742	Billion MPN/Year
Total Load for Existing Condition	55,462	Billion MPN/Year
Total Load Using Allowance Criteria	4,933	Billion MPN/Year
Non-allowable Exceedance Load	4,506	Billion MPN/Year
Required Annual Load Reduction	91.4%	Percentage
Wet Day Exceedances	39	None
Allowable Wet Day Exceedances	13	None
Excess Wet Day Exceedances	26	None

Table K-85. Fecal coliform load duration curve and TMDL results for subwatershed 1801 – Interim Period



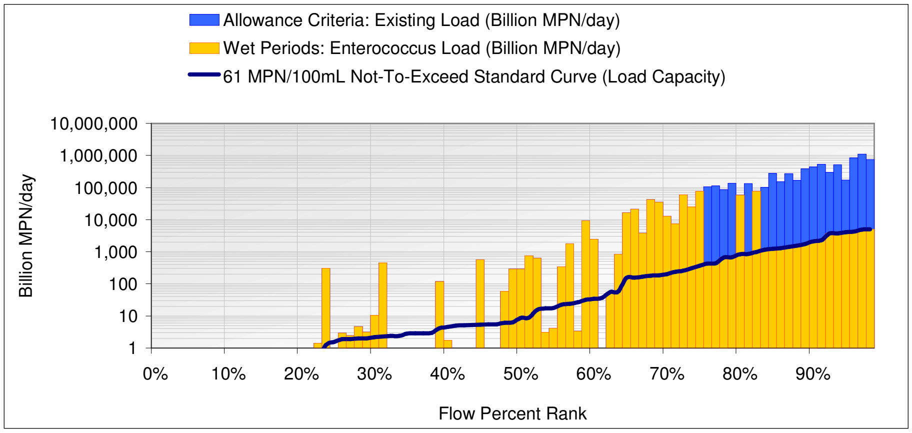
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	312,219	Billion MPN/Year
Total Load for Existing Condition	4,932,380	Billion MPN/Year
Total Load Using Allowance Criteria	562,362	Billion MPN/Year
Non-allowable Exceedance Load	251,230	Billion MPN/Year
Required Annual Load Reduction	44.7%	Percentage
Wet Day Exceedances	57	None
Allowable Wet Day Exceedances	19	None
Excess Wet Day Exceedances	38	None

Table K-86. Total coliform load duration curve and TMDL results for subwatershed 1801 – Interim Period



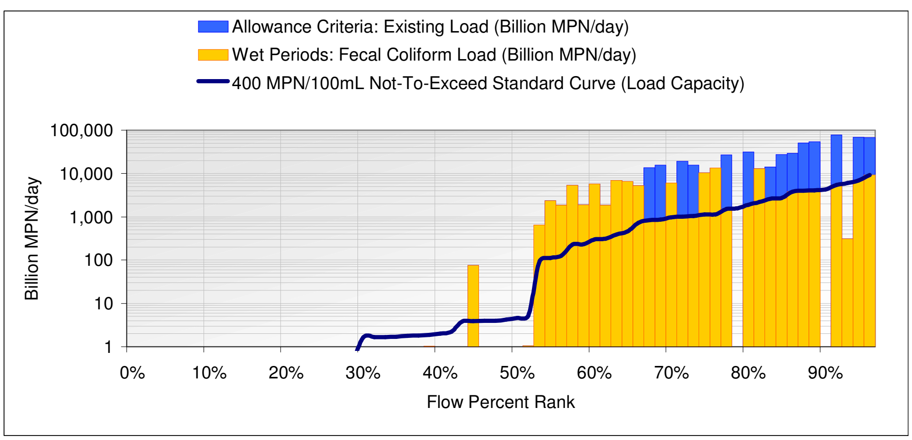
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	7,805,470	Billion MPN/Year
Total Load for Existing Condition	72,757,569	Billion MPN/Year
Total Load Using Allowance Criteria	14,404,631	Billion MPN/Year
Non-allowable Exceedance Load	6,643,285	Billion MPN/Year
Required Annual Load Reduction	46.1%	Percentage
Wet Day Exceedances	51	None
Allowable Wet Day Exceedances	19	None
Excess Wet Day Exceedances	32	None

Table K-87. Enterococcus load duration curve and TMDL results for subwatershed 1801 – Interim Period (based on numeric target for inland surface waters)



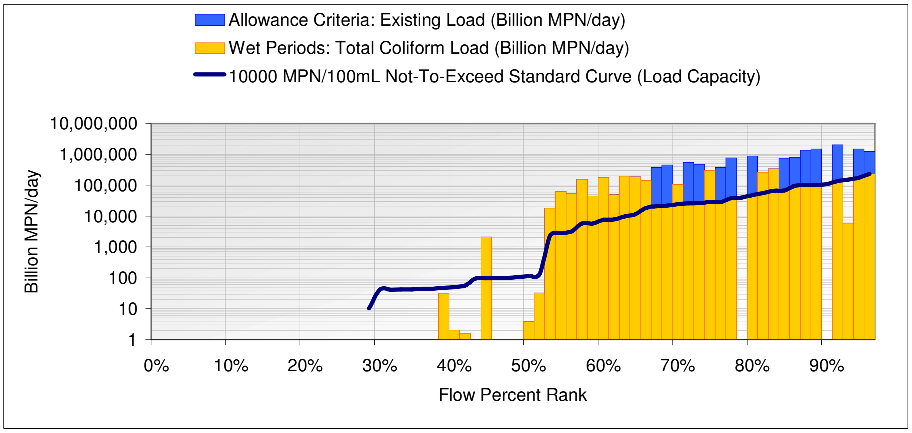
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	47,613	Billion MPN/Year
Total Load for Existing Condition	7,255,759	Billion MPN/Year
Total Load Using Allowance Criteria	712,273	Billion MPN/Year
Non-allowable Exceedance Load	663,917	Billion MPN/Year
Required Annual Load Reduction	93.2%	Percentage
Wet Day Exceedances	59	None
Allowable Wet Day Exceedances	19	None
Excess Wet Day Exceedances	40	None

Table K-88. Fecal coliform load duration curve and TMDL results for subwatershed 1901 – Interim Period



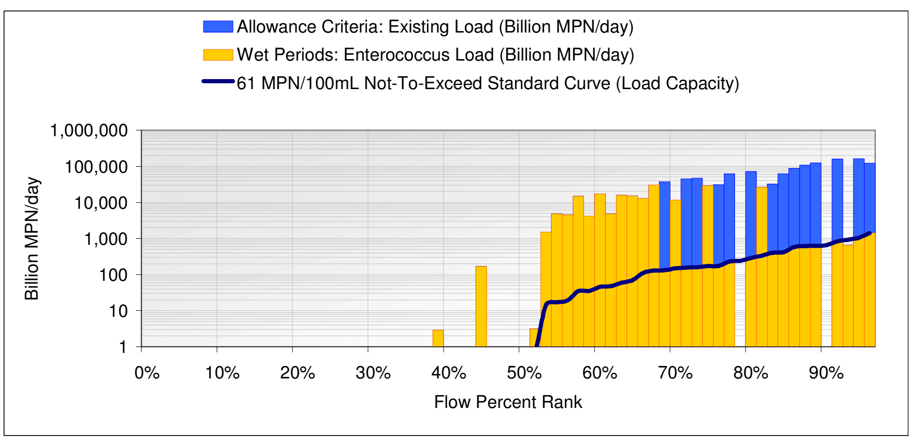
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	67,232	Billion MPN/Year
Total Load for Existing Condition	603,863	Billion MPN/Year
Total Load Using Allowance Criteria	138,938	Billion MPN/Year
Non-allowable Exceedance Load	83,423	Billion MPN/Year
Required Annual Load Reduction	60.0%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	14	None
Excess Wet Day Exceedances	29	None

Table K-89. Total coliform load duration curve and TMDL results for subwatershed 1901 – Interim Period



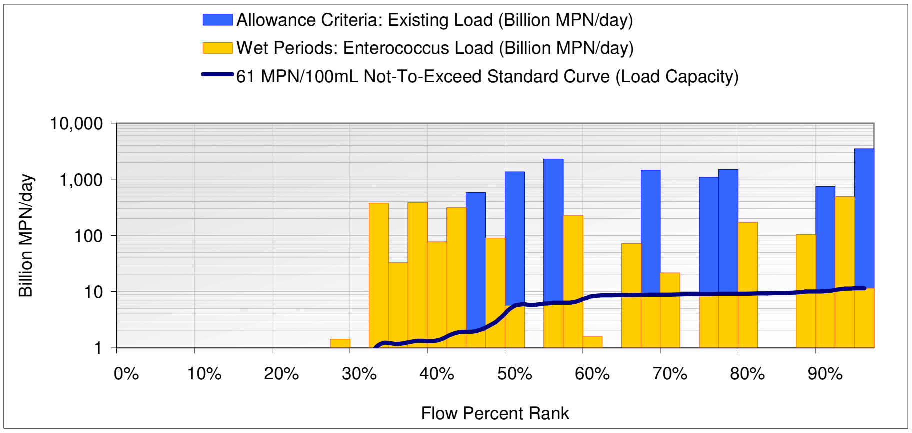
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,680,809	Billion MPN/Year
Total Load for Existing Condition	15,390,608	Billion MPN/Year
Total Load Using Allowance Criteria	3,529,019	Billion MPN/Year
Non-allowable Exceedance Load	2,142,982	Billion MPN/Year
Required Annual Load Reduction	60.7%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	14	None
Excess Wet Day Exceedances	29	None

Table K-90. Enterococcus load duration curve and TMDL results for subwatershed 1901 – Interim Period (based on numeric target for inland surface waters)



Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	10,253	Billion MPN/Year
Total Load for Existing Condition	1,371,972	Billion MPN/Year
Total Load Using Allowance Criteria	228,401	Billion MPN/Year
Non-allowable Exceedance Load	219,327	Billion MPN/Year
Required Annual Load Reduction	96.0%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	14	None
Excess Wet Day Exceedances	31	None

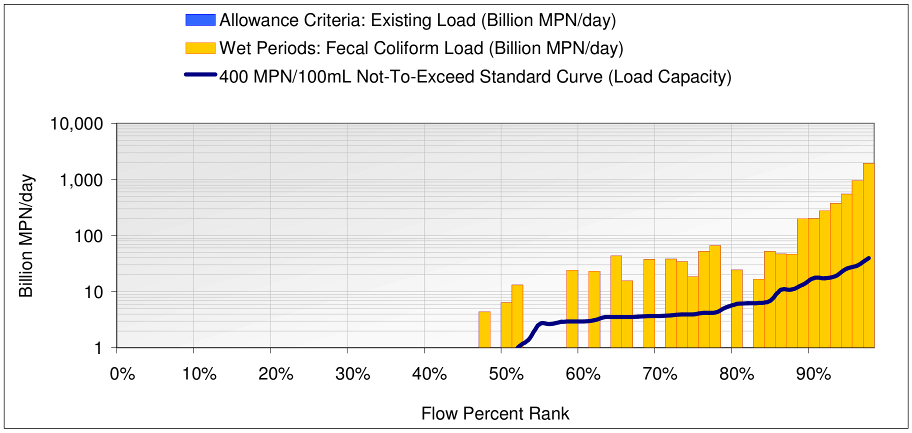
Table K-91. Enterococcus load duration curve and TMDL results for subwatershed 2001 – Interim Period (based on numeric target for inland surface waters)



Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	179	Billion MPN/Year
Total Load for Existing Condition	14,860	Billion MPN/Year
Total Load Using Allowance Criteria	2,429	Billion MPN/Year
Non-allowable Exceedance Load	2,298	Billion MPN/Year
Required Annual Load Reduction	94.6%	Percentage
Wet Day Exceedances	29	None
Allowable Wet Day Exceedances	8	None
Excess Wet Day Exceedances	21	None

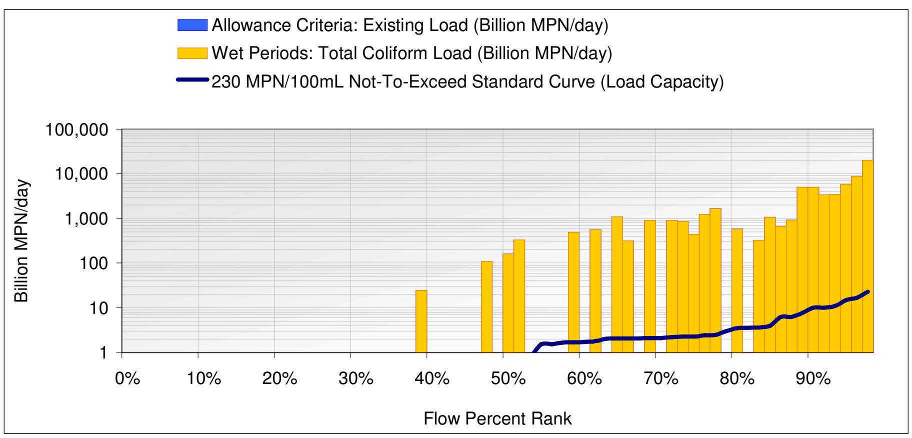
Appendix L
Wet Weather TMDL Results

Table L-1. Fecal coliform load duration curve and TMDL results for subwatershed 101 – TMDL



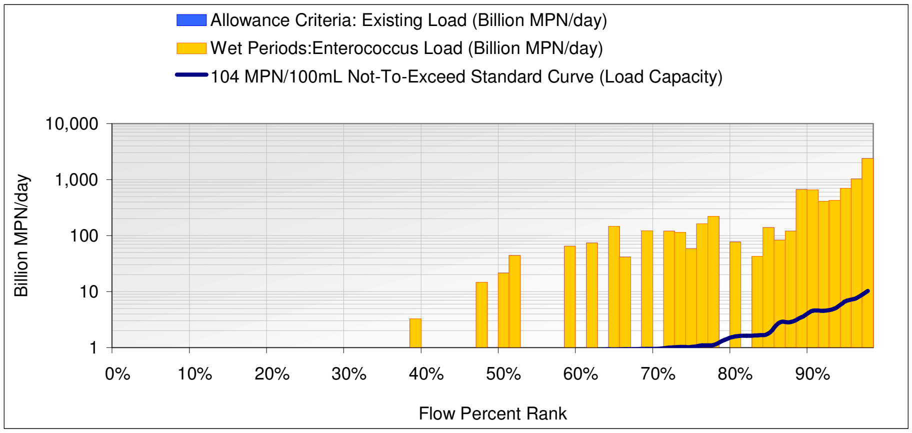
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	309	Billion MPN/Year
Total Load for Existing Condition	5,179	Billion MPN/Year
Total Load Using Allowance Criteria	5,179	Billion MPN/Year
Non-allowable Exceedance Load	4,923	Billion MPN/Year
Required Annual Load Reduction	95.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-2. Total coliform load duration curve and TMDL results for subwatershed 101 – TMDL



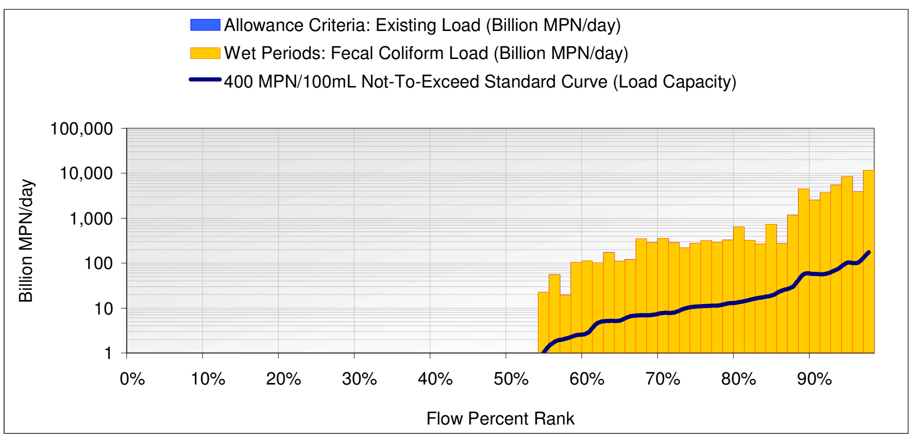
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	177	Billion MPN/Year
Total Load for Existing Condition	67,350	Billion MPN/Year
Total Load Using Allowance Criteria	67,350	Billion MPN/Year
Non-allowable Exceedance Load	67,203	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-3. Enterococcus load duration curve and TMDL results for subwatershed 101 – TMDL



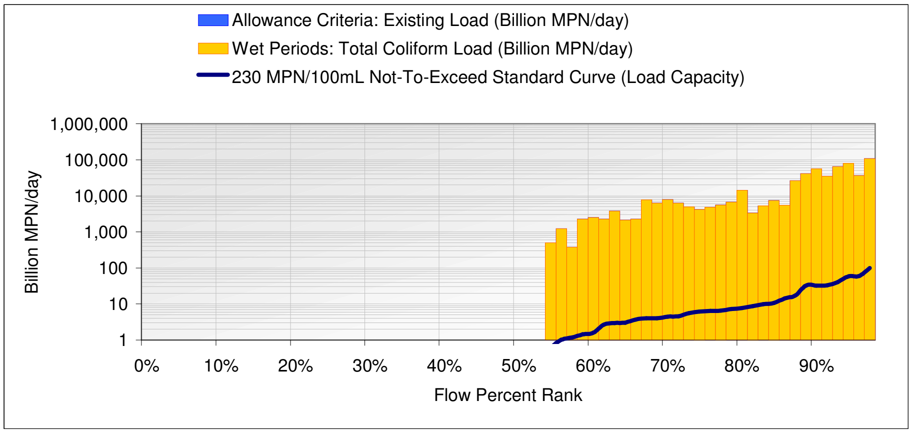
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	80	Billion MPN/Year
Total Load for Existing Condition	8,374	Billion MPN/Year
Total Load Using Allowance Criteria	8,374	Billion MPN/Year
Non-allowable Exceedance Load	8,308	Billion MPN/Year
Required Annual Load Reduction	99.2%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-4. Fecal coliform load duration curve and TMDL results for subwatershed 103 – TMDL



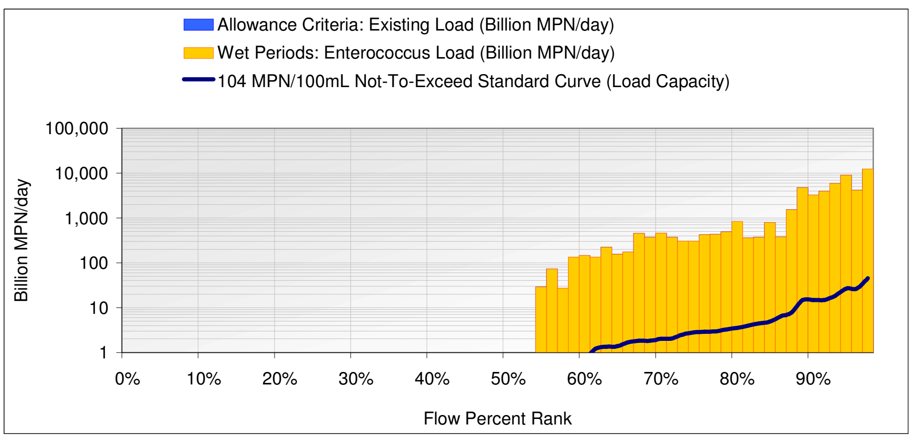
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	872	Billion MPN/Year
Total Load for Existing Condition	47,497	Billion MPN/Year
Total Load Using Allowance Criteria	47,497	Billion MPN/Year
Non-allowable Exceedance Load	46,633	Billion MPN/Year
Required Annual Load Reduction	98.2%	Percentage
Wet Day Exceedances	36	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	36	None

Table L-5. Total coliform load duration curve and TMDL results for subwatershed 103 – TMDL



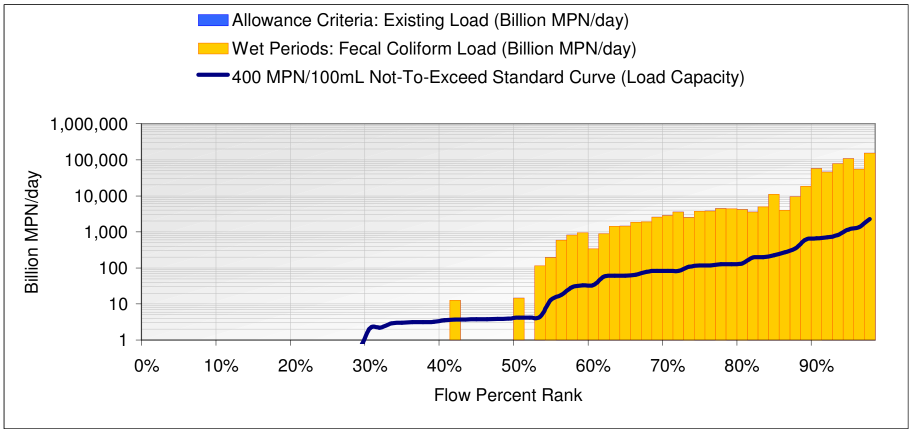
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	501	Billion MPN/Year
Total Load for Existing Condition	561,319	Billion MPN/Year
Total Load Using Allowance Criteria	561,319	Billion MPN/Year
Non-allowable Exceedance Load	560,821	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	37	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	37	None

Table L-6. Enterococcus load duration curve and TMDL results for subwatershed 103 – TMDL



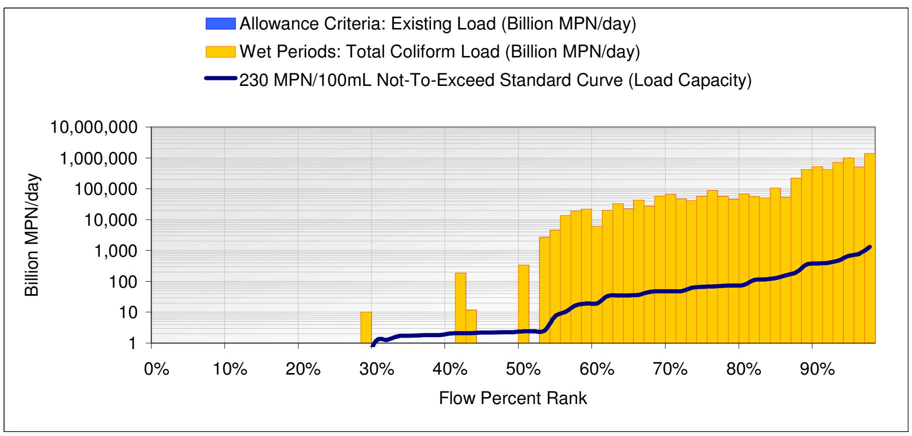
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	227	Billion MPN/Year
Total Load for Existing Condition	52,977	Billion MPN/Year
Total Load Using Allowance Criteria	52,977	Billion MPN/Year
Non-allowable Exceedance Load	52,752	Billion MPN/Year
Required Annual Load Reduction	99.6%	Percentage
Wet Day Exceedances	37	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	37	None

Table L-7. Fecal coliform load duration curve and TMDL results for subwatershed 104 – TMDL



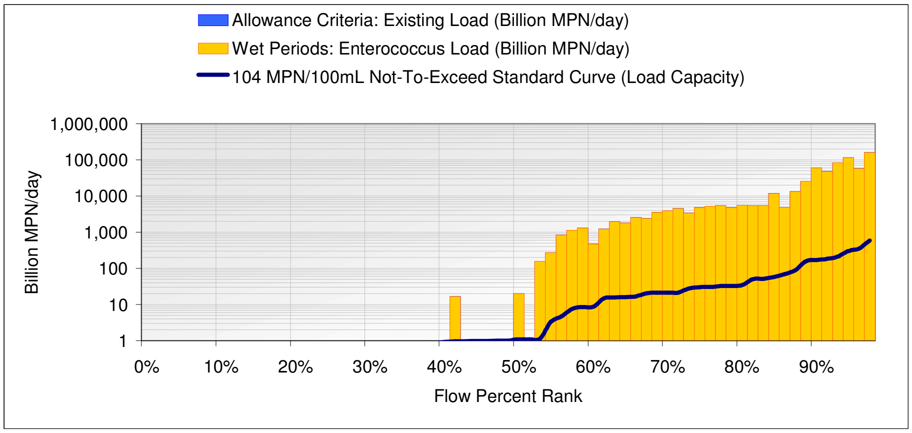
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	10,505	Billion MPN/Year
Total Load for Existing Condition	592,496	Billion MPN/Year
Total Load Using Allowance Criteria	592,496	Billion MPN/Year
Non-allowable Exceedance Load	582,079	Billion MPN/Year
Required Annual Load Reduction	98.2%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	43	None

Table L-8. Total coliform load duration curve and TMDL results for subwatershed 104 – TMDL



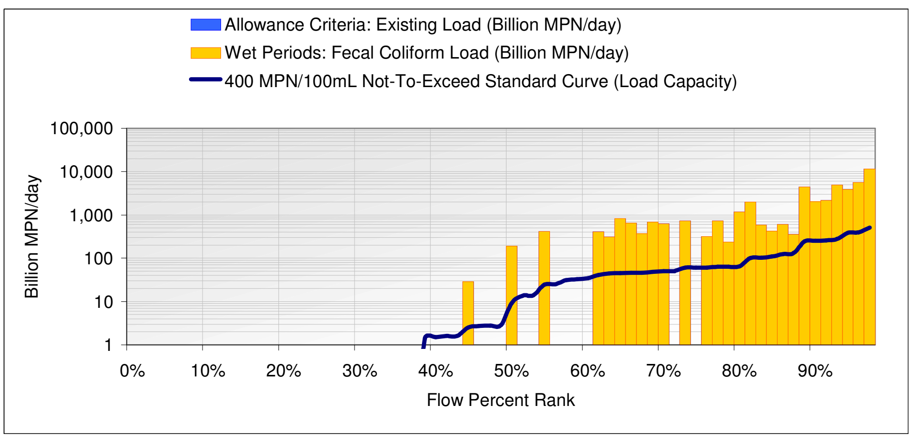
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	6,040	Billion MPN/Year
Total Load for Existing Condition	6,278,214	Billion MPN/Year
Total Load Using Allowance Criteria	6,278,214	Billion MPN/Year
Non-allowable Exceedance Load	6,272,211	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	49	None

Table L-9. Enterococcus load duration curve and TMDL results for subwatershed 104 – TMDL



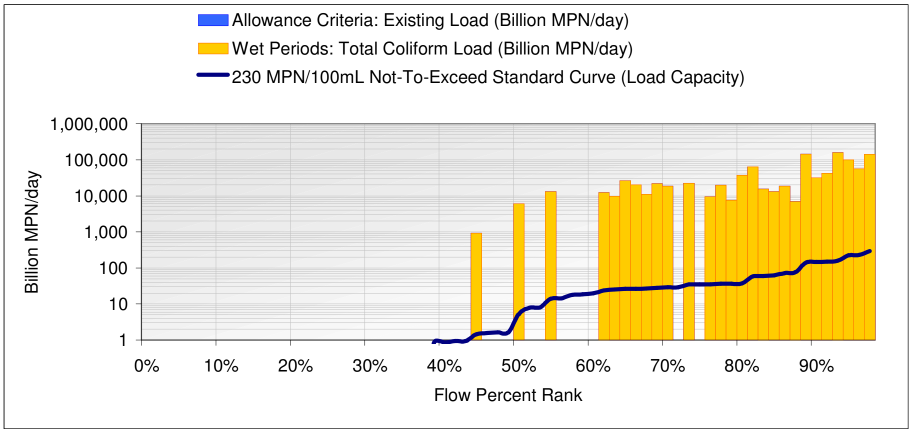
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,731	Billion MPN/Year
Total Load for Existing Condition	650,651	Billion MPN/Year
Total Load Using Allowance Criteria	650,651	Billion MPN/Year
Non-allowable Exceedance Load	647,939	Billion MPN/Year
Required Annual Load Reduction	99.6%	Percentage
Wet Day Exceedances	44	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	44	None

Table L-10. Fecal coliform load duration curve and TMDL results for subwatershed 105 – TMDL



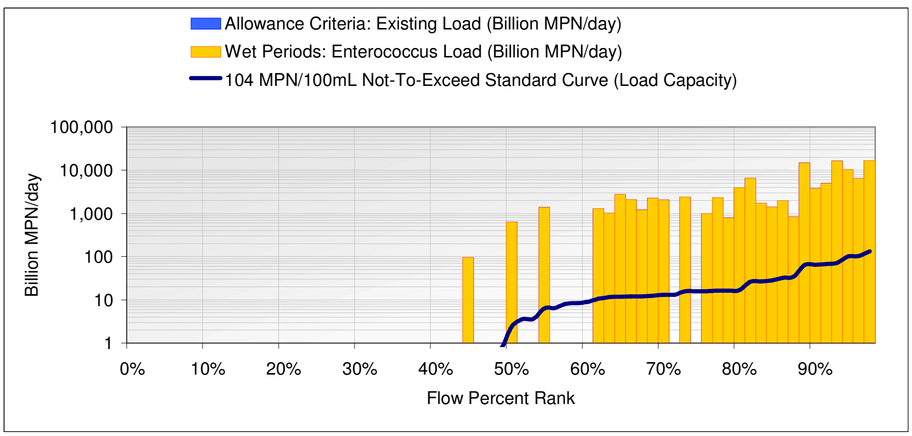
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	4,174	Billion MPN/Year
Total Load for Existing Condition	47,842	Billion MPN/Year
Total Load Using Allowance Criteria	47,842	Billion MPN/Year
Non-allowable Exceedance Load	44,154	Billion MPN/Year
Required Annual Load Reduction	92.3%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-11. Total coliform load duration curve and TMDL results for subwatershed 105 – TMDL



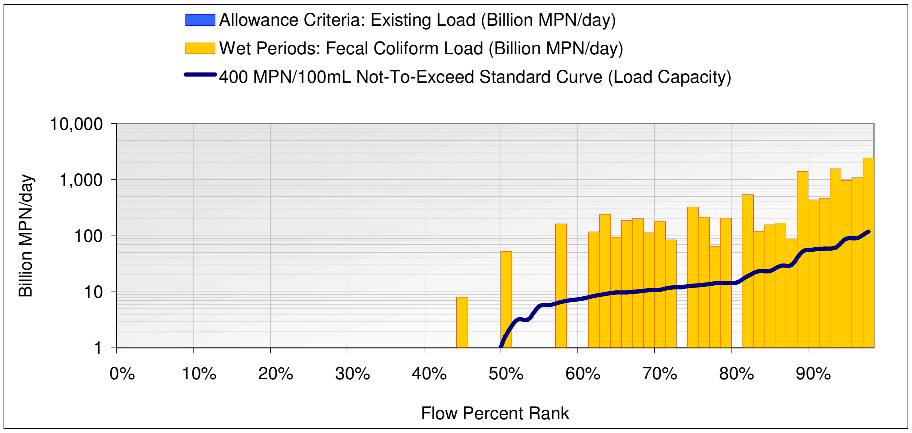
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,400	Billion MPN/Year
Total Load for Existing Condition	1,076,489	Billion MPN/Year
Total Load Using Allowance Criteria	1,076,489	Billion MPN/Year
Non-allowable Exceedance Load	1,074,368	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-12. Enterococcus load duration curve and TMDL results for subwatershed 105 – TMDL



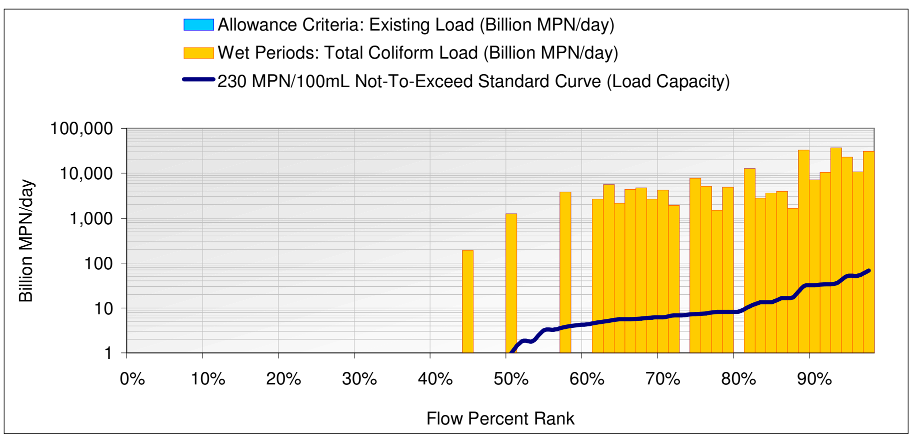
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,085	Billion MPN/Year
Total Load for Existing Condition	117,393	Billion MPN/Year
Total Load Using Allowance Criteria	117,393	Billion MPN/Year
Non-allowable Exceedance Load	116,434	Billion MPN/Year
Required Annual Load Reduction	99.2%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-13. Fecal coliform load duration curve and TMDL results for subwatershed 106 – TMDL



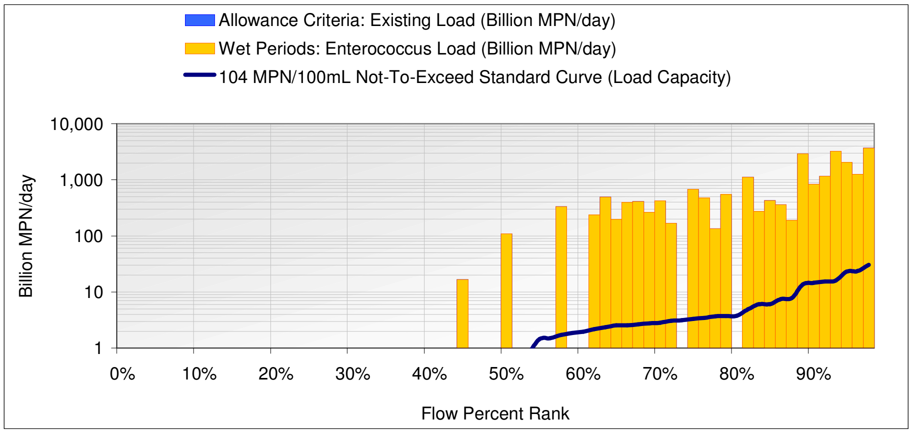
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	932	Billion MPN/Year
Total Load for Existing Condition	12,001	Billion MPN/Year
Total Load Using Allowance Criteria	12,001	Billion MPN/Year
Non-allowable Exceedance Load	11,183	Billion MPN/Year
Required Annual Load Reduction	93.2%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-14. Total coliform load duration curve and TMDL results for subwatershed 106 – TMDL



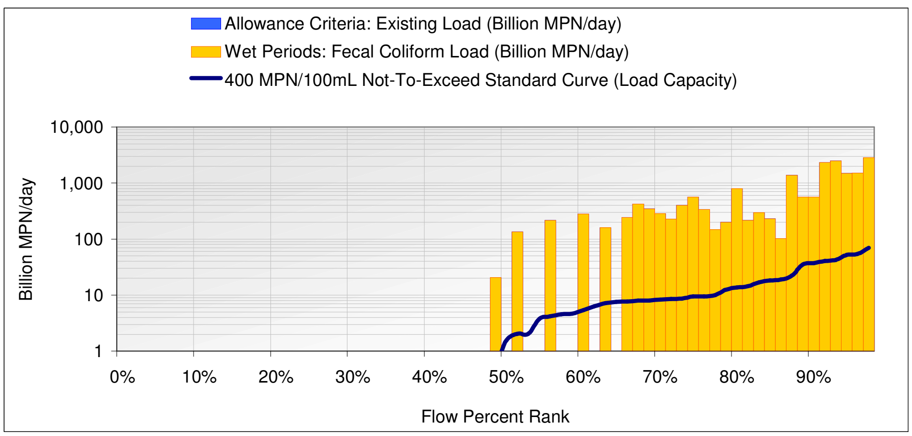
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	536	Billion MPN/Year
Total Load for Existing Condition	238,530	Billion MPN/Year
Total Load Using Allowance Criteria	238,530	Billion MPN/Year
Non-allowable Exceedance Load	238,060	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-15. Enterococcus load duration curve and TMDL results for subwatershed 106 – TMDL



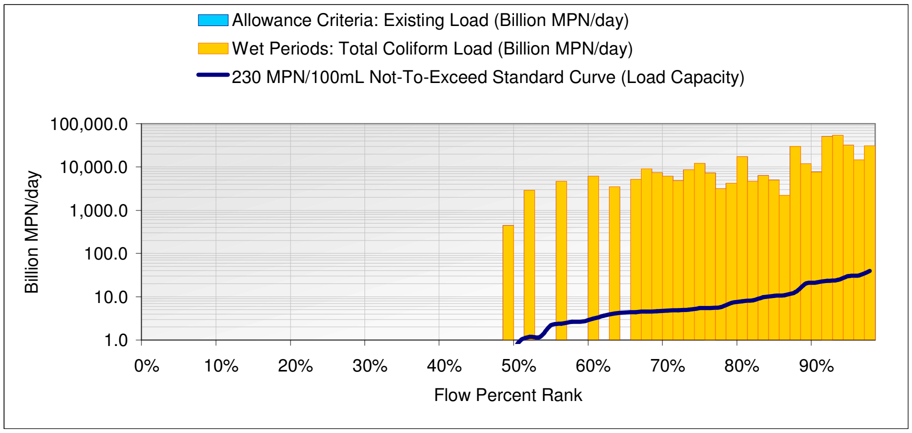
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	242	Billion MPN/Year
Total Load for Existing Condition	23,254	Billion MPN/Year
Total Load Using Allowance Criteria	23,254	Billion MPN/Year
Non-allowable Exceedance Load	23,041	Billion MPN/Year
Required Annual Load Reduction	99.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-16. Fecal coliform load duration curve and TMDL results for subwatershed 201 – TMDL



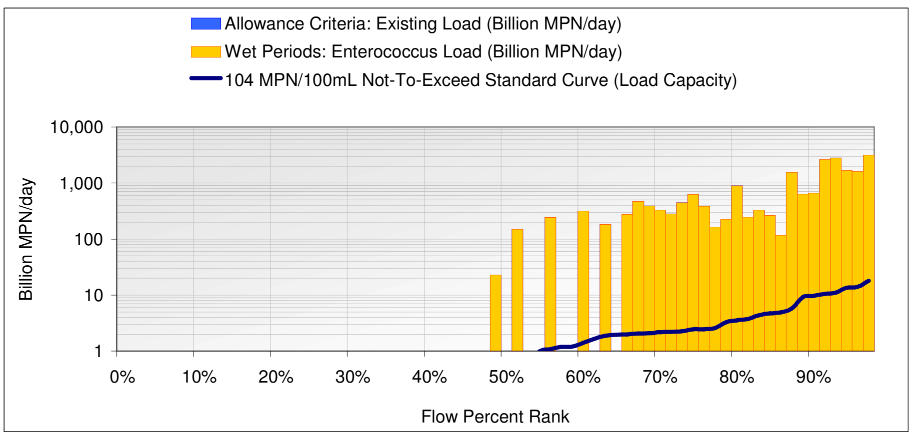
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	630	Billion MPN/Year
Total Load for Existing Condition	19,386	Billion MPN/Year
Total Load Using Allowance Criteria	19,386	Billion MPN/Year
Non-allowable Exceedance Load	18,823	Billion MPN/Year
Required Annual Load Reduction	97.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-17. Total coliform load duration curve and TMDL results for subwatershed 201 – TMDL



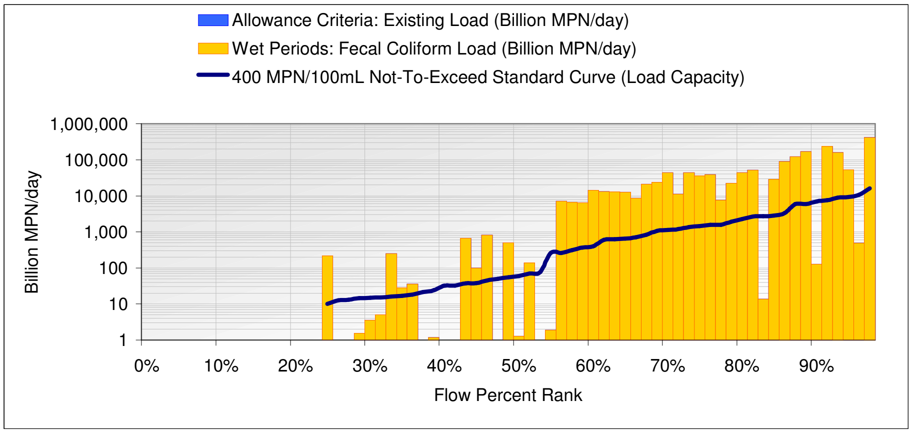
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	362	Billion MPN/Year
Total Load for Existing Condition	364,715	Billion MPN/Year
Total Load Using Allowance Criteria	364,715	Billion MPN/Year
Non-allowable Exceedance Load	364,391	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-18. Enterococcus load duration curve and TMDL results for subwatershed 201 – TMDL



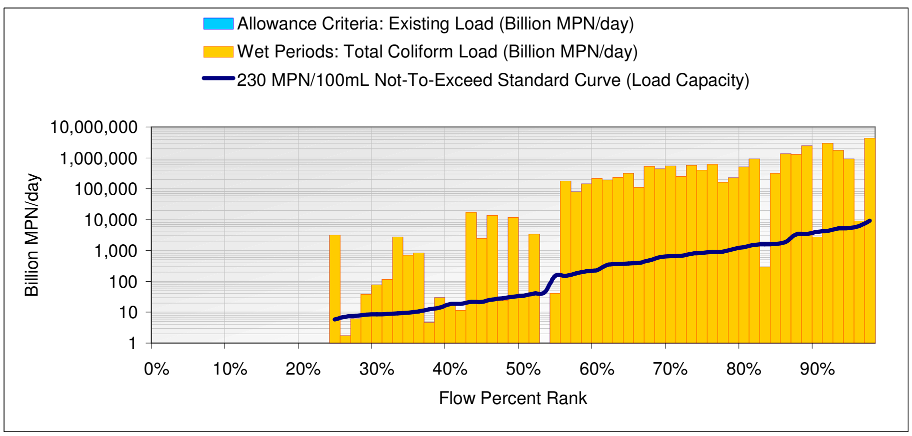
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	164	Billion MPN/Year
Total Load for Existing Condition	21,646	Billion MPN/Year
Total Load Using Allowance Criteria	21,646	Billion MPN/Year
Non-allowable Exceedance Load	21,500	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-19. Fecal coliform load duration curve and TMDL results for subwatershed 202 – TMDL



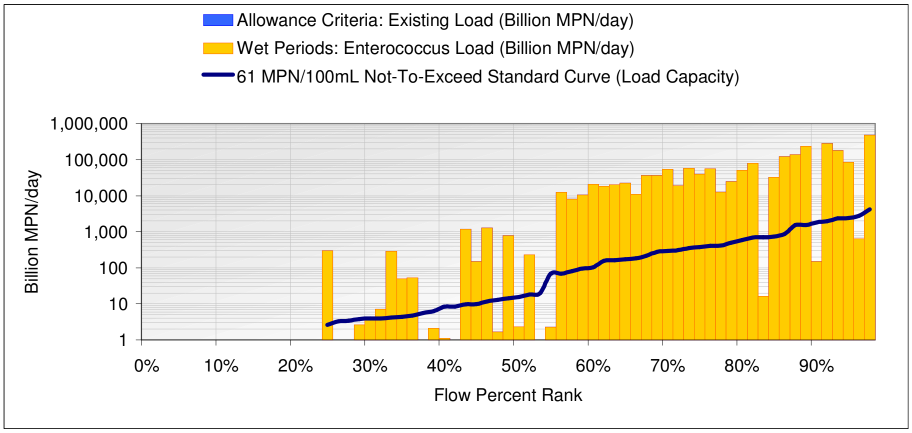
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	104,792	Billion MPN/Year
Total Load for Existing Condition	1,732,709	Billion MPN/Year
Total Load Using Allowance Criteria	1,732,709	Billion MPN/Year
Non-allowable Exceedance Load	1,648,711	Billion MPN/Year
Required Annual Load Reduction	95.2%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	49	None

Table L-20. Total coliform load duration curve and TMDL results for subwatershed 202 – TMDL



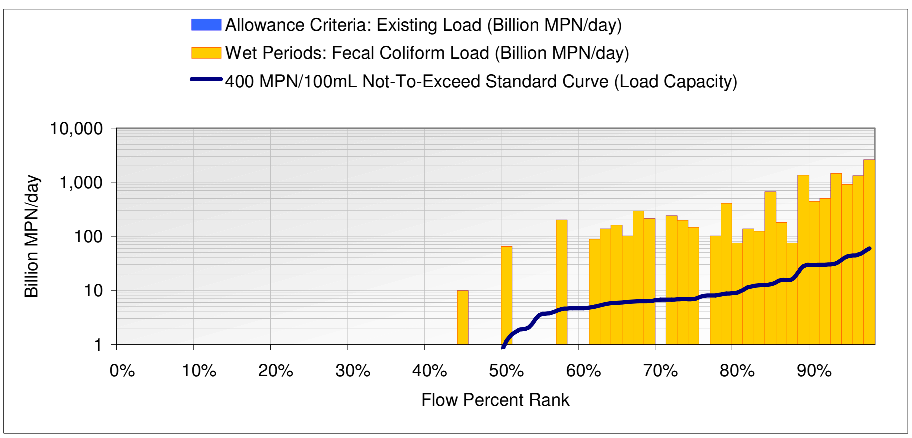
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	60,255	Billion MPN/Year
Total Load for Existing Condition	22,846,059	Billion MPN/Year
Total Load Using Allowance Criteria	22,846,059	Billion MPN/Year
Non-allowable Exceedance Load	22,788,754	Billion MPN/Year
Required Annual Load Reduction	99.7%	Percentage
Wet Day Exceedances	55	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	55	None

Table L-21. Enterococcus load duration curve and TMDL results for subwatershed 202 – TMDL (based on numeric target for inland surface waters)



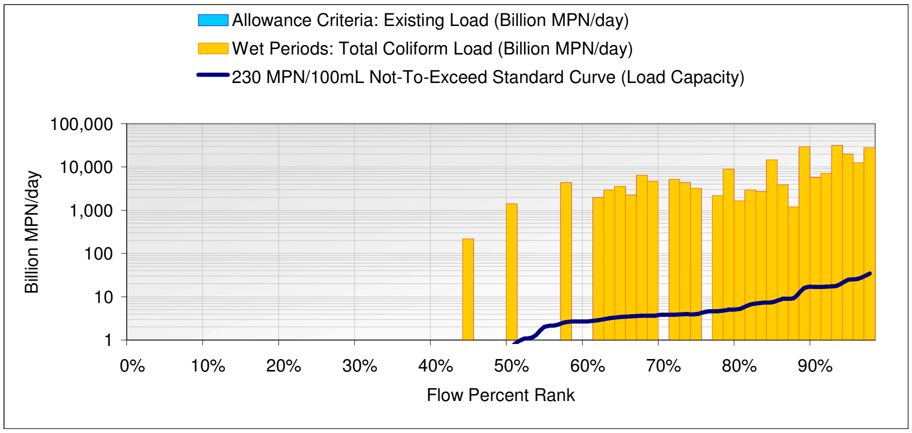
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	15,981	Billion MPN/Year
Total Load for Existing Condition	2,208,560	Billion MPN/Year
Total Load Using Allowance Criteria	2,208,560	Billion MPN/Year
Non-allowable Exceedance Load	2,195,002	Billion MPN/Year
Required Annual Load Reduction	99.4%	Percentage
Wet Day Exceedances	53	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	53	None

Table L-22. Fecal coliform load duration curve and TMDL results for subwatershed 301 – TMDL



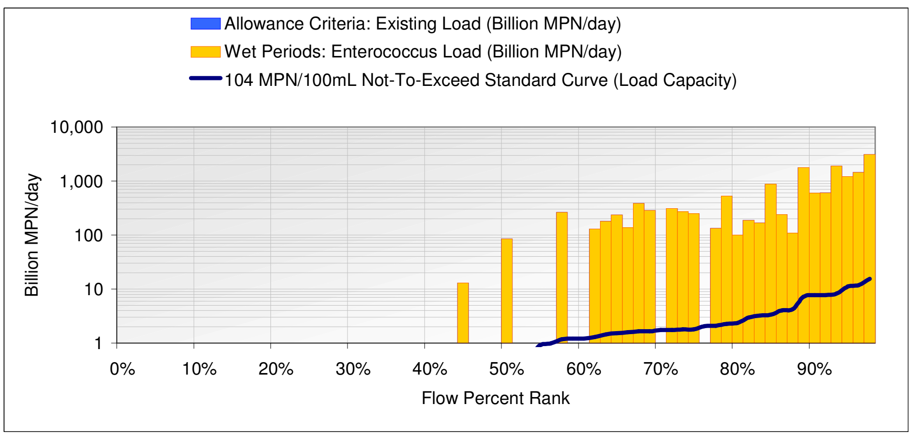
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	507	Billion MPN/Year
Total Load for Existing Condition	12,677	Billion MPN/Year
Total Load Using Allowance Criteria	12,677	Billion MPN/Year
Non-allowable Exceedance Load	12,239	Billion MPN/Year
Required Annual Load Reduction	96.5%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-23. Total coliform load duration curve and TMDL results for subwatershed 301 – TMDL



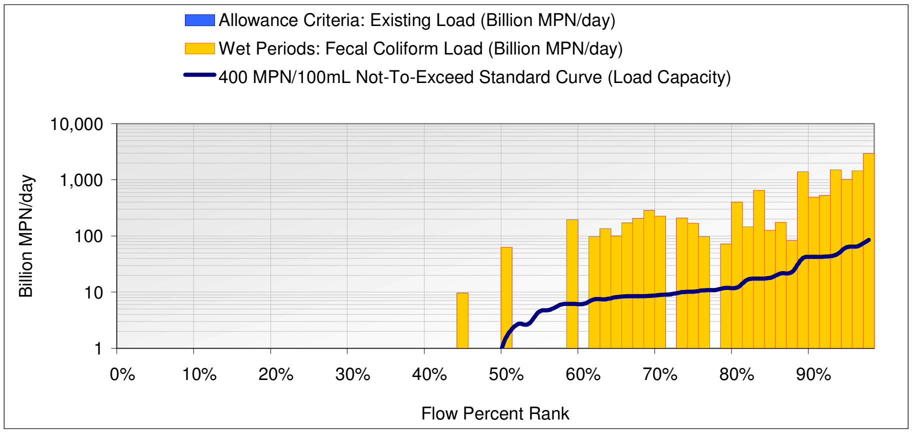
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	292	Billion MPN/Year
Total Load for Existing Condition	224,286	Billion MPN/Year
Total Load Using Allowance Criteria	224,286	Billion MPN/Year
Non-allowable Exceedance Load	224,034	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-24. Enterococcus load duration curve and TMDL results for subwatershed 301 – TMDL



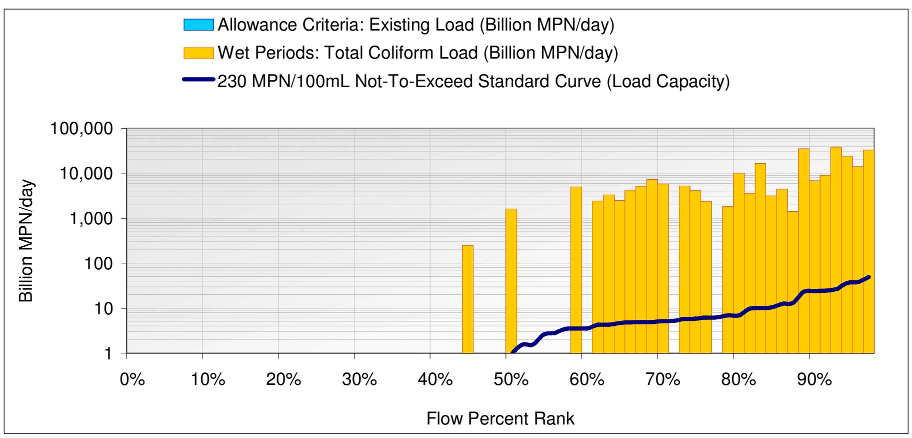
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	132	Billion MPN/Year
Total Load for Existing Condition	16,137	Billion MPN/Year
Total Load Using Allowance Criteria	16,137	Billion MPN/Year
Non-allowable Exceedance Load	16,024	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-25. Fecal coliform load duration curve and TMDL results for subwatershed 302 – TMDL



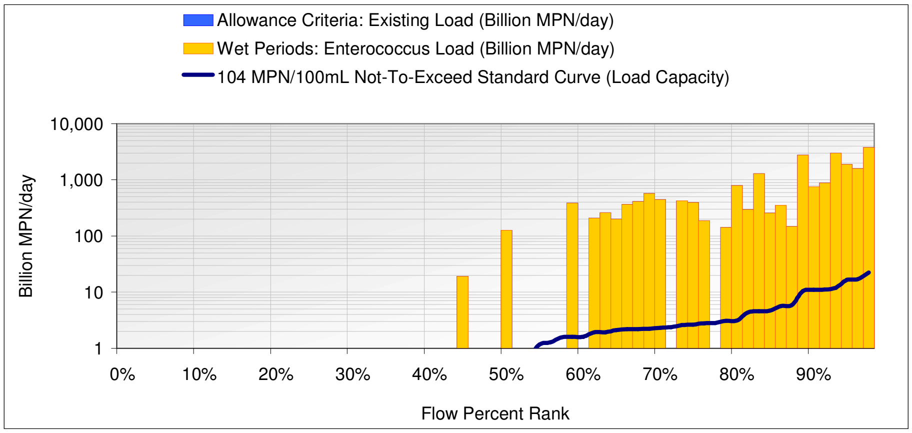
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	715	Billion MPN/Year
Total Load for Existing Condition	13,426	Billion MPN/Year
Total Load Using Allowance Criteria	13,426	Billion MPN/Year
Non-allowable Exceedance Load	12,803	Billion MPN/Year
Required Annual Load Reduction	95.4%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-26. Total coliform load duration curve and TMDL results for subwatershed 302 – TMDL



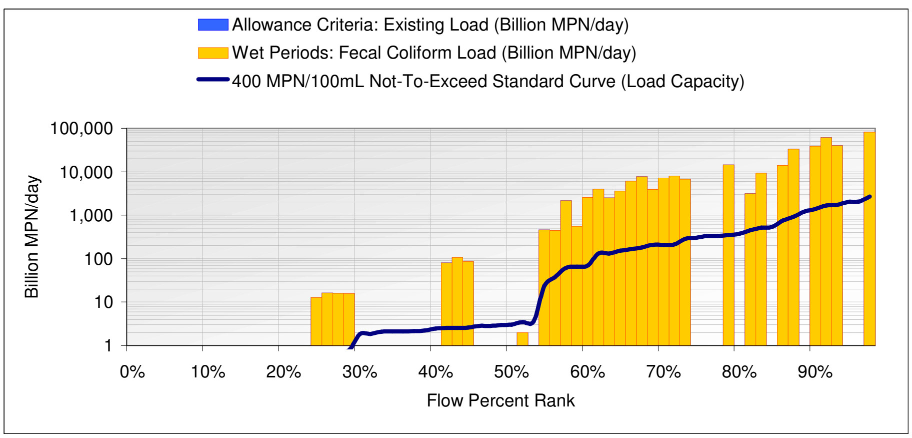
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	411	Billion MPN/Year
Total Load for Existing Condition	261,979	Billion MPN/Year
Total Load Using Allowance Criteria	261,979	Billion MPN/Year
Non-allowable Exceedance Load	261,621	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-27. Enterococcus load duration curve and TMDL results for subwatershed 302 – TMDL



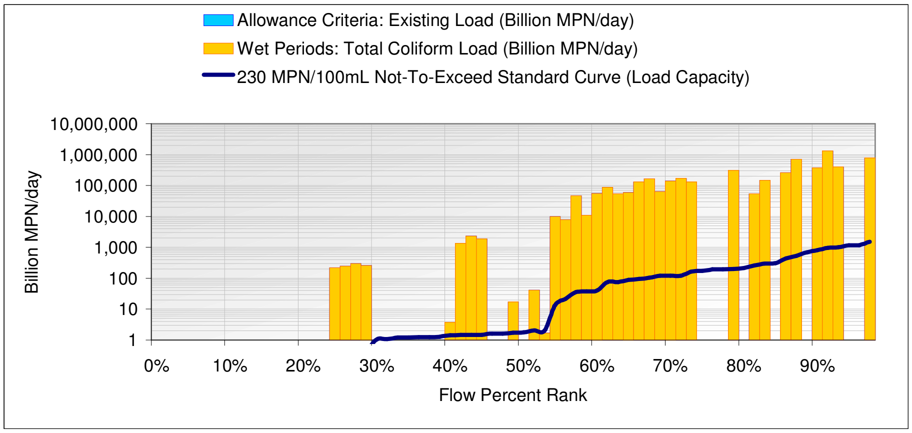
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	186	Billion MPN/Year
Total Load for Existing Condition	22,871	Billion MPN/Year
Total Load Using Allowance Criteria	22,871	Billion MPN/Year
Non-allowable Exceedance Load	22,709	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-28. Fecal coliform load duration curve and TMDL results for subwatershed 304 – TMDL



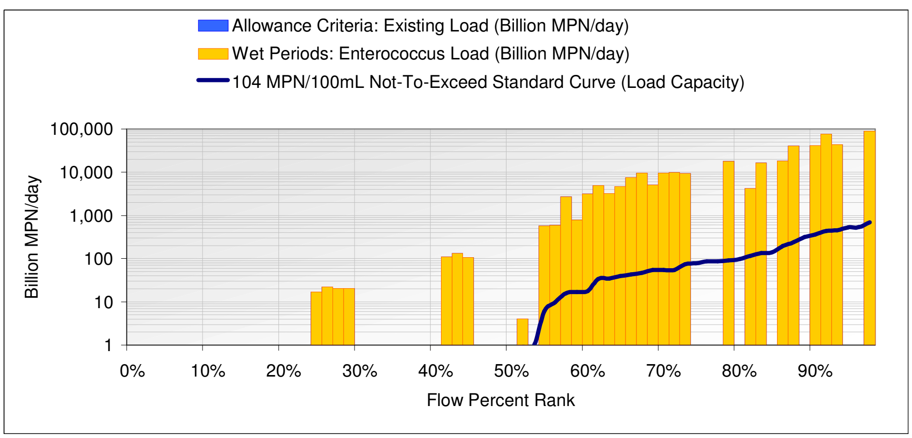
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	19,885	Billion MPN/Year
Total Load for Existing Condition	356,926	Billion MPN/Year
Total Load Using Allowance Criteria	356,926	Billion MPN/Year
Non-allowable Exceedance Load	344,269	Billion MPN/Year
Required Annual Load Reduction	96.5%	Percentage
Wet Day Exceedances	39	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	39	None

Table L-29. Total coliform load duration curve and TMDL results for subwatershed 304 – TMDL



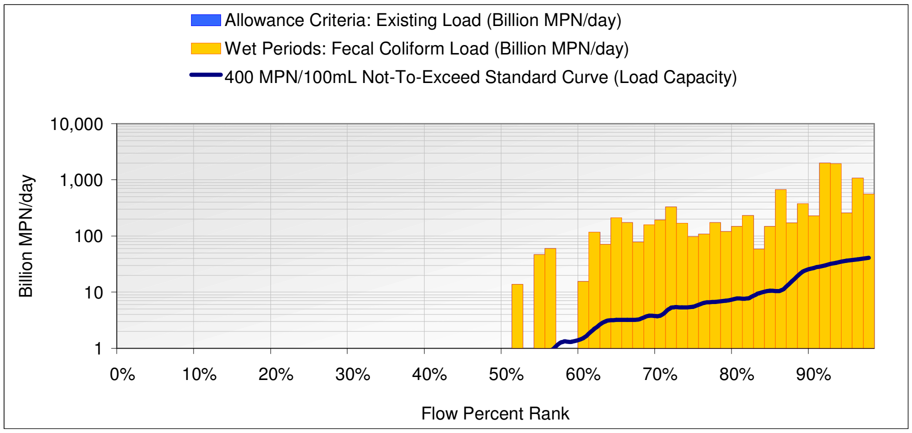
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	11,434	Billion MPN/Year
Total Load for Existing Condition	5,599,516	Billion MPN/Year
Total Load Using Allowance Criteria	5,599,516	Billion MPN/Year
Non-allowable Exceedance Load	5,592,229	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	44	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	44	None

Table L-30. Enterococcus load duration curve and TMDL results for subwatershed 304 – TMDL



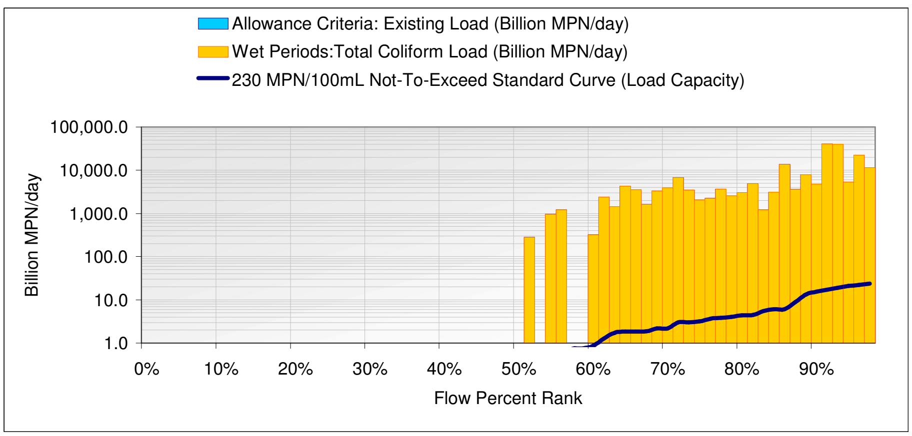
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	5,170	Billion MPN/Year
Total Load for Existing Condition	428,285	Billion MPN/Year
Total Load Using Allowance Criteria	428,285	Billion MPN/Year
Non-allowable Exceedance Load	424,991	Billion MPN/Year
Required Annual Load Reduction	99.2%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	42	None

Table L-31. Fecal coliform load duration curve and TMDL results for subwatershed 305 – TMDL



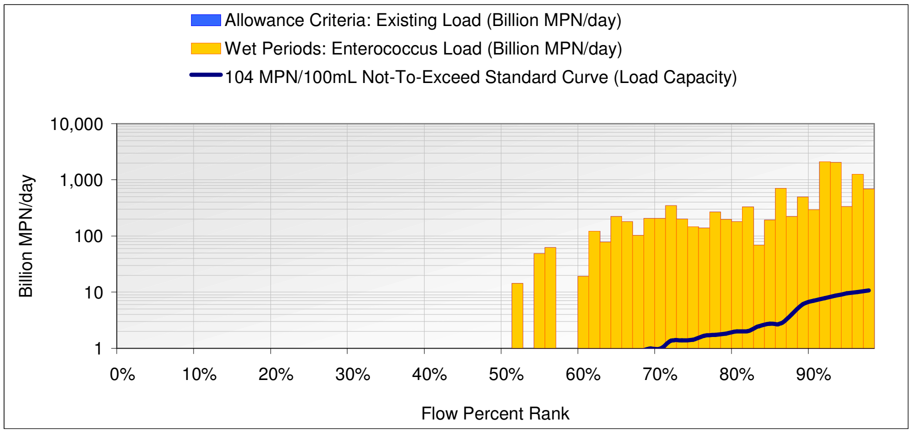
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	367	Billion MPN/Year
Total Load for Existing Condition	10,149	Billion MPN/Year
Total Load Using Allowance Criteria	10,149	Billion MPN/Year
Non-allowable Exceedance Load	9,792	Billion MPN/Year
Required Annual Load Reduction	96.5%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-32. Total coliform load duration curve and TMDL results for subwatershed 305 – TMDL



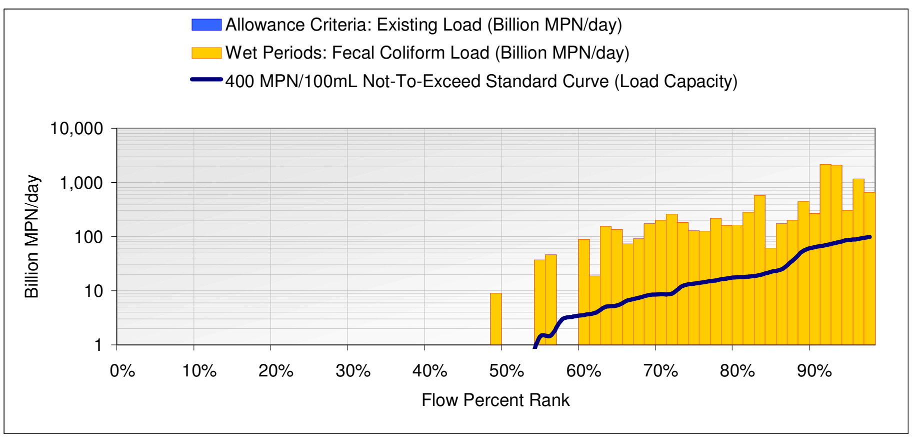
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	211	Billion MPN/Year
Total Load for Existing Condition	209,193	Billion MPN/Year
Total Load Using Allowance Criteria	209,193	Billion MPN/Year
Non-allowable Exceedance Load	208,988	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-33. Enterococcus load duration curve and TMDL results for subwatershed 305 – TMDL



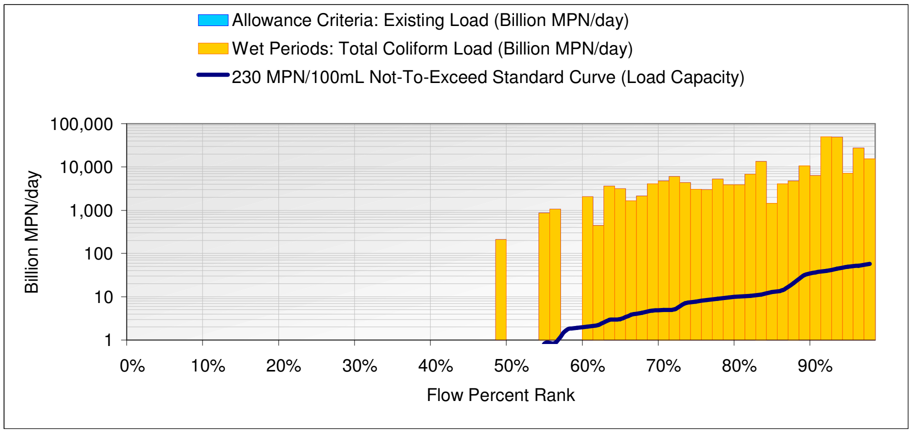
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	95	Billion MPN/Year
Total Load for Existing Condition	11,603	Billion MPN/Year
Total Load Using Allowance Criteria	11,603	Billion MPN/Year
Non-allowable Exceedance Load	11,510	Billion MPN/Year
Required Annual Load Reduction	99.2%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-34. Fecal coliform load duration curve and TMDL results for subwatershed 306 – TMDL



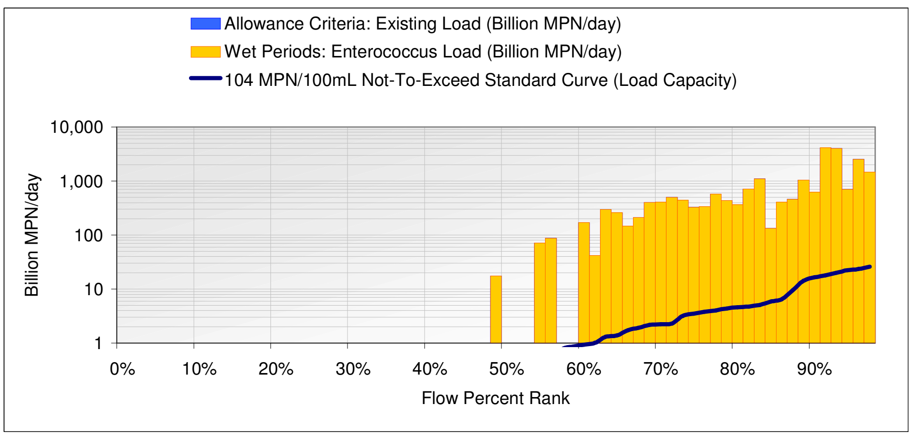
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	843	Billion MPN/Year
Total Load for Existing Condition	10,733	Billion MPN/Year
Total Load Using Allowance Criteria	10,733	Billion MPN/Year
Non-allowable Exceedance Load	9,914	Billion MPN/Year
Required Annual Load Reduction	92.4%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-35. Total coliform load duration curve and TMDL results for subwatershed 306 – TMDL



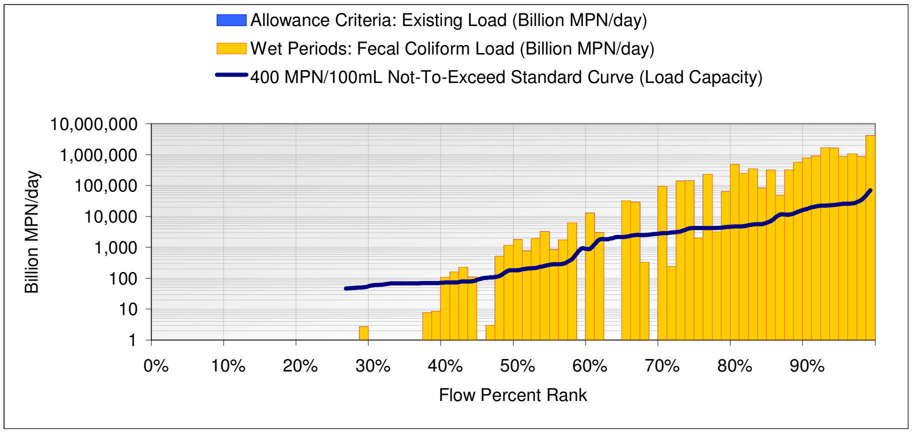
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	485	Billion MPN/Year
Total Load for Existing Condition	251,988	Billion MPN/Year
Total Load Using Allowance Criteria	251,988	Billion MPN/Year
Non-allowable Exceedance Load	251,517	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-36. Enterococcus load duration curve and TMDL results for subwatershed 306 – TMDL



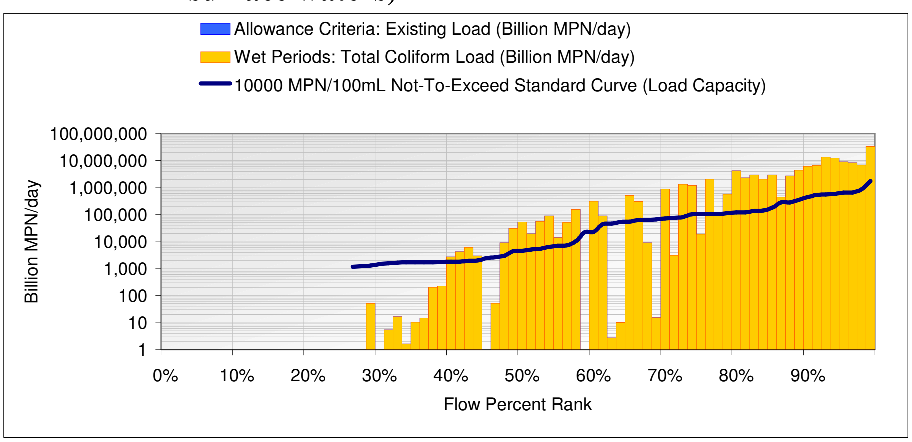
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	219	Billion MPN/Year
Total Load for Existing Condition	22,629	Billion MPN/Year
Total Load Using Allowance Criteria	22,629	Billion MPN/Year
Non-allowable Exceedance Load	22,416	Billion MPN/Year
Required Annual Load Reduction	99.1%	Percentage
Wet Day Exceedances	33	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	33	None

Table L-37. Fecal coliform load duration curve and TMDL results for subwatershed 401 – TMDL



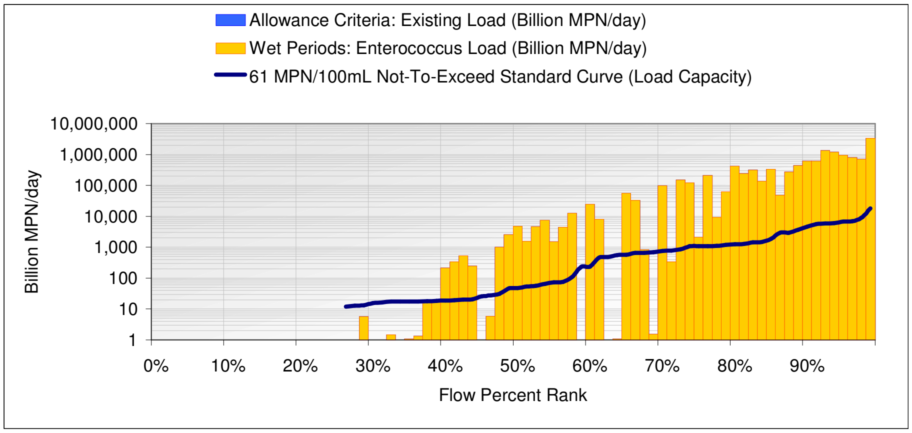
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	381,639	Billion MPN/Year
Total Load for Existing Condition	15,304,790	Billion MPN/Year
Total Load Using Allowance Criteria	15,304,790	Billion MPN/Year
Non-allowable Exceedance Load	14,946,381	Billion MPN/Year
Required Annual Load Reduction	97.7%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	50	None

Table L-38. Total coliform load duration curve and TMDL results for subwatershed 401 – TMDL (based on numeric target for inland surface waters)



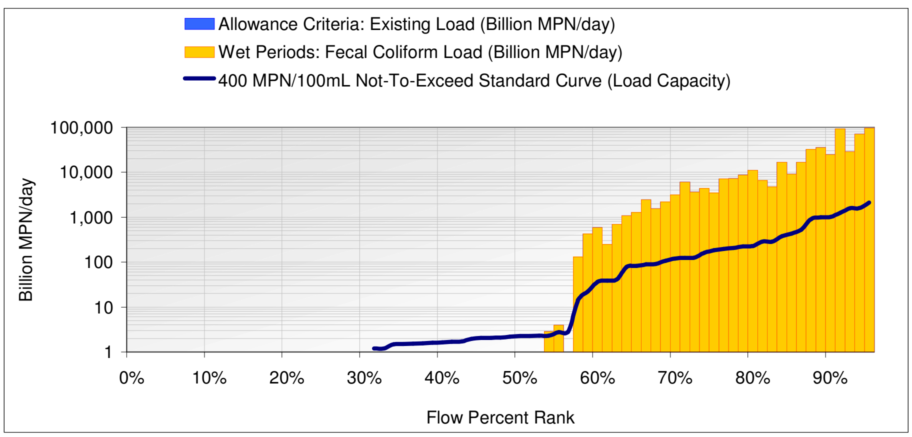
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	9,540,977	Billion MPN/Year
Total Load for Existing Condition	130,258,863	Billion MPN/Year
Total Load Using Allowance Criteria	130,258,863	Billion MPN/Year
Non-allowable Exceedance Load	121,311,749	Billion MPN/Year
Required Annual Load Reduction	93.1%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	50	None

Table L-39. Enterococcus load duration curve and TMDL results for subwatershed 401 – TMDL (based on numeric target for inland surface waters)



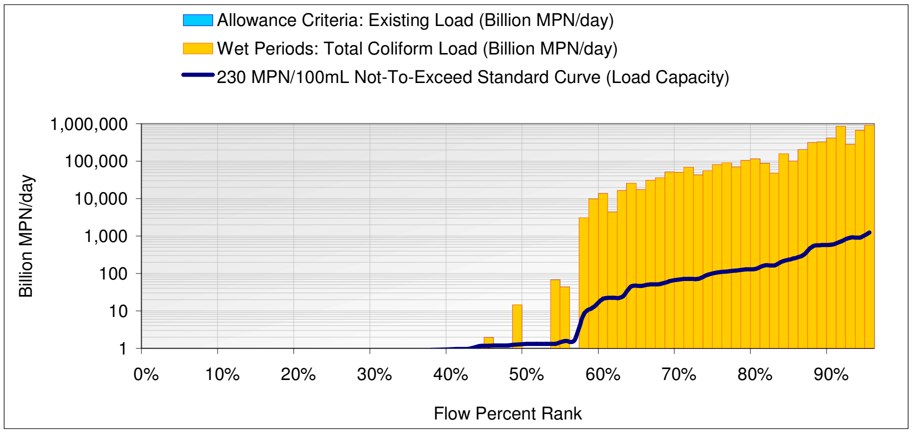
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	58,200	Billion MPN/Year
Total Load for Existing Condition	12,980,098	Billion MPN/Year
Total Load Using Allowance Criteria	12,980,098	Billion MPN/Year
Non-allowable Exceedance Load	12,923,979	Billion MPN/Year
Required Annual Load Reduction	99.6%	Percentage
Wet Day Exceedances	56	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	56	None

Table L-40. Fecal coliform load duration curve and TMDL results for subwatershed 501 – TMDL



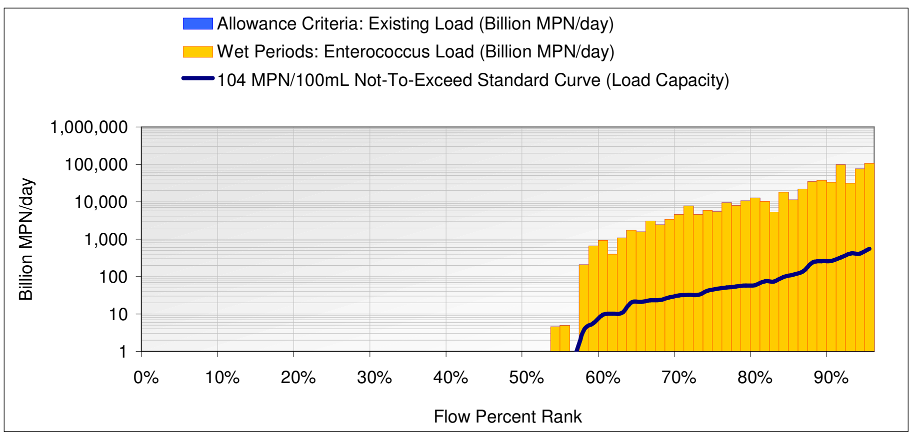
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	13,761	Billion MPN/Year
Total Load for Existing Condition	503,463	Billion MPN/Year
Total Load Using Allowance Criteria	503,463	Billion MPN/Year
Non-allowable Exceedance Load	489,757	Billion MPN/Year
Required Annual Load Reduction	97.3%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	42	None

Table L-41. Total coliform load duration curve and TMDL results for subwatershed 501 – TMDL



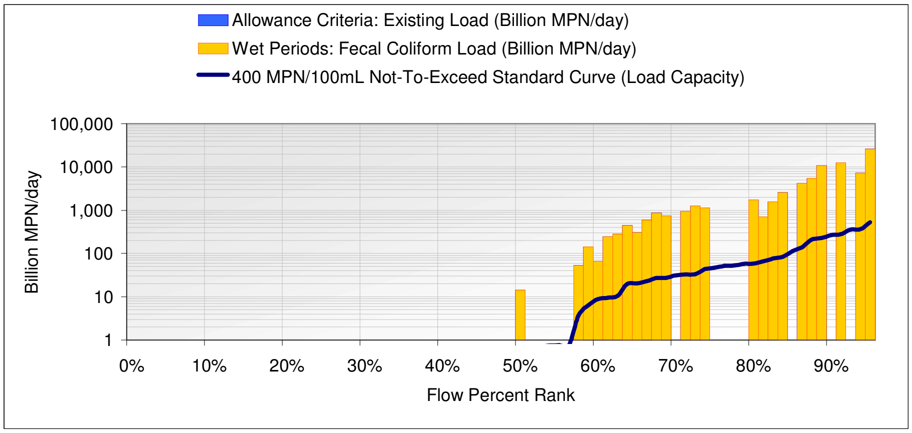
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	7,912	Billion MPN/Year
Total Load for Existing Condition	5,276,541	Billion MPN/Year
Total Load Using Allowance Criteria	5,276,541	Billion MPN/Year
Non-allowable Exceedance Load	5,268,651	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	48	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	48	None

Table L-42. Enterococcus load duration curve and TMDL results for subwatershed 501 – TMDL



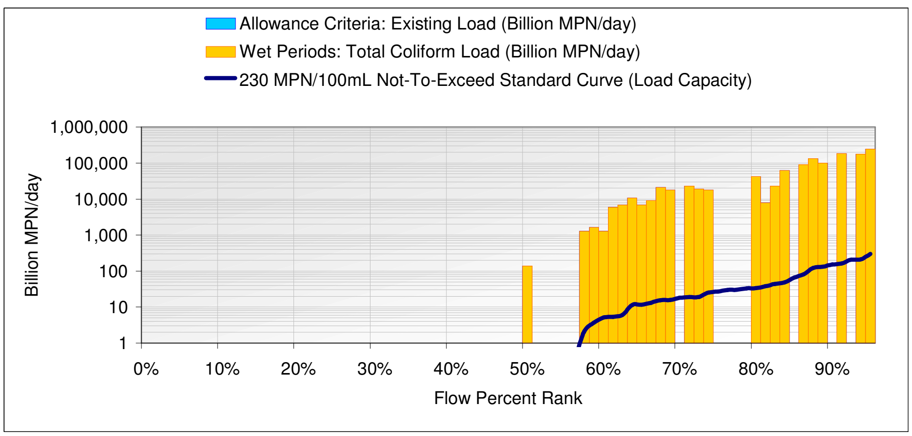
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	3,578	Billion MPN/Year
Total Load for Existing Condition	570,531	Billion MPN/Year
Total Load Using Allowance Criteria	570,531	Billion MPN/Year
Non-allowable Exceedance Load	566,966	Billion MPN/Year
Required Annual Load Reduction	99.4%	Percentage
Wet Day Exceedances	44	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	44	None

Table L-43. Fecal coliform load duration curve and TMDL results for subwatershed 502 – TMDL



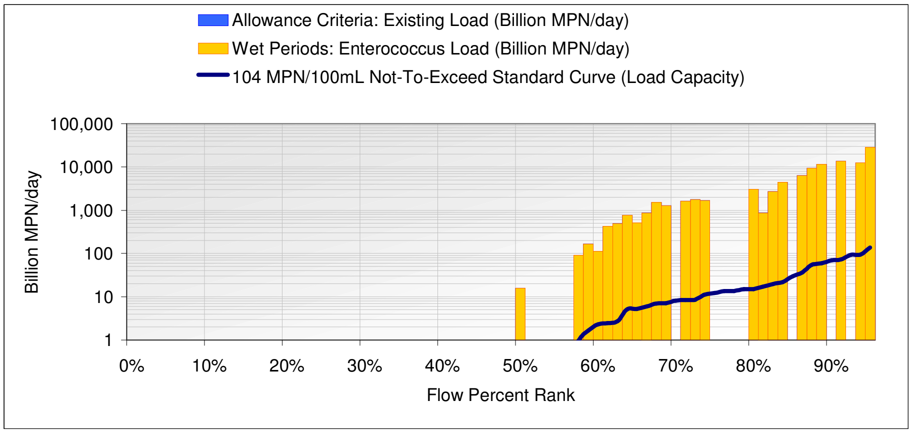
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	3,342	Billion MPN/Year
Total Load for Existing Condition	81,333	Billion MPN/Year
Total Load Using Allowance Criteria	81,333	Billion MPN/Year
Non-allowable Exceedance Load	78,993	Billion MPN/Year
Required Annual Load Reduction	97.1%	Percentage
Wet Day Exceedances	30	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	30	None

Table L-44. Total coliform load duration curve and TMDL results for subwatershed 502 – TMDL



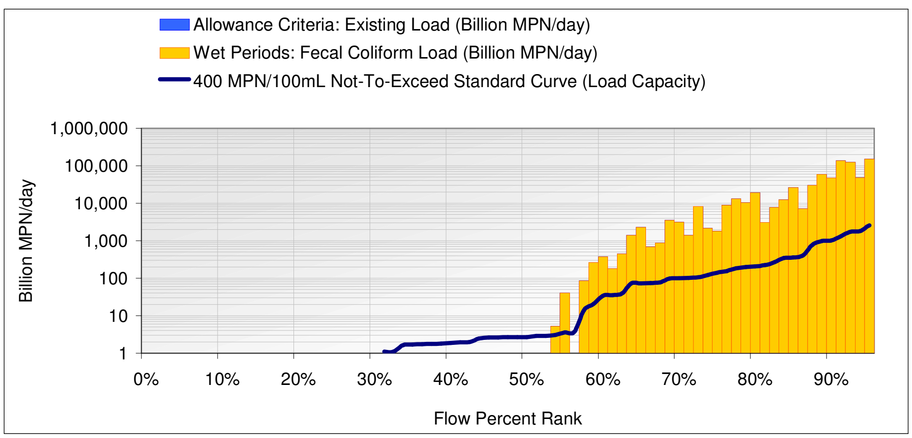
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,922	Billion MPN/Year
Total Load for Existing Condition	1,216,982	Billion MPN/Year
Total Load Using Allowance Criteria	1,216,982	Billion MPN/Year
Non-allowable Exceedance Load	1,215,636	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	31	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	31	None

Table L-45. Enterococcus load duration curve and TMDL results for subwatershed 502 – TMDL



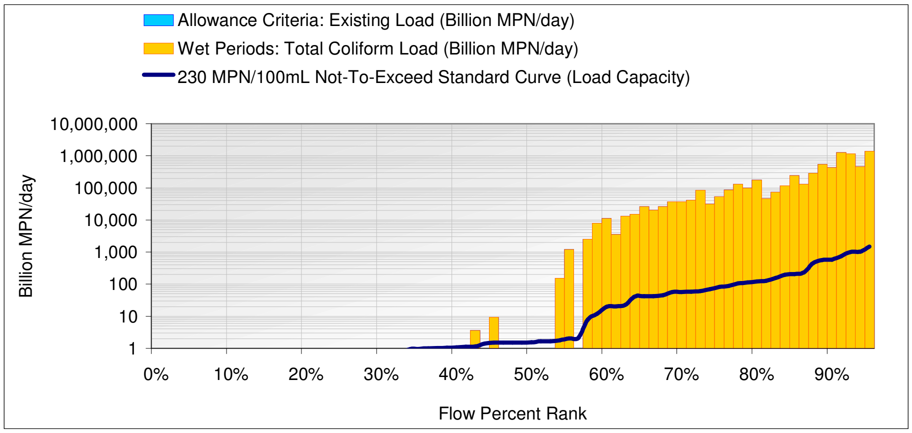
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	869	Billion MPN/Year
Total Load for Existing Condition	105,718	Billion MPN/Year
Total Load Using Allowance Criteria	105,718	Billion MPN/Year
Non-allowable Exceedance Load	105,110	Billion MPN/Year
Required Annual Load Reduction	99.4%	Percentage
Wet Day Exceedances	31	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	31	None

Table L-46. Fecal coliform load duration curve and TMDL results for subwatershed 503 – TMDL



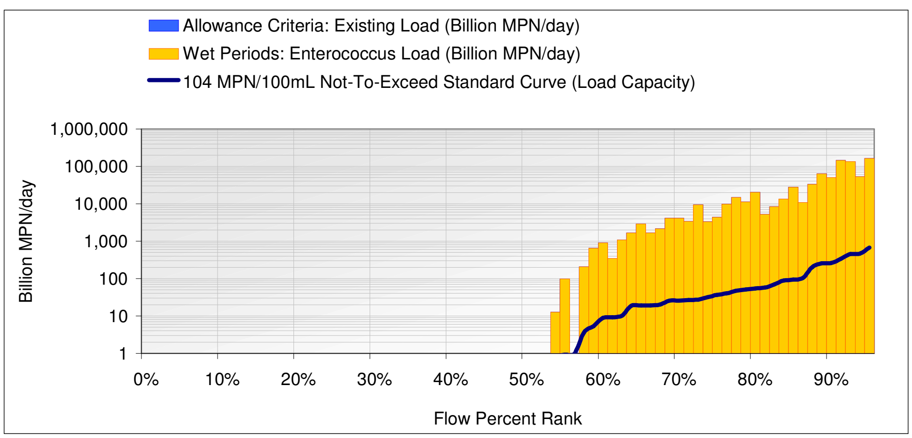
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	13,867	Billion MPN/Year
Total Load for Existing Condition	736,628	Billion MPN/Year
Total Load Using Allowance Criteria	736,628	Billion MPN/Year
Non-allowable Exceedance Load	722,826	Billion MPN/Year
Required Annual Load Reduction	98.1%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	42	None

Table L-47. Total coliform load duration curve and TMDL results for subwatershed 503 – TMDL



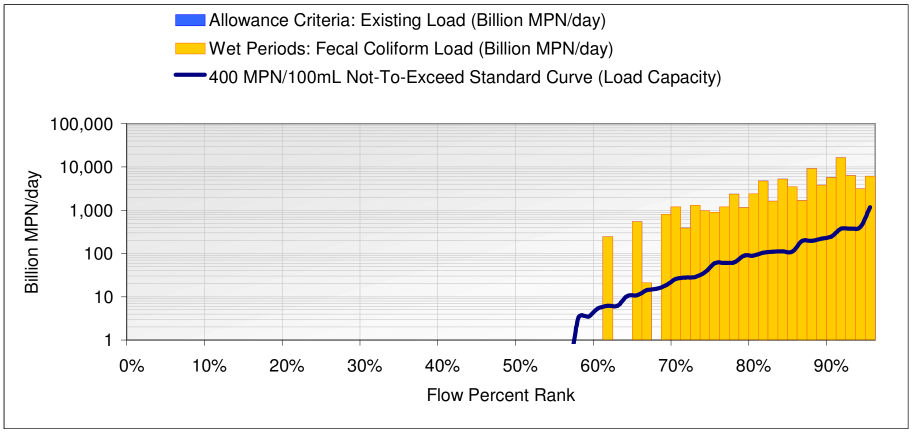
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	7,974	Billion MPN/Year
Total Load for Existing Condition	7,101,860	Billion MPN/Year
Total Load Using Allowance Criteria	7,101,860	Billion MPN/Year
Non-allowable Exceedance Load	7,093,912	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	50	None

Table L-48. Enterococcus load duration curve and TMDL results for subwatershed 503 – TMDL



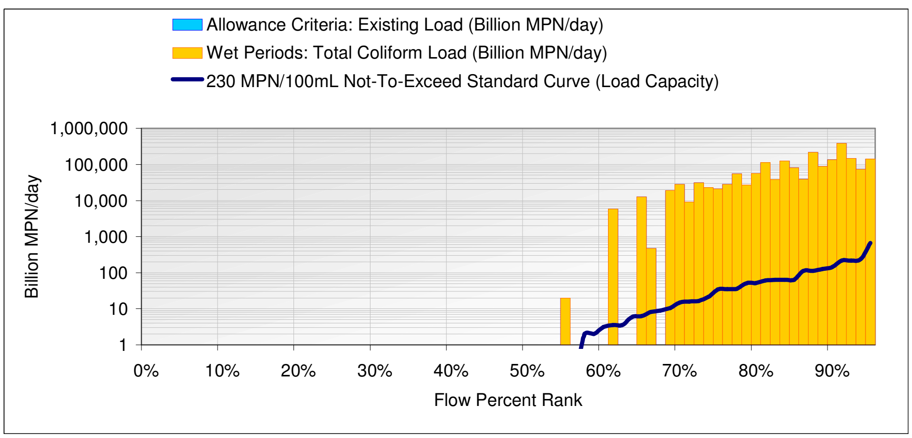
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	3,605	Billion MPN/Year
Total Load for Existing Condition	806,852	Billion MPN/Year
Total Load Using Allowance Criteria	806,852	Billion MPN/Year
Non-allowable Exceedance Load	803,260	Billion MPN/Year
Required Annual Load Reduction	99.6%	Percentage
Wet Day Exceedances	46	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	46	None

Table L-49. Fecal coliform load duration curve and TMDL results for subwatershed 504 – TMDL



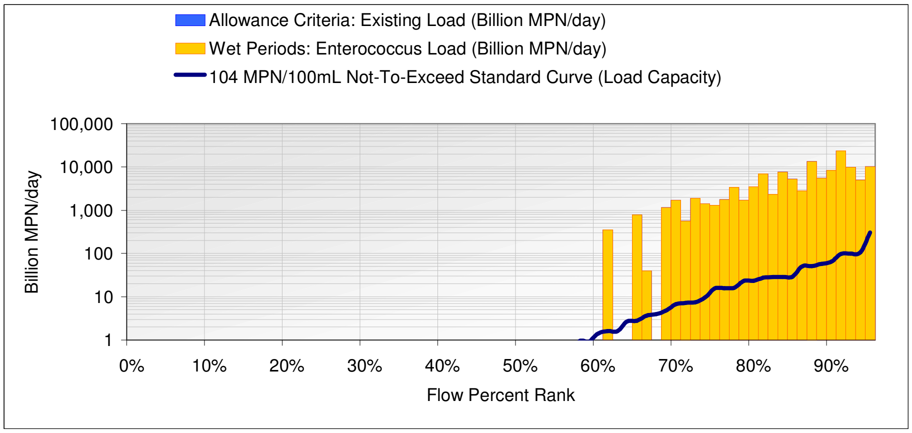
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	4,235	Billion MPN/Year
Total Load for Existing Condition	81,576	Billion MPN/Year
Total Load Using Allowance Criteria	81,576	Billion MPN/Year
Non-allowable Exceedance Load	77,404	Billion MPN/Year
Required Annual Load Reduction	94.9%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-50. Total coliform load duration curve and TMDL results for subwatershed 504 – TMDL



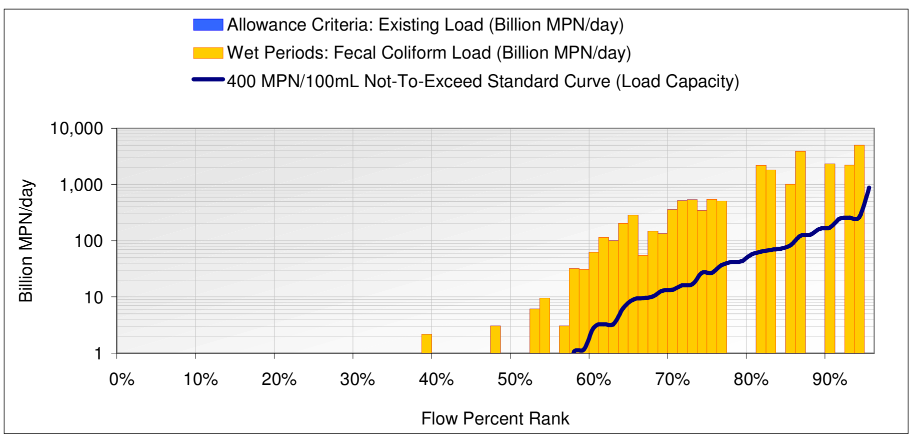
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,435	Billion MPN/Year
Total Load for Existing Condition	1,903,632	Billion MPN/Year
Total Load Using Allowance Criteria	1,903,632	Billion MPN/Year
Non-allowable Exceedance Load	1,901,233	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-51. Enterococcus load duration curve and TMDL results for subwatershed 504 – TMDL



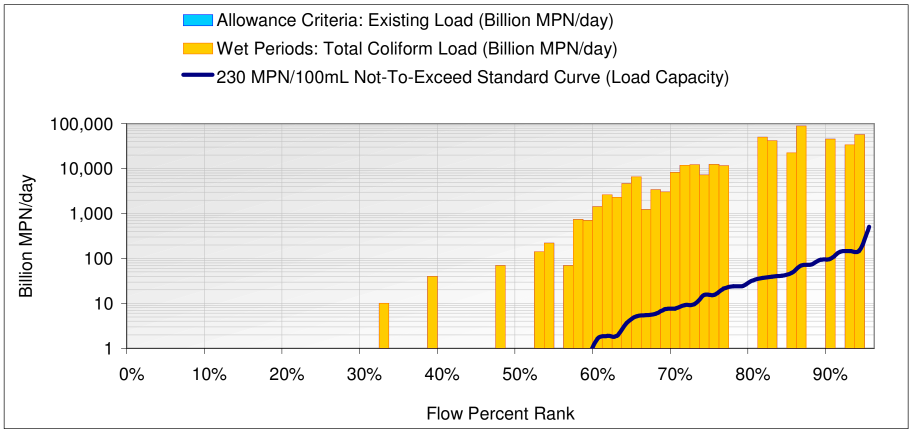
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,101	Billion MPN/Year
Total Load for Existing Condition	120,842	Billion MPN/Year
Total Load Using Allowance Criteria	120,842	Billion MPN/Year
Non-allowable Exceedance Load	119,757	Billion MPN/Year
Required Annual Load Reduction	99.1%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-52. Fecal coliform load duration curve and TMDL results for subwatershed 505 – TMDL



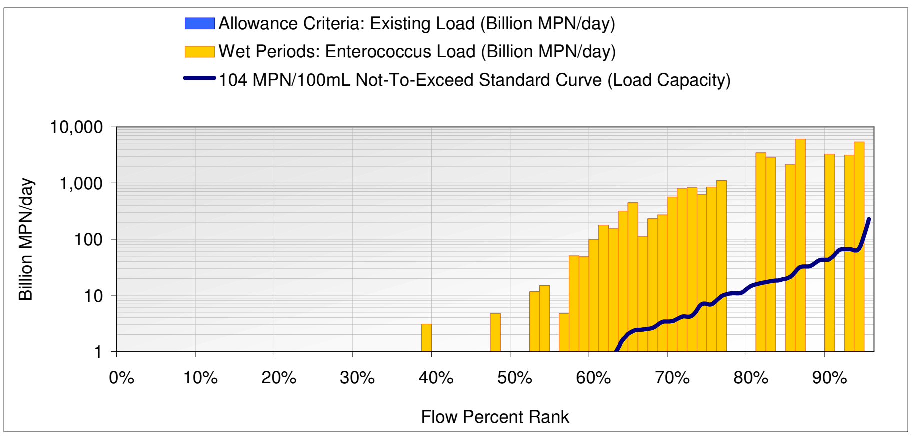
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,875	Billion MPN/Year
Total Load for Existing Condition	22,705	Billion MPN/Year
Total Load Using Allowance Criteria	22,705	Billion MPN/Year
Non-allowable Exceedance Load	21,471	Billion MPN/Year
Required Annual Load Reduction	94.6%	Percentage
Wet Day Exceedances	35	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	35	None

Table L-53. Total coliform load duration curve and TMDL results for subwatershed 505 – TMDL



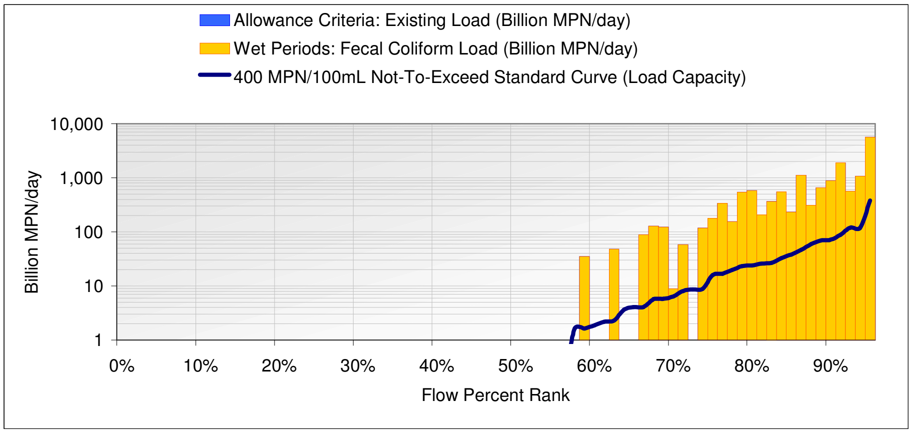
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,653	Billion MPN/Year
Total Load for Existing Condition	439,306	Billion MPN/Year
Total Load Using Allowance Criteria	439,306	Billion MPN/Year
Non-allowable Exceedance Load	438,596	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	35	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	35	None

Table L-54. Enterococcus load duration curve and TMDL results for subwatershed 505 – TMDL



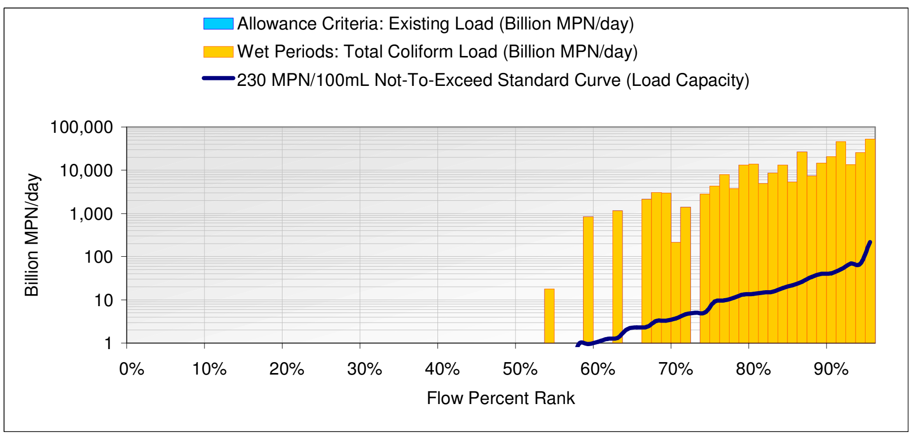
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	747	Billion MPN/Year
Total Load for Existing Condition	33,570	Billion MPN/Year
Total Load Using Allowance Criteria	33,570	Billion MPN/Year
Non-allowable Exceedance Load	33,249	Billion MPN/Year
Required Annual Load Reduction	99.0%	Percentage
Wet Day Exceedances	35	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	35	None

Table L-55. Fecal coliform load duration curve and TMDL results for subwatershed 506 – TMDL



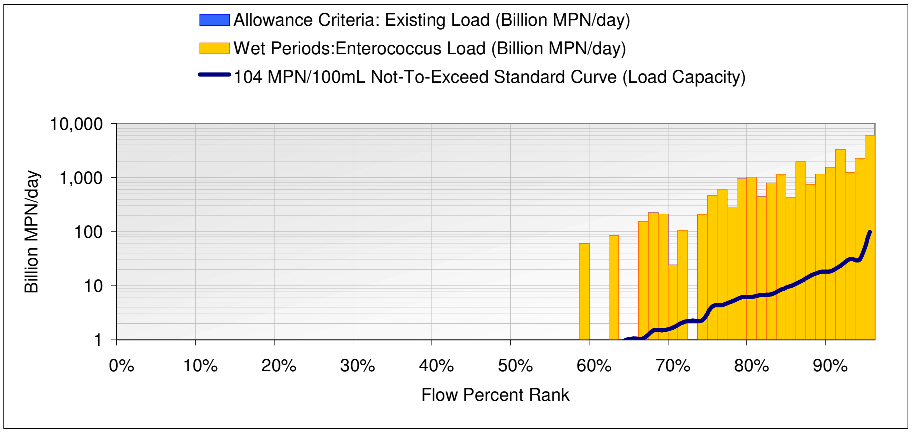
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,259	Billion MPN/Year
Total Load for Existing Condition	16,014	Billion MPN/Year
Total Load Using Allowance Criteria	16,014	Billion MPN/Year
Non-allowable Exceedance Load	14,788	Billion MPN/Year
Required Annual Load Reduction	92.3%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-56. Total coliform load duration curve and TMDL results for subwatershed 506 – TMDL



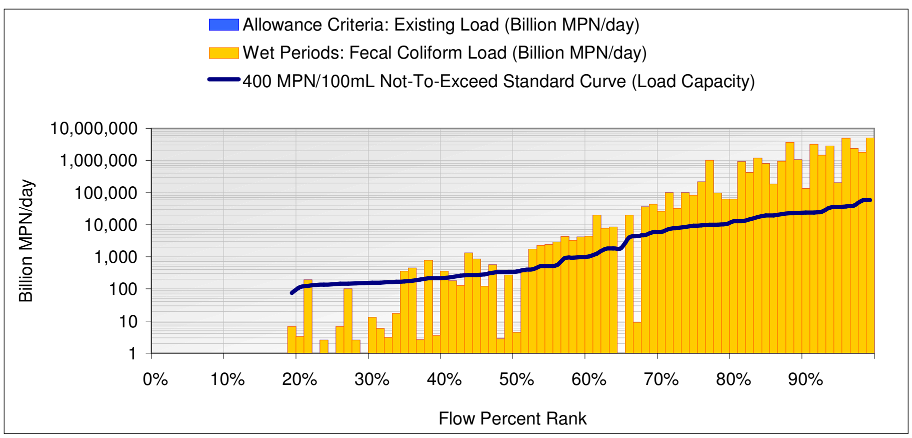
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	724	Billion MPN/Year
Total Load for Existing Condition	298,219	Billion MPN/Year
Total Load Using Allowance Criteria	298,219	Billion MPN/Year
Non-allowable Exceedance Load	297,513	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-57. Enterococcus load duration curve and TMDL results for subwatershed 506 – TMDL



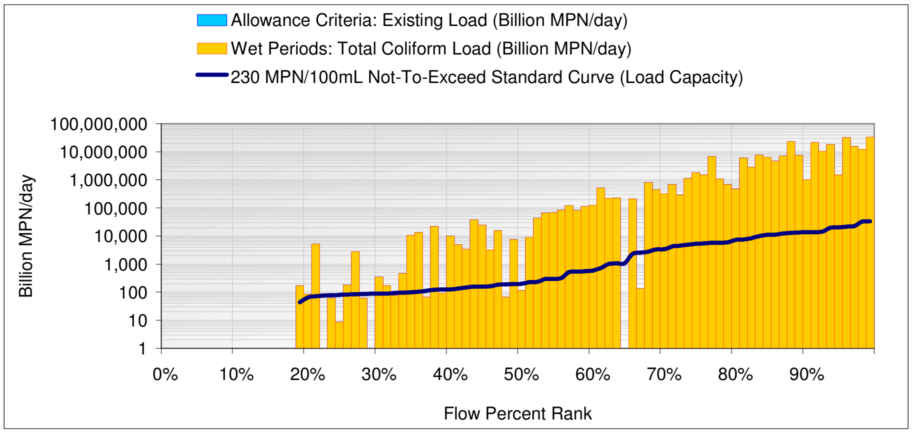
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	327	Billion MPN/Year
Total Load for Existing Condition	25,580	Billion MPN/Year
Total Load Using Allowance Criteria	25,580	Billion MPN/Year
Non-allowable Exceedance Load	25,262	Billion MPN/Year
Required Annual Load Reduction	98.8%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-58. Fecal coliform load duration curve and TMDL results for subwatershed 701 – TMDL



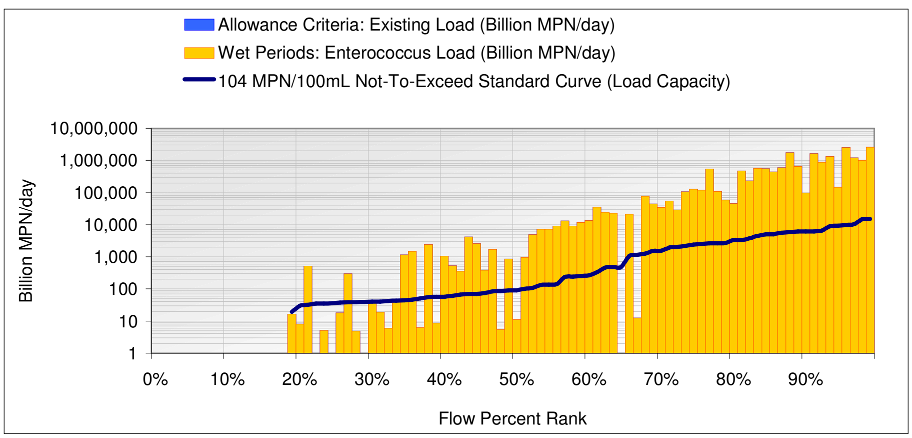
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	662,782	Billion MPN/Year
Total Load for Existing Condition	33,120,012	Billion MPN/Year
Total Load Using Allowance Criteria	33,120,012	Billion MPN/Year
Non-allowable Exceedance Load	32,478,189	Billion MPN/Year
Required Annual Load Reduction	98.1%	Percentage
Wet Day Exceedances	56	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	56	None

Table L-59. Total coliform load duration curve and TMDL results for subwatershed 701 – TMDL



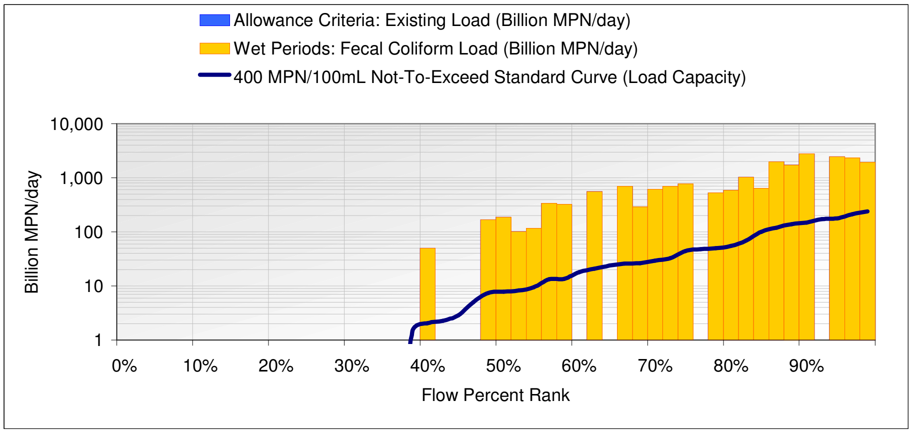
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	381,100	Billion MPN/Year
Total Load for Existing Condition	231,598,677	Billion MPN/Year
Total Load Using Allowance Criteria	231,598,677	Billion MPN/Year
Non-allowable Exceedance Load	231,158,330	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	61	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	61	None

Table L-60. Enterococcus load duration curve and TMDL results for subwatershed 701 – TMDL



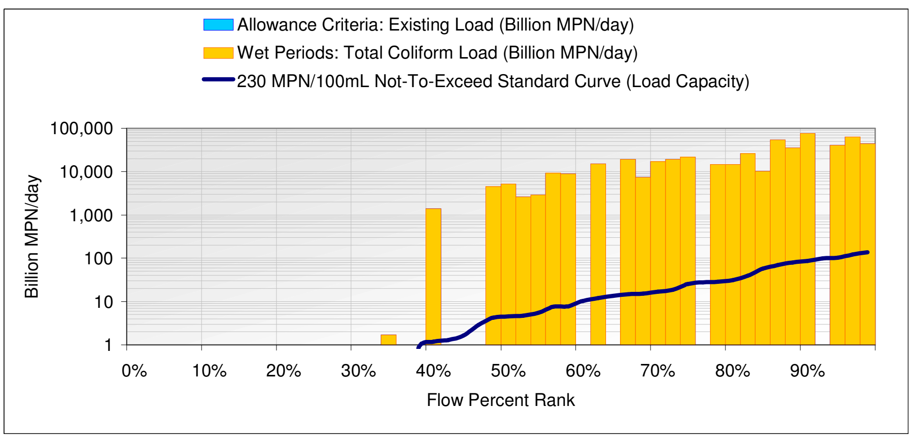
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	172,323	Billion MPN/Year
Total Load for Existing Condition	18,439,920	Billion MPN/Year
Total Load Using Allowance Criteria	18,439,920	Billion MPN/Year
Non-allowable Exceedance Load	18,265,699	Billion MPN/Year
Required Annual Load Reduction	99.1%	Percentage
Wet Day Exceedances	60	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	60	None

Table L-61. Fecal coliform load duration curve and TMDL results for subwatershed 1101 – TMDL



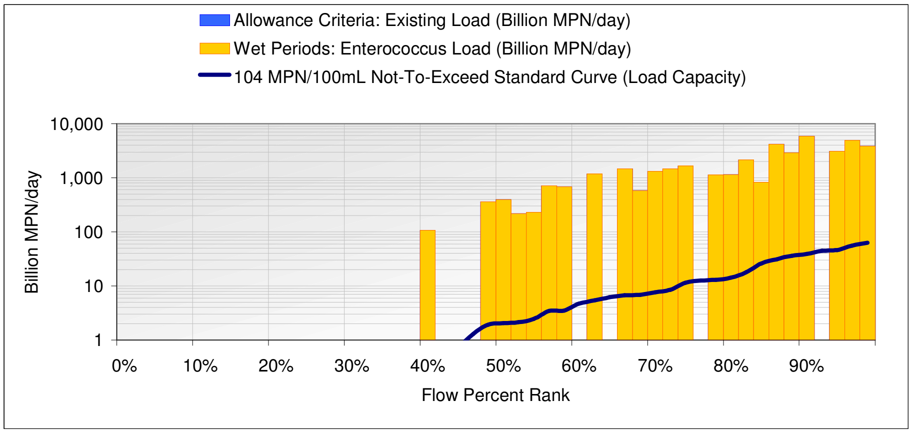
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,845	Billion MPN/Year
Total Load for Existing Condition	20,886	Billion MPN/Year
Total Load Using Allowance Criteria	20,886	Billion MPN/Year
Non-allowable Exceedance Load	19,327	Billion MPN/Year
Required Annual Load Reduction	92.5%	Percentage
Wet Day Exceedances	48	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	48	None

Table L-62. Total coliform load duration curve and TMDL results for subwatershed 1101 – TMDL



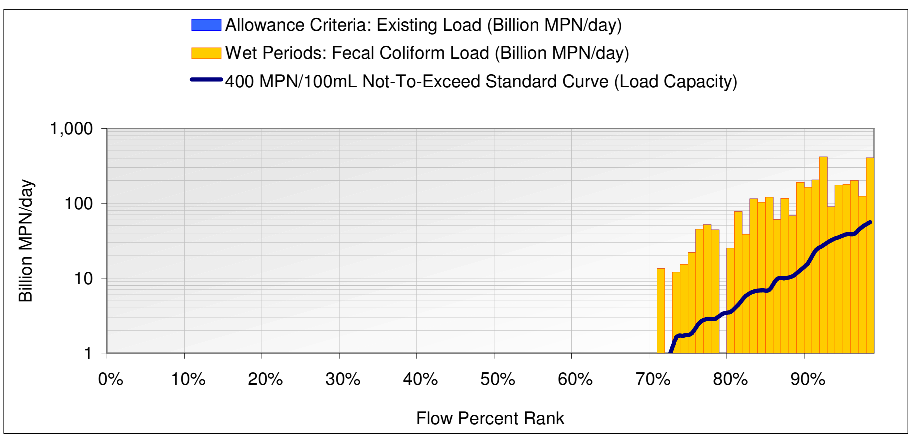
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,061	Billion MPN/Year
Total Load for Existing Condition	515,278	Billion MPN/Year
Total Load Using Allowance Criteria	515,278	Billion MPN/Year
Non-allowable Exceedance Load	514,380	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	49	None

Table L-63. Enterococcus load duration curve and TMDL results for subwatershed 1101 – TMDL



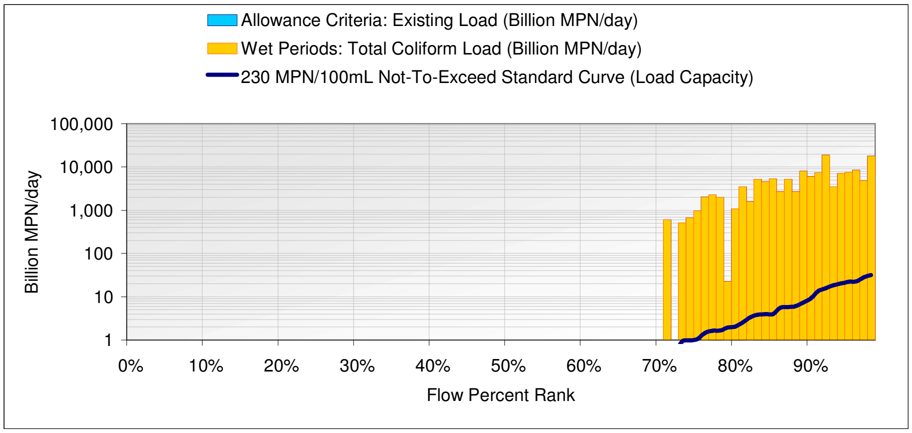
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	480	Billion MPN/Year
Total Load for Existing Condition	40,558	Billion MPN/Year
Total Load Using Allowance Criteria	40,558	Billion MPN/Year
Non-allowable Exceedance Load	40,152	Billion MPN/Year
Required Annual Load Reduction	99.0%	Percentage
Wet Day Exceedances	49	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	49	None

Table L-64. Fecal coliform load duration curve and TMDL results for subwatershed 1301 – TMDL



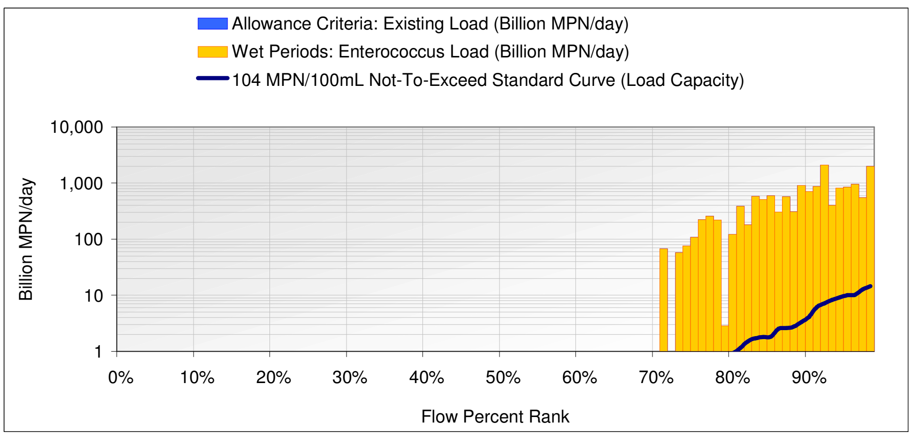
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	418	Billion MPN/Year
Total Load for Existing Condition	3,081	Billion MPN/Year
Total Load Using Allowance Criteria	3,081	Billion MPN/Year
Non-allowable Exceedance Load	2,672	Billion MPN/Year
Required Annual Load Reduction	86.7%	Percentage
Wet Day Exceedances	27	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	27	None

Table L-65. Total coliform load duration curve and TMDL results for subwatershed 1301 – TMDL



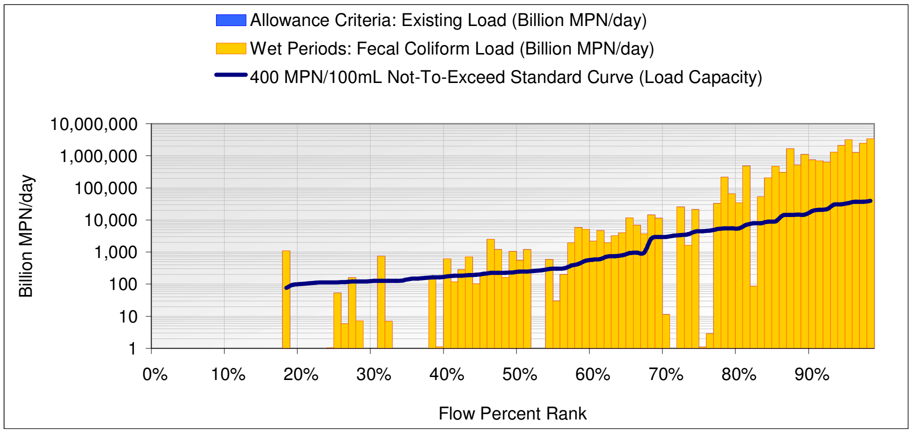
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	240	Billion MPN/Year
Total Load for Existing Condition	130,532	Billion MPN/Year
Total Load Using Allowance Criteria	130,532	Billion MPN/Year
Non-allowable Exceedance Load	130,295	Billion MPN/Year
Required Annual Load Reduction	99.8%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-66. Enterococcus load duration curve and TMDL results for subwatershed 1301 – TMDL



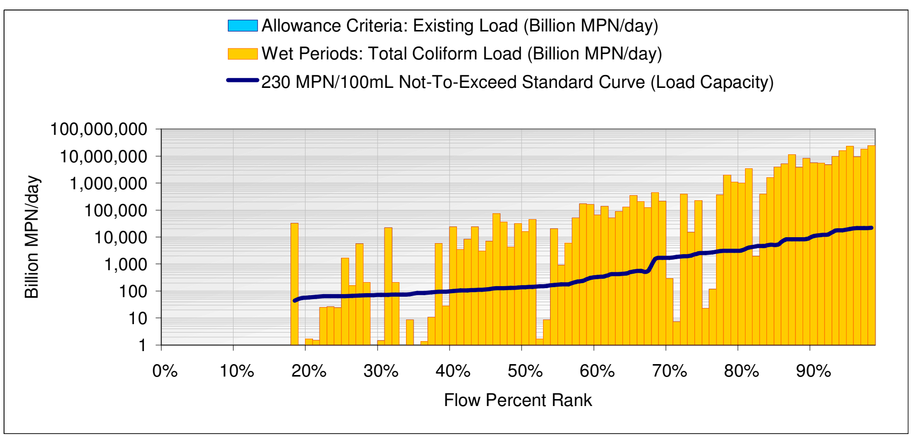
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	109	Billion MPN/Year
Total Load for Existing Condition	14,763	Billion MPN/Year
Total Load Using Allowance Criteria	14,763	Billion MPN/Year
Non-allowable Exceedance Load	14,656	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	28	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	28	None

Table L-67. Fecal coliform load duration curve and TMDL results for subwatershed 1302 – TMDL



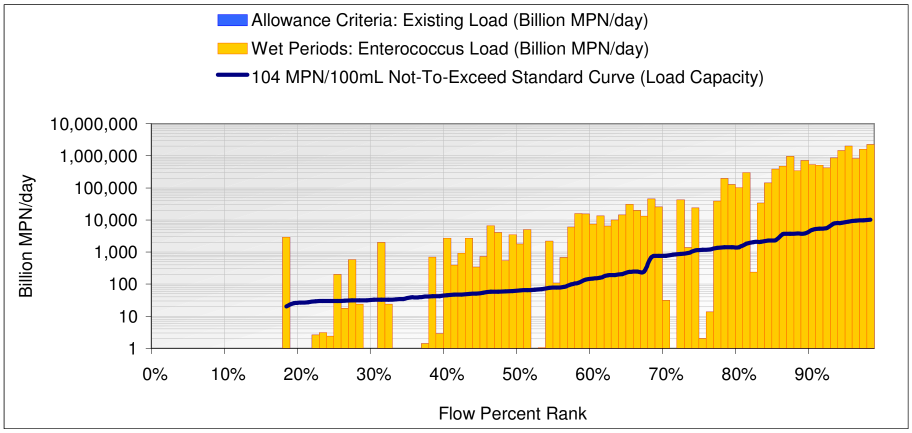
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	467,420	Billion MPN/Year
Total Load for Existing Condition	21,283,828	Billion MPN/Year
Total Load Using Allowance Criteria	21,283,828	Billion MPN/Year
Non-allowable Exceedance Load	20,853,235	Billion MPN/Year
Required Annual Load Reduction	98.0%	Percentage
Wet Day Exceedances	50	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	50	None

Table L-68. Total coliform load duration curve and TMDL results for subwatershed 1302 – TMDL



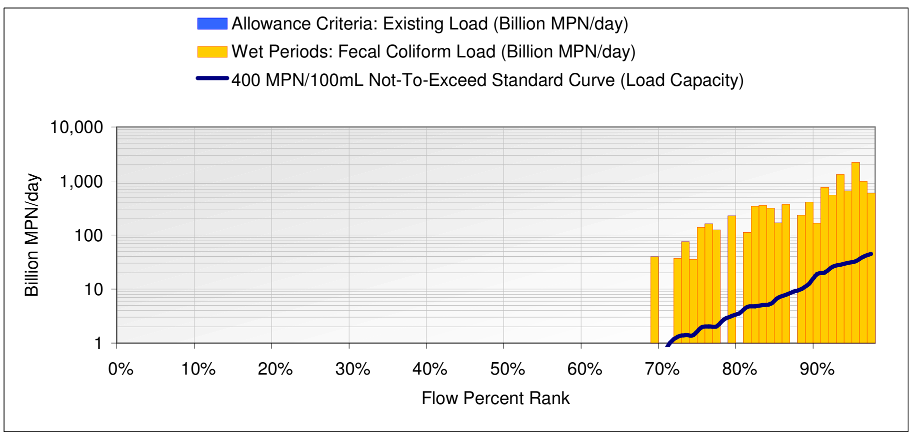
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	268,767	Billion MPN/Year
Total Load for Existing Condition	163,410,600	Billion MPN/Year
Total Load Using Allowance Criteria	163,410,600	Billion MPN/Year
Non-allowable Exceedance Load	162,948,951	Billion MPN/Year
Required Annual Load Reduction	99.7%	Percentage
Wet Day Exceedances	58	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	58	None

Table L-69. Enterococcus load duration curve and TMDL results for subwatershed 1302 – TMDL



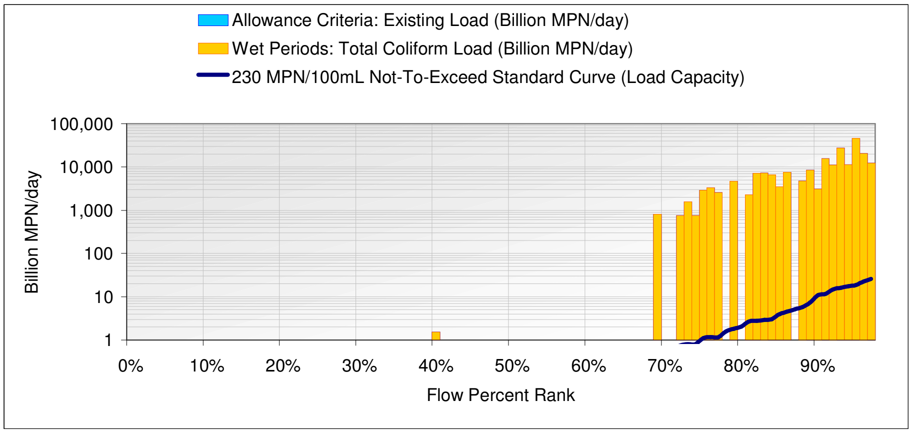
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	121,529	Billion MPN/Year
Total Load for Existing Condition	14,781,447	Billion MPN/Year
Total Load Using Allowance Criteria	14,781,447	Billion MPN/Year
Non-allowable Exceedance Load	14,648,024	Billion MPN/Year
Required Annual Load Reduction	99.1%	Percentage
Wet Day Exceedances	57	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	57	None

Table L-70. Fecal coliform load duration curve and TMDL results for subwatershed 1401 – TMDL



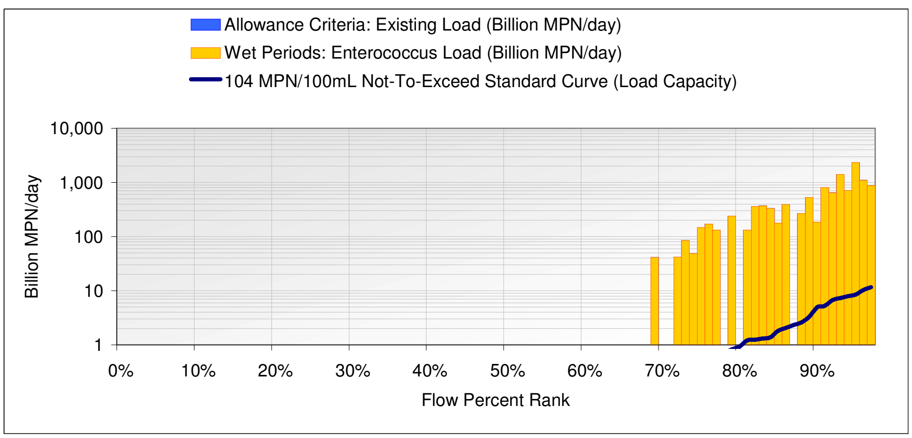
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	335	Billion MPN/Year
Total Load for Existing Condition	10,392	Billion MPN/Year
Total Load Using Allowance Criteria	10,392	Billion MPN/Year
Non-allowable Exceedance Load	10,079	Billion MPN/Year
Required Annual Load Reduction	97.0%	Percentage
Wet Day Exceedances	26	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	26	None

Table L-71. Total coliform load duration curve and TMDL results for subwatershed 1401 – TMDL



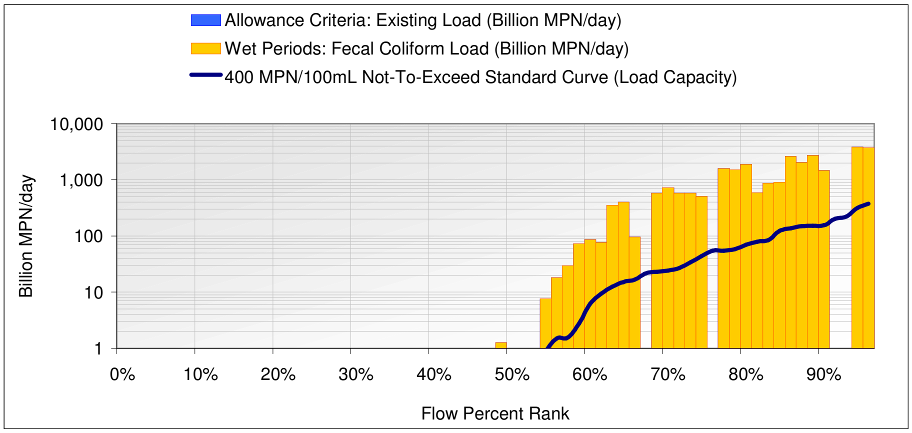
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	192	Billion MPN/Year
Total Load for Existing Condition	212,986	Billion MPN/Year
Total Load Using Allowance Criteria	212,986	Billion MPN/Year
Non-allowable Exceedance Load	212,805	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	26	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	26	None

Table L-72. Enterococcus load duration curve and TMDL results for subwatershed 1401 – TMDL



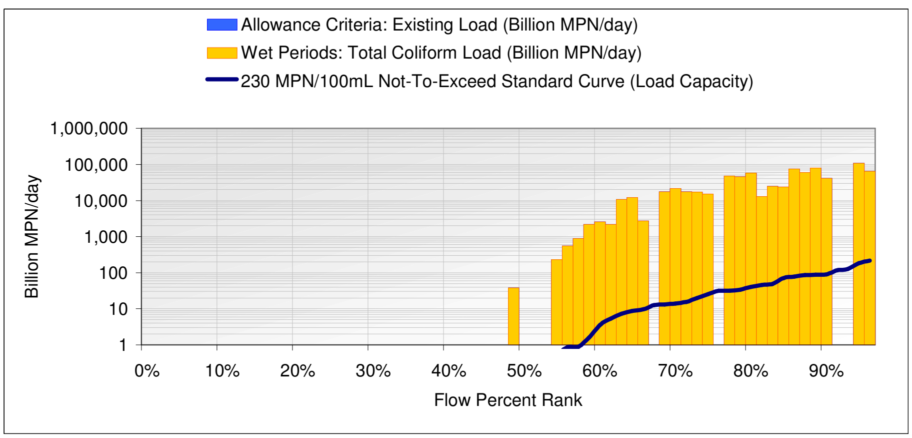
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	87	Billion MPN/Year
Total Load for Existing Condition	11,564	Billion MPN/Year
Total Load Using Allowance Criteria	11,564	Billion MPN/Year
Non-allowable Exceedance Load	11,483	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	26	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	26	None

Table L-73. Fecal coliform load duration curve and TMDL results for subwatershed 1501 – TMDL



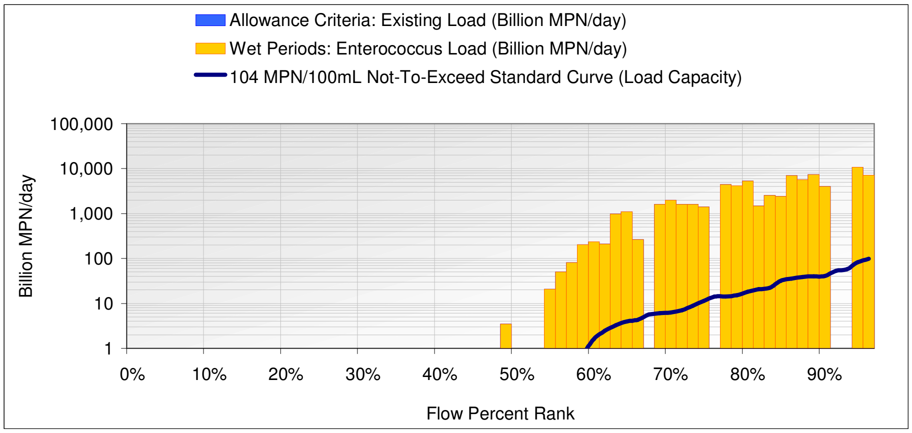
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,487	Billion MPN/Year
Total Load for Existing Condition	28,044	Billion MPN/Year
Total Load Using Allowance Criteria	28,044	Billion MPN/Year
Non-allowable Exceedance Load	26,061	Billion MPN/Year
Required Annual Load Reduction	92.9%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	41	None

Table L-74. Total coliform load duration curve and TMDL results for subwatershed 1501 – TMDL



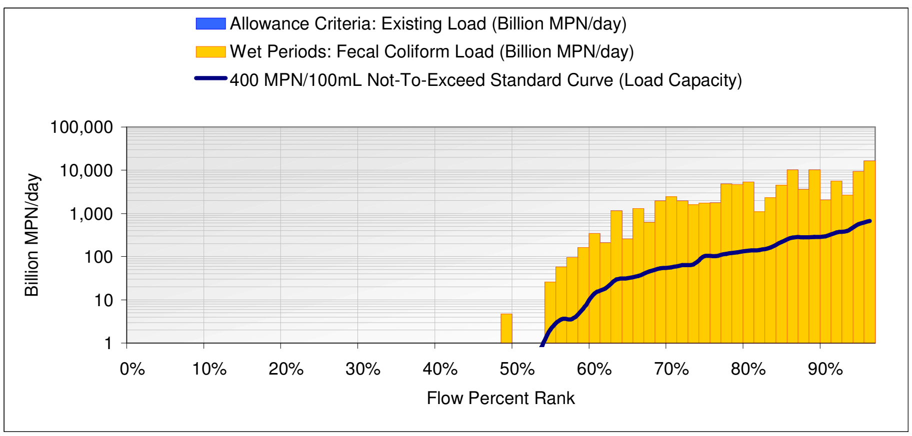
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,430	Billion MPN/Year
Total Load for Existing Condition	768,912	Billion MPN/Year
Total Load Using Allowance Criteria	768,912	Billion MPN/Year
Non-allowable Exceedance Load	767,772	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	41	None

Table L-75. Enterococcus load duration curve and TMDL results for subwatershed 1501 – TMDL



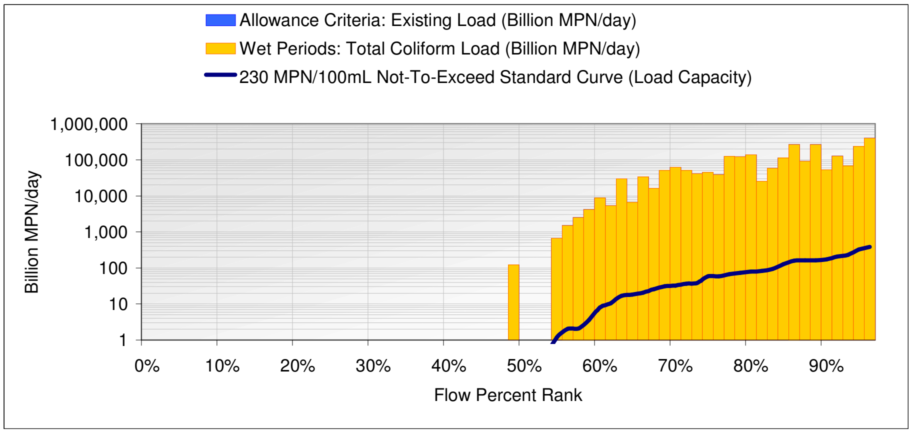
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	647	Billion MPN/Year
Total Load for Existing Condition	74,057	Billion MPN/Year
Total Load Using Allowance Criteria	74,057	Billion MPN/Year
Non-allowable Exceedance Load	73,541	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	41	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	41	None

Table L-76. Fecal coliform load duration curve and TMDL results for subwatershed 1503 – TMDL



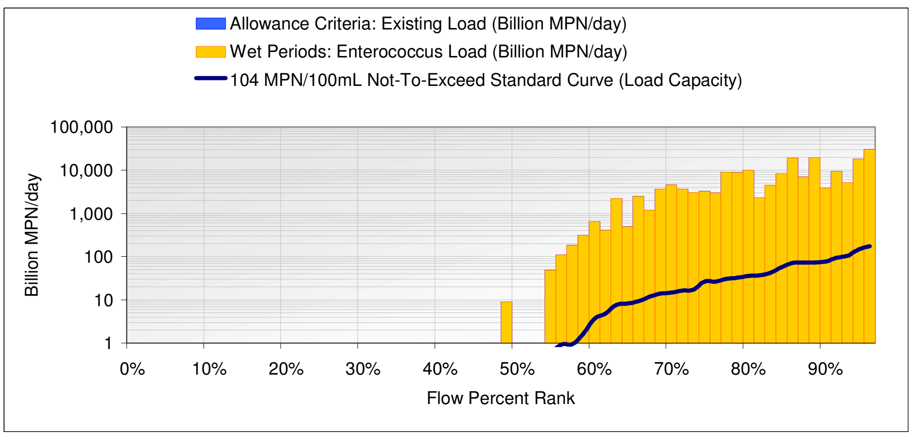
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	4,692	Billion MPN/Year
Total Load for Existing Condition	98,955	Billion MPN/Year
Total Load Using Allowance Criteria	98,955	Billion MPN/Year
Non-allowable Exceedance Load	94,272	Billion MPN/Year
Required Annual Load Reduction	95.3%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	45	None

Table L-77. Total coliform load duration curve and TMDL results for subwatershed 1503 – TMDL



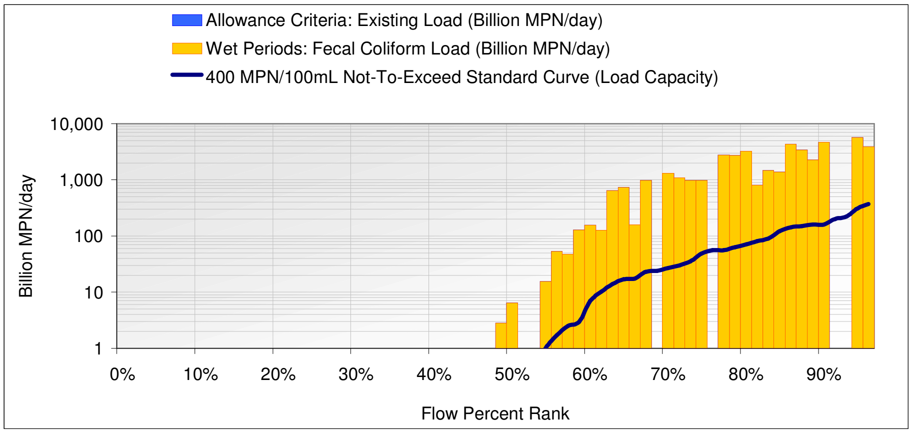
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,698	Billion MPN/Year
Total Load for Existing Condition	2,485,458	Billion MPN/Year
Total Load Using Allowance Criteria	2,485,458	Billion MPN/Year
Non-allowable Exceedance Load	2,482,765	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	45	None

Table L-78. Enterococcus load duration curve and TMDL results for subwatershed 1503 – TMDL



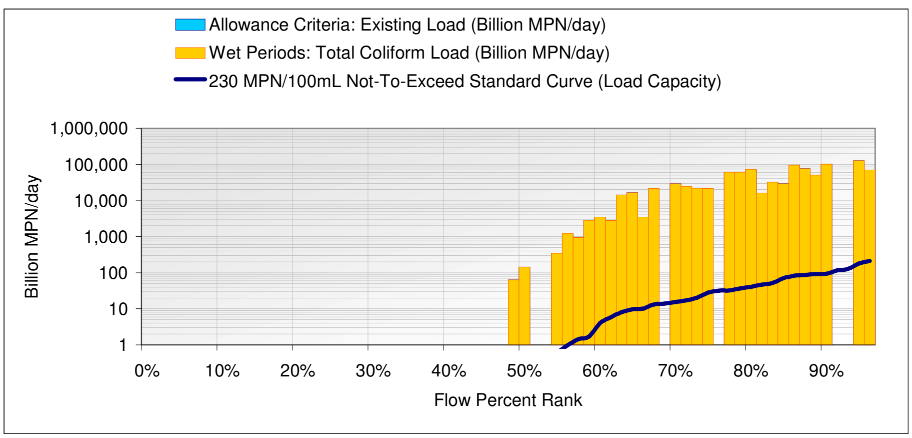
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,220	Billion MPN/Year
Total Load for Existing Condition	185,674	Billion MPN/Year
Total Load Using Allowance Criteria	185,674	Billion MPN/Year
Non-allowable Exceedance Load	184,457	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	45	None

Table L-79. Fecal coliform load duration curve and TMDL results for subwatershed 1505 – TMDL



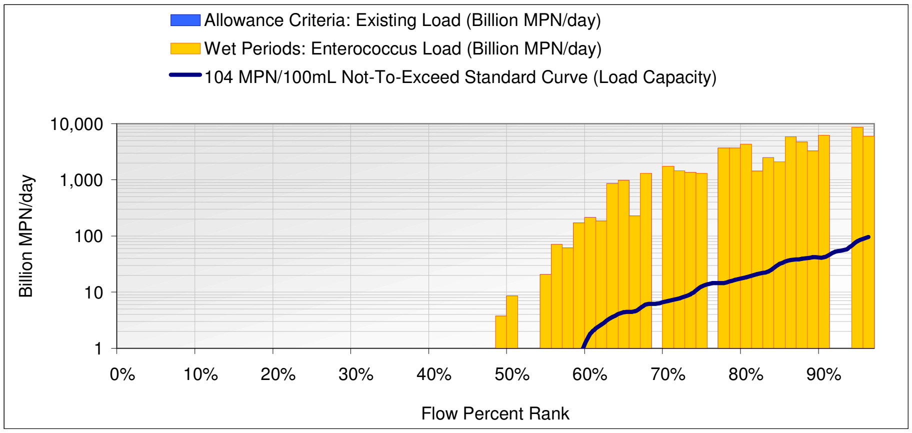
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,530	Billion MPN/Year
Total Load for Existing Condition	44,212	Billion MPN/Year
Total Load Using Allowance Criteria	44,212	Billion MPN/Year
Non-allowable Exceedance Load	42,190	Billion MPN/Year
Required Annual Load Reduction	95.4%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	42	None

Table L-80. Total coliform load duration curve and TMDL results for subwatershed 1505 – TMDL



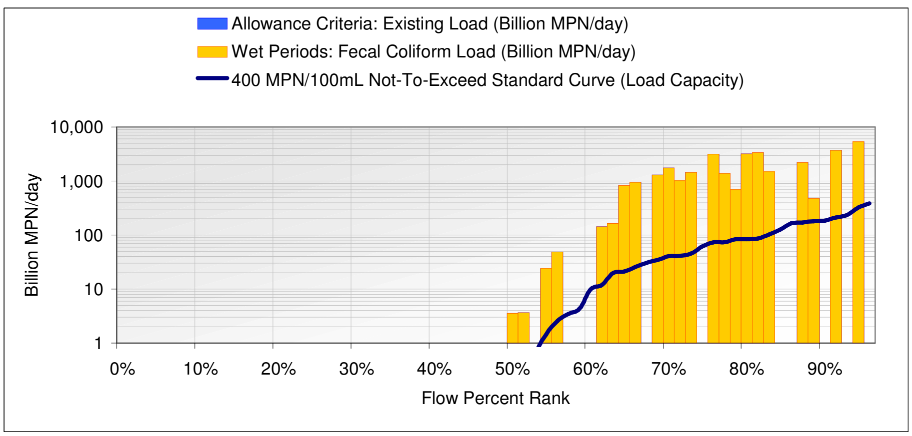
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,454	Billion MPN/Year
Total Load for Existing Condition	958,988	Billion MPN/Year
Total Load Using Allowance Criteria	958,988	Billion MPN/Year
Non-allowable Exceedance Load	957,825	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	42	None

Table L-81. Enterococcus load duration curve and TMDL results for subwatershed 1505 – TMDL



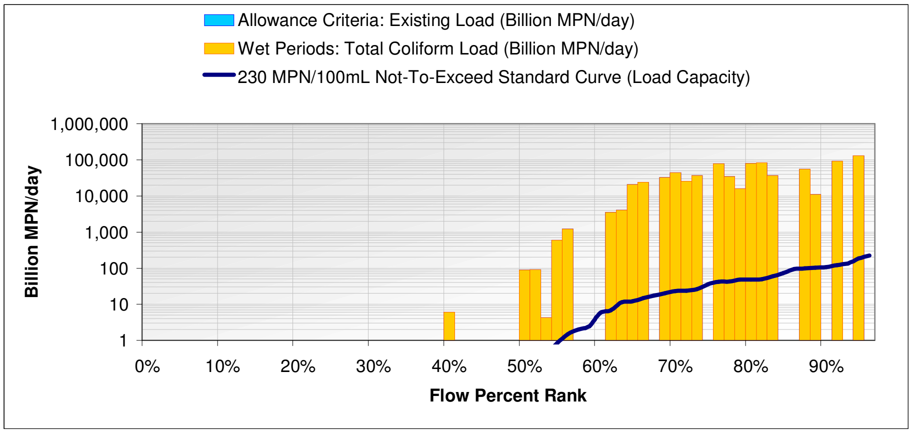
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	658	Billion MPN/Year
Total Load for Existing Condition	62,646	Billion MPN/Year
Total Load Using Allowance Criteria	62,646	Billion MPN/Year
Non-allowable Exceedance Load	62,120	Billion MPN/Year
Required Annual Load Reduction	99.2%	Percentage
Wet Day Exceedances	42	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	42	None

Table L-82. Fecal coliform load duration curve and TMDL results for subwatershed 1507 – TMDL



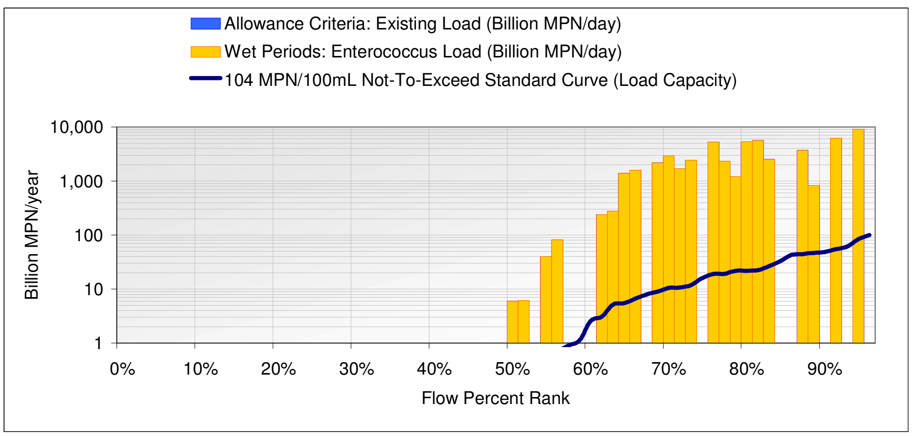
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	2,852	Billion MPN/Year
Total Load for Existing Condition	32,846	Billion MPN/Year
Total Load Using Allowance Criteria	32,846	Billion MPN/Year
Non-allowable Exceedance Load	31,206	Billion MPN/Year
Required Annual Load Reduction	95.0%	Percentage
Wet Day Exceedances	38	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	38	None

Table L-83. Total coliform load duration curve and TMDL results for subwatershed 1507 – TMDL



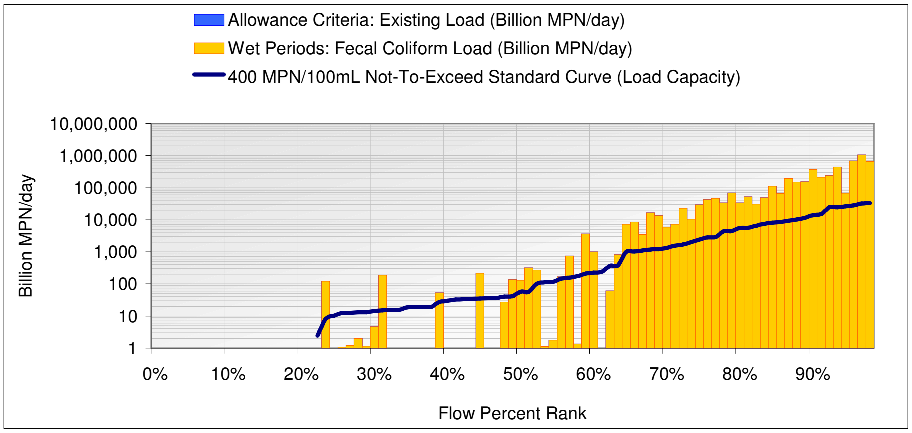
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,640	Billion MPN/Year
Total Load for Existing Condition	816,160	Billion MPN/Year
Total Load Using Allowance Criteria	816,160	Billion MPN/Year
Non-allowable Exceedance Load	815,216	Billion MPN/Year
Required Annual Load Reduction	99.9%	Percentage
Wet Day Exceedances	39	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	39	None

Table L-84. Enterococcus load duration curve and TMDL results for subwatershed 1507 – TMDL



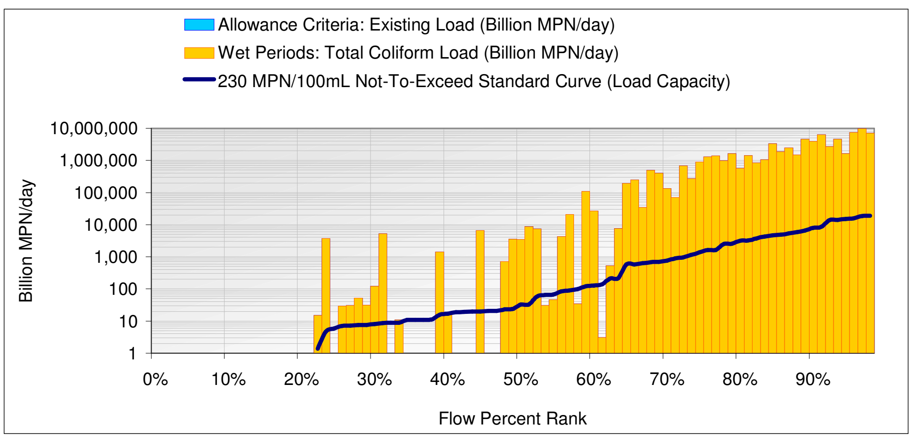
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	742	Billion MPN/Year
Total Load for Existing Condition	55,462	Billion MPN/Year
Total Load Using Allowance Criteria	55,462	Billion MPN/Year
Non-allowable Exceedance Load	55,035	Billion MPN/Year
Required Annual Load Reduction	99.2%	Percentage
Wet Day Exceedances	39	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	39	None

Table L-85. Fecal coliform load duration curve and TMDL results for subwatershed 1801 – TMDL



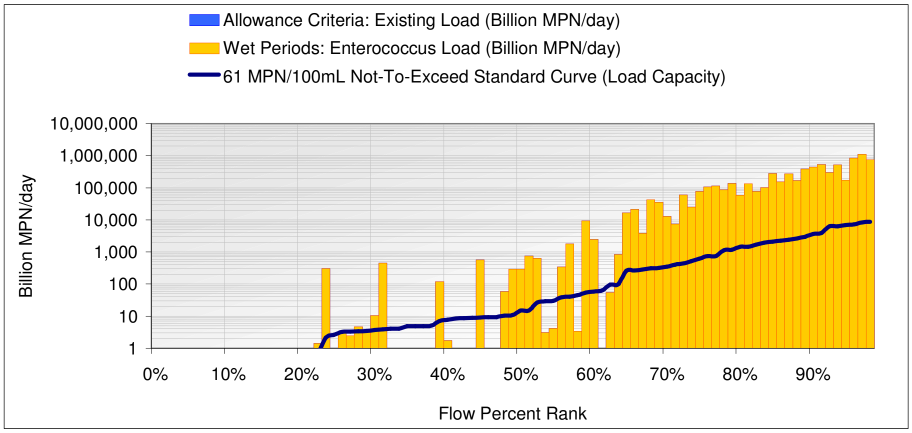
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	312,219	Billion MPN/Year
Total Load for Existing Condition	4,932,380	Billion MPN/Year
Total Load Using Allowance Criteria	4,932,380	Billion MPN/Year
Non-allowable Exceedance Load	4,621,248	Billion MPN/Year
Required Annual Load Reduction	93.7%	Percentage
Wet Day Exceedances	57	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	57	None

Table L-86. Total coliform load duration curve and TMDL results for subwatershed 1801 – TMDL



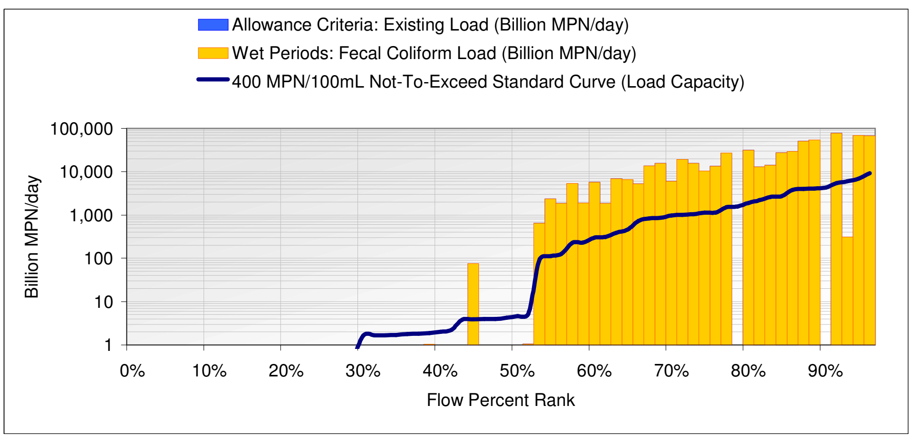
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	179,526	Billion MPN/Year
Total Load for Existing Condition	72,757,569	Billion MPN/Year
Total Load Using Allowance Criteria	72,757,569	Billion MPN/Year
Non-allowable Exceedance Load	72,567,919	Billion MPN/Year
Required Annual Load Reduction	99.7%	Percentage
Wet Day Exceedances	60	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	60	None

Table L-87. Enterococcus load duration curve and TMDL results for subwatershed 1801 – TMDL (based on numeric target for inland surface waters)



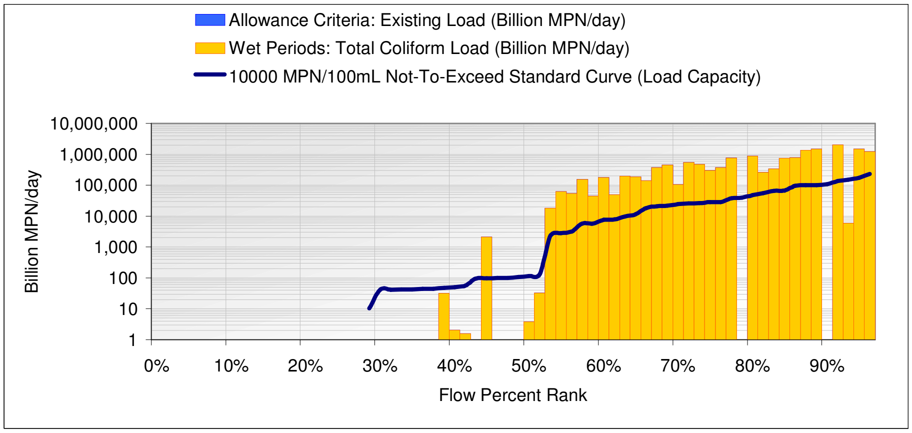
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	47,613	Billion MPN/Year
Total Load for Existing Condition	7,255,759	Billion MPN/Year
Total Load Using Allowance Criteria	7,255,759	Billion MPN/Year
Non-allowable Exceedance Load	7,207,403	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	59	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	59	None

Table L-88. Fecal coliform load duration curve and TMDL results for subwatershed 1901 – TMDL



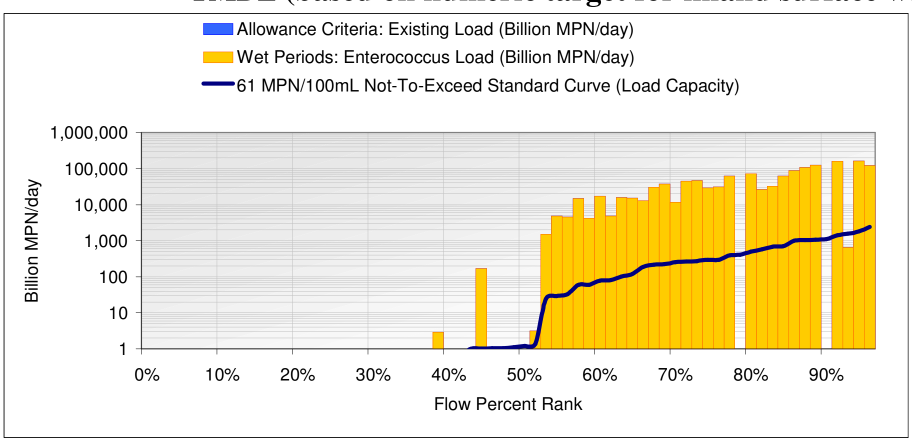
Fecal Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	67,232	Billion MPN/Year
Total Load for Existing Condition	603,863	Billion MPN/Year
Total Load Using Allowance Criteria	603,863	Billion MPN/Year
Non-allowable Exceedance Load	548,347	Billion MPN/Year
Required Annual Load Reduction	90.8%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	43	None

Table L-89. Total coliform load duration curve and TMDL results for subwatershed 1901 – TMDL (based on numeric target for inland surface waters)



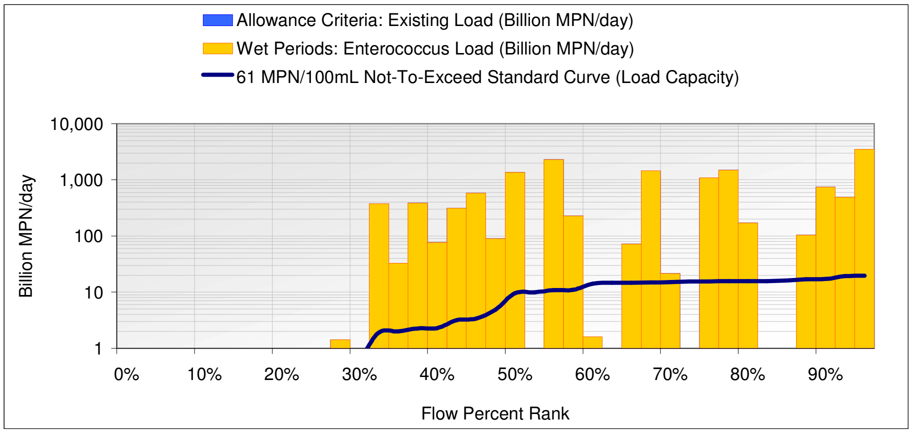
Total Coliform Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	1,680,809	Billion MPN/Year
Total Load for Existing Condition	15,390,608	Billion MPN/Year
Total Load Using Allowance Criteria	15,390,608	Billion MPN/Year
Non-allowable Exceedance Load	14,004,571	Billion MPN/Year
Required Annual Load Reduction	91.0%	Percentage
Wet Day Exceedances	43	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	43	None

Table L-90. Enterococcus load duration curve and TMDL results for subwatershed 1901 – TMDL (based on numeric target for inland surface waters)



Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	10,253	Billion MPN/Year
Total Load for Existing Condition	1,371,972	Billion MPN/Year
Total Load Using Allowance Criteria	1,371,972	Billion MPN/Year
Non-allowable Exceedance Load	1,362,899	Billion MPN/Year
Required Annual Load Reduction	99.3%	Percentage
Wet Day Exceedances	45	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	45	None

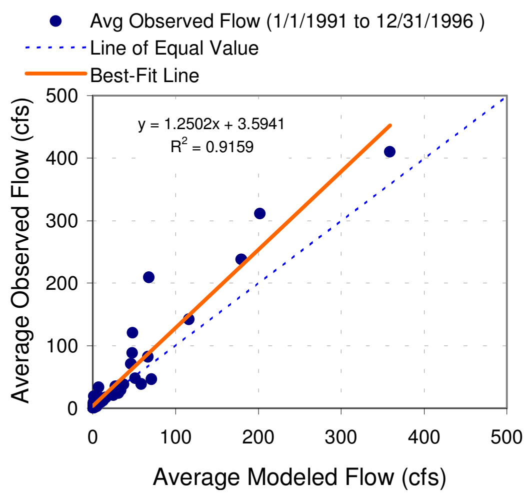
Table L-91. Enterococcus load duration curve and TMDL results for subwatershed 2001 – TMDL (based on numeric target for inland surface waters)

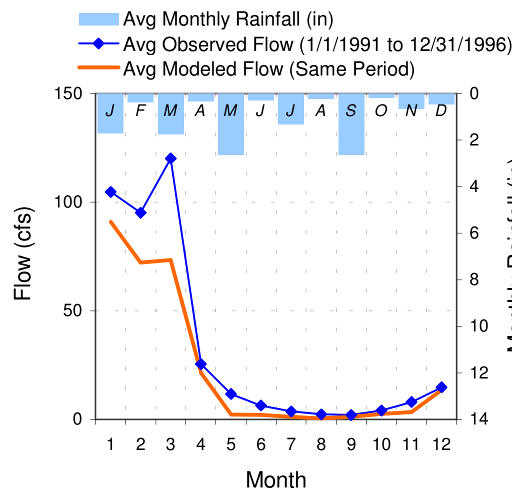


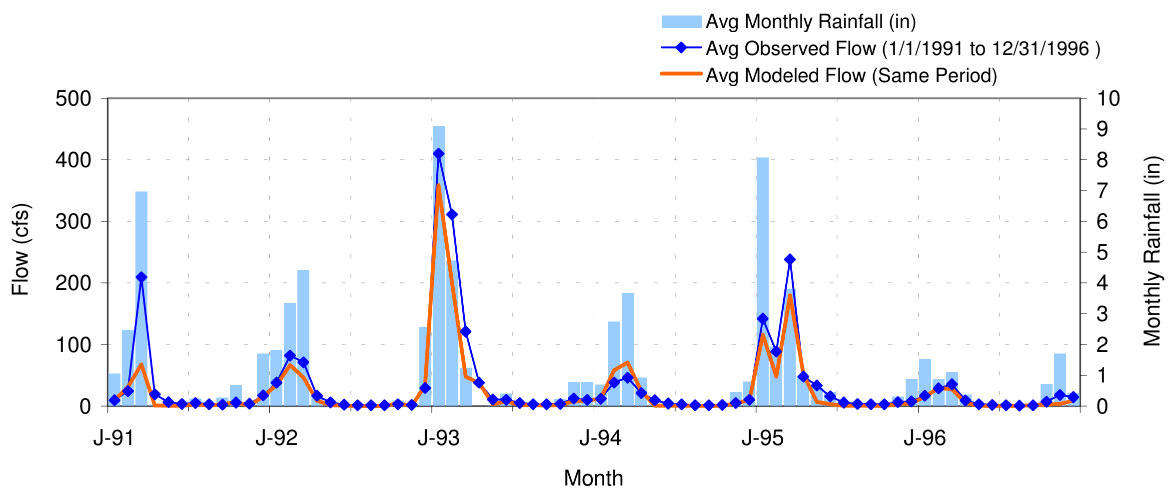
Enterococcus Loading Summary	Value	Units
Waste Load Allocation (Load capacity below WQO curve)	179	Billion MPN/Year
Total Load for Existing Condition	14,860	Billion MPN/Year
Total Load Using Allowance Criteria	14,860	Billion MPN/Year
Non-allowable Exceedance Load	14,729	Billion MPN/Year
Required Annual Load Reduction	99.1%	Percentage
Wet Day Exceedances	29	None
Allowable Wet Day Exceedances	0	None
Excess Wet Day Exceedances	29	None

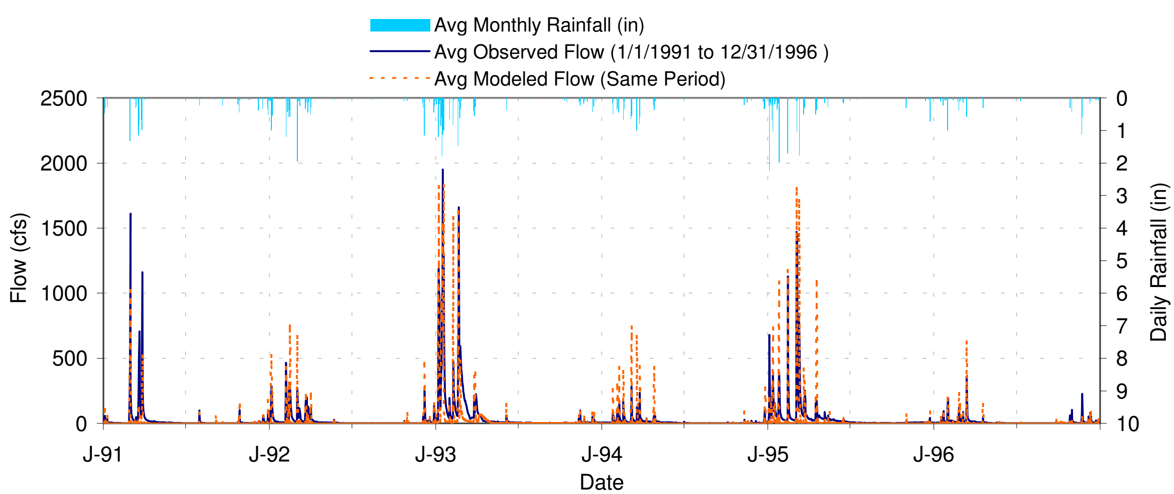
Appendix M
Wet Weather Model Hydrology Calibration and Validation Results

Summary statistics of model hydrology calibration to USGS gage 11022480 (Appendix B, No. 3) (1 of 2)





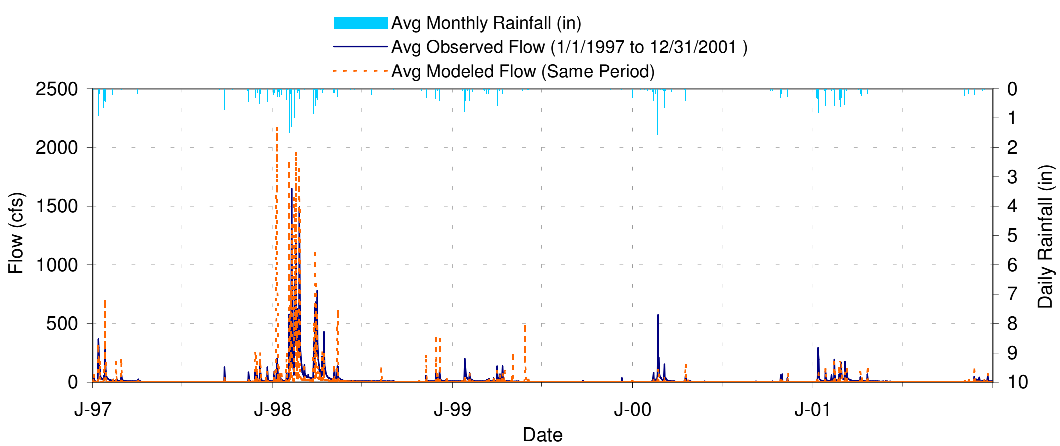




Summary statistics of model hydrology calibration to USGS gage 11022480 (Appendix B, No. 3) (2 of 2)

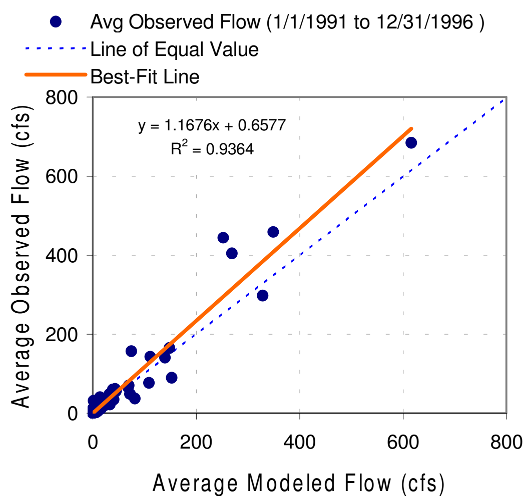
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1805 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11022480 SAN DIEGO R A MAST RD NR SANTEE CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°50'25", Longitude 117°01'30" NAD27 Drainage area 368 square miles		
Total Simulated In-stream Flow:	**13.93**	Total Observed In-stream Flow:		**19.55**
Total of simulated highest 10% flows:	**13.16**	Total of Observed highest 10% flows:		**14.77**
Total of Simulated lowest 50% flows:	**0.04**	Total of Observed Lowest 50% flows:		**0.77**
Simulated Summer Flow Volume (months 7-9):	**0.12**	Observed Summer Flow Volume (7-9):		**0.39**
Simulated Fall Flow Volume (months 10-12):	**0.98**	Observed Fall Flow Volume (10-12):		**1.33**
Simulated Winter Flow Volume (months 1-3):	**11.59**	Observed Winter Flow Volume (1-3):		**15.69**
Simulated Spring Flow Volume (months 4-6):	**1.25**	Observed Spring Flow Volume (4-6):		**2.13**
Total Simulated Storm Volume:	**12.06**	Total Observed Storm Volume:		**10.08**
Simulated Summer Storm Volume (7-9):	**0.06**	Observed Summer Storm Volume (7-9):		**0.06**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-12.20	15		
Error in storm volumes:	16.43	20		

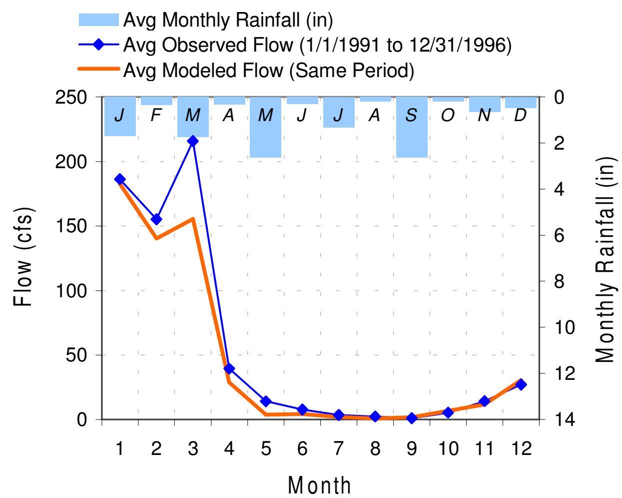
Summary statistics of model hydrology validation to USGS gage 11022480 (Appendix B, No. 3)

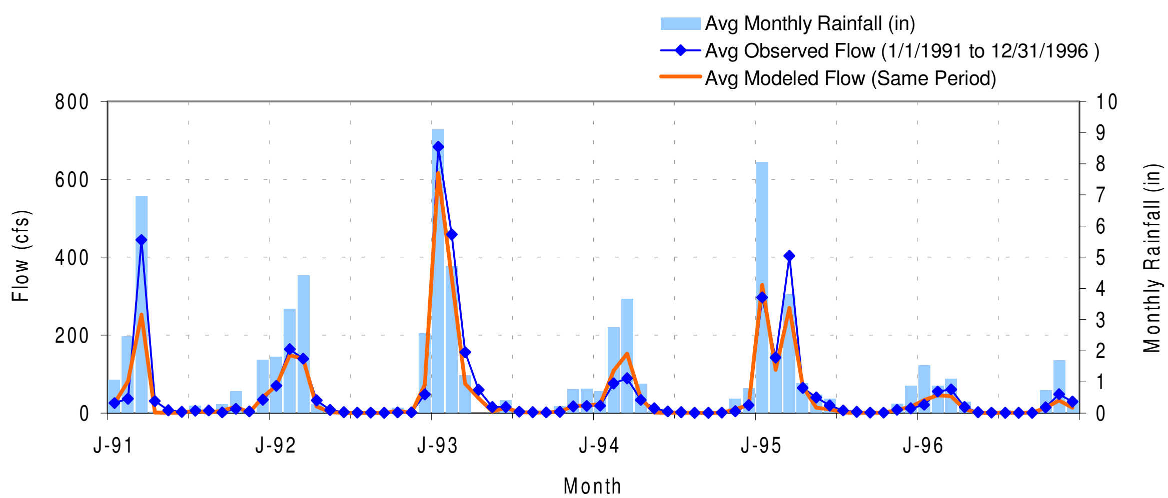


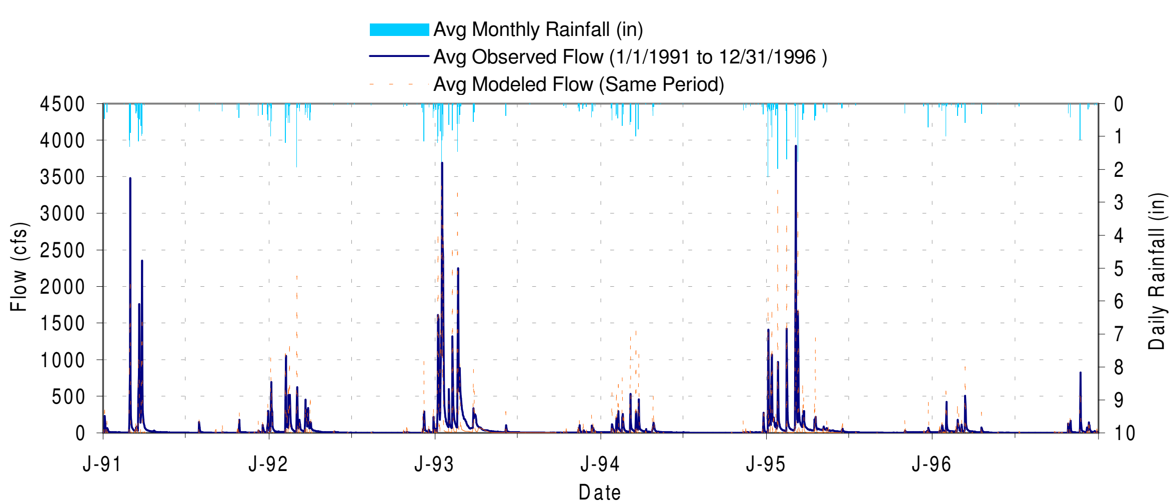
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1805 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11022480 SAN DIEGO R A MAST RD NR SANTEE CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°50' 25", Longitude 117°01' 30" NAD27 Drainage area 368 square miles		
Total Simulated In-stream Flow:	**11.23**	Total Observed In-stream Flow:		**12.95**
Total of simulated highest 10% flows:	**10.66**	Total of Observed highest 10% flows:		**9.60**
Total of Simulated lowest 50% flows:	**0.01**	Total of Observed Lowest 50% flows:		**0.68**
Simulated Summer Flow Volume (months 7-9):	**0.15**	Observed Summer Flow Volume (7-9):		**0.42**
Simulated Fall Flow Volume (months 10-12):	**1.09**	Observed Fall Flow Volume (10-12):		**1.18**
Simulated Winter Flow Volume (months 1-3):	**8.19**	Observed Winter Flow Volume (1-3):		**8.87**
Simulated Spring Flow Volume (months 4-6):	**1.80**	Observed Spring Flow Volume (4-6):		**2.47**
Total Simulated Storm Volume:	**10.11**	Total Observed Storm Volume:		**6.69**
Simulated Summer Storm Volume (7-9):	**0.07**	Observed Summer Storm Volume (7-9):		**0.08**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	9.93	15		
Error in storm volumes:	33.83	20		

Summary statistics of model hydrology calibration to USGS gage 11023000 (Appendix B, No. 3) (1 of 2)





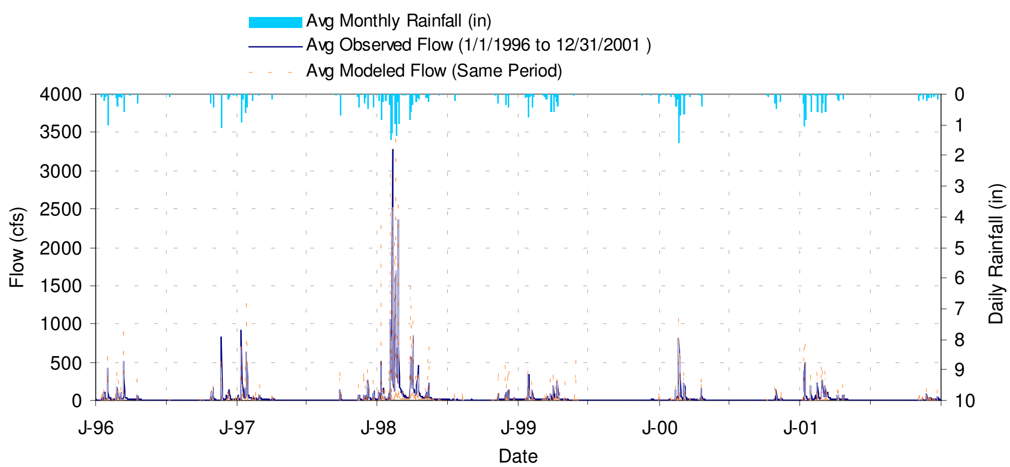




Summary statistics of model hydrology calibration to USGS gage 11023000 (Appendix B, No. 3) (2 of 2)

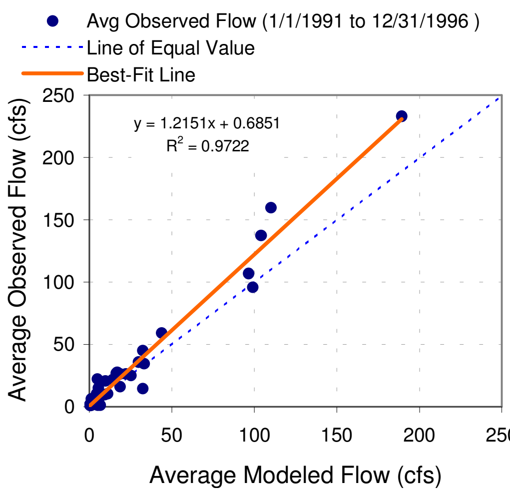
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1801 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11023000 SAN DIEGO R A FASHION VALLEY AT SAN DIEGO CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°45' 54", Longitude 117°10' 04" NAD27 Drainage area 429 square miles		
Total Simulated In-stream Flow:	**1.49**	Total Observed In-stream Flow:		**1.77**
Total of simulated highest 10% flows:	**1.42**	Total of Observed highest 10% flows:		**1.38**
Total of Simulated lowest 50% flows:	**0.00**	Total of Observed Lowest 50% flows:		**0.04**
Simulated Summer Flow Volume (months 7-9):	**0.01**	Observed Summer Flow Volume (7-9):		**0.02**
Simulated Fall Flow Volume (months 10-12):	**0.13**	Observed Fall Flow Volume (10-12):		**0.12**
Simulated Winter Flow Volume (months 1-3):	**1.25**	Observed Winter Flow Volume (1-3):		**1.46**
Simulated Spring Flow Volume (months 4-6):	**0.10**	Observed Spring Flow Volume (4-6):		**0.16**
Total Simulated Storm Volume:	**1.43**	Total Observed Storm Volume:		**1.26**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	2.65	15		
Error in storm volumes:	12.33	20		

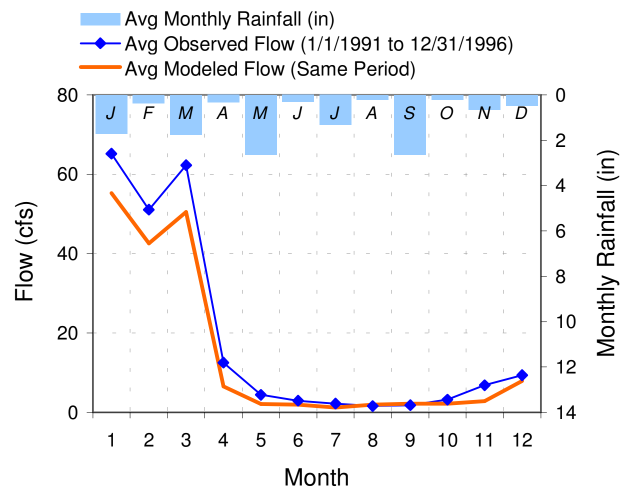
Summary statistics of model hydrology validation to USGS gage 11023000 (Appendix B, No. 3)

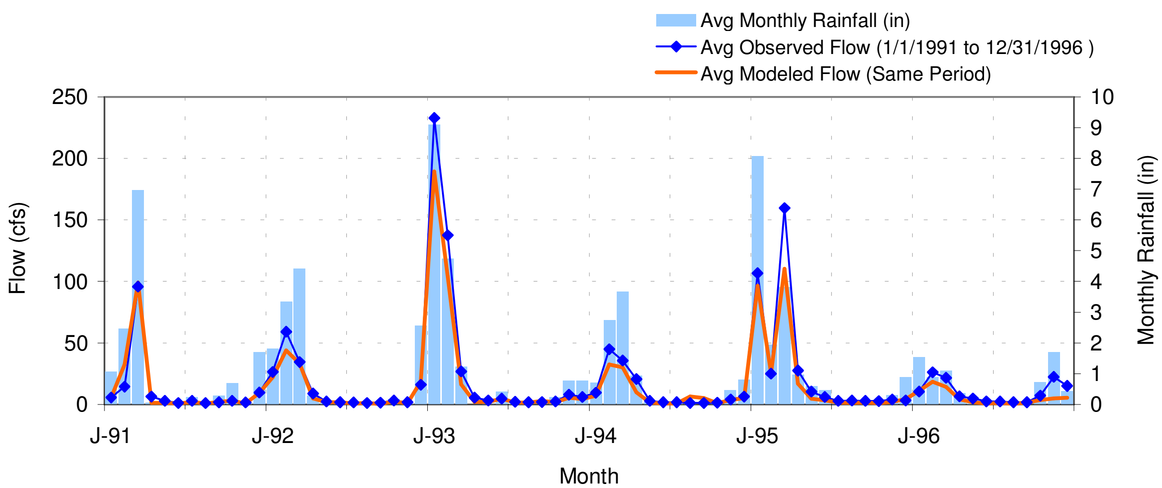


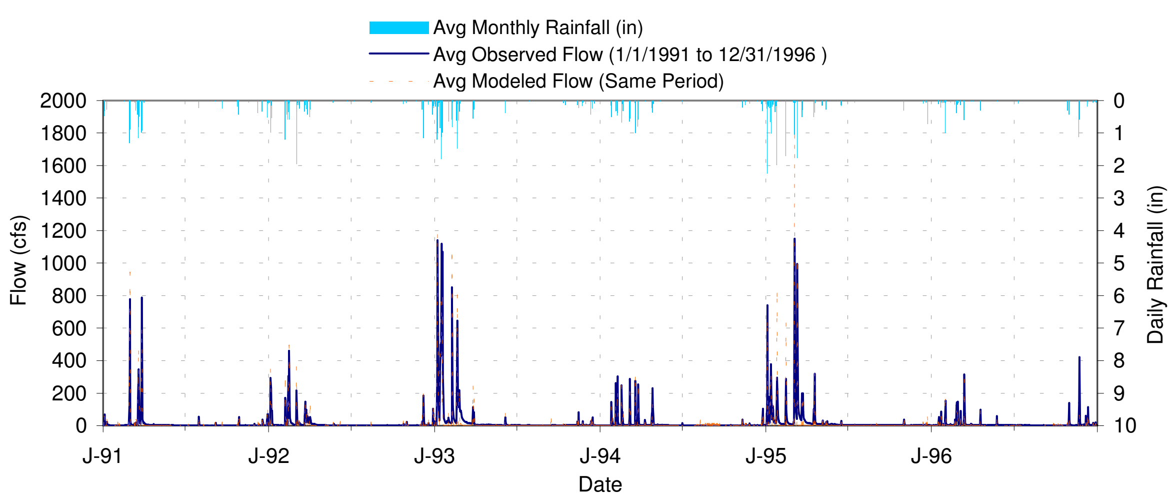
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1801 6-Year Analysis Period: 1/1/1996 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11023000 SAN DIEGO R A FASHION VALLEY AT SAN DIEGO CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°45' 54", Longitude 117°10' 04" NAD27 Drainage area 429 square miles		
Total Simulated In-stream Flow:	**0.93**	Total Observed In-stream Flow:		**0.97**
Total of simulated highest 10% flows:	**0.89**	Total of Observed highest 10% flows:		**0.71**
Total of Simulated lowest 50% flows:	**0.00**	Total of Observed Lowest 50% flows:		**0.04**
Simulated Summer Flow Volume (months 7-9):	**0.01**	Observed Summer Flow Volume (7-9):		**0.02**
Simulated Fall Flow Volume (months 10-12):	**0.11**	Observed Fall Flow Volume (10-12):		**0.12**
Simulated Winter Flow Volume (months 1-3):	**0.68**	Observed Winter Flow Volume (1-3):		**0.68**
Simulated Spring Flow Volume (months 4-6):	**0.12**	Observed Spring Flow Volume (4-6):		**0.15**
Total Simulated Storm Volume:	**0.89**	Total Observed Storm Volume:		**0.62**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	20.16	15		
Error in storm volumes:	29.61	20		

Summary statistics of model hydrology calibration to USGS gage 11023340 (Appendix B, No. 3) (1 of 2)





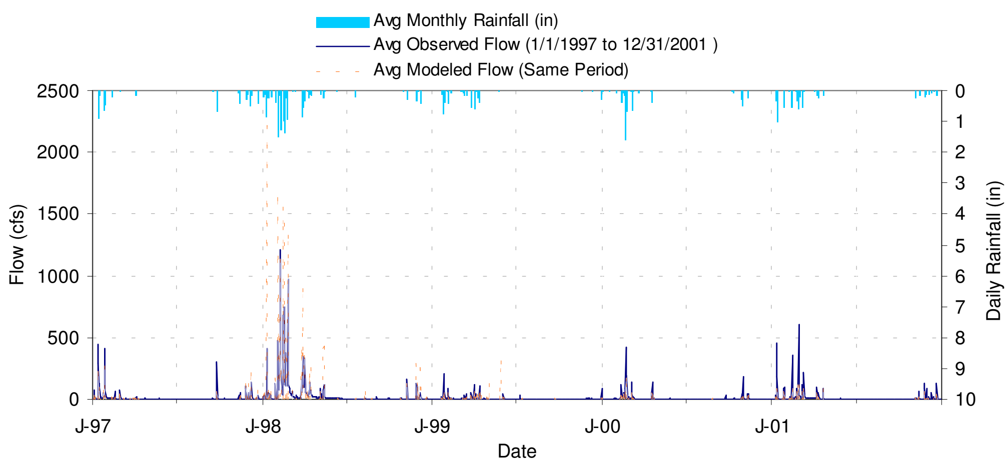




Summary statistics of model hydrology calibration to USGS gage 11023340 (Appendix B, No. 3) (2 of 2)

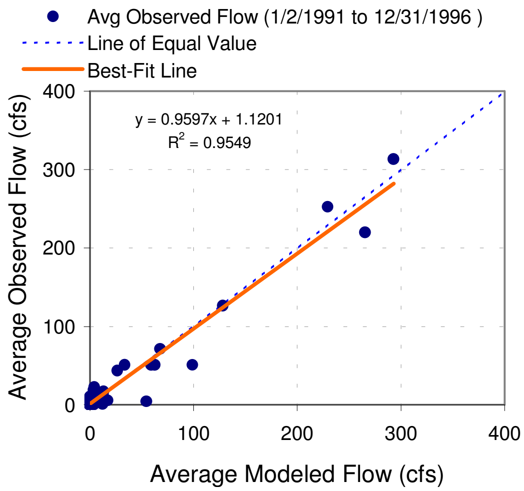
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1406 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11023340 LOS PENASQUITOS C NR POWAY CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°56' 35", Longitude 117°07' 15" NAD27 Drainage area 42.1 square miles		
Total Simulated In-stream Flow:	**4.74**	Total Observed In-stream Flow:		**5.98**
Total of simulated highest 10% flows:	**4.38**	Total of Observed highest 10% flows:		**4.91**
Total of Simulated lowest 50% flows:	**0.09**	Total of Observed Lowest 50% flows:		**0.26**
Simulated Summer Flow Volume (months 7-9):	**0.14**	Observed Summer Flow Volume (7-9):		**0.15**
Simulated Fall Flow Volume (months 10-12):	**0.35**	Observed Fall Flow Volume (10-12):		**0.53**
Simulated Winter Flow Volume (months 1-3):	**3.96**	Observed Winter Flow Volume (1-3):		**4.77**
Simulated Spring Flow Volume (months 4-6):	**0.28**	Observed Spring Flow Volume (4-6):		**0.53**
Total Simulated Storm Volume:	**4.44**	Total Observed Storm Volume:		**4.49**
Simulated Summer Storm Volume (7-9):	**0.09**	Observed Summer Storm Volume (7-9):		**0.03**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-12.11	15		
Error in storm volumes:	-1.31	20		

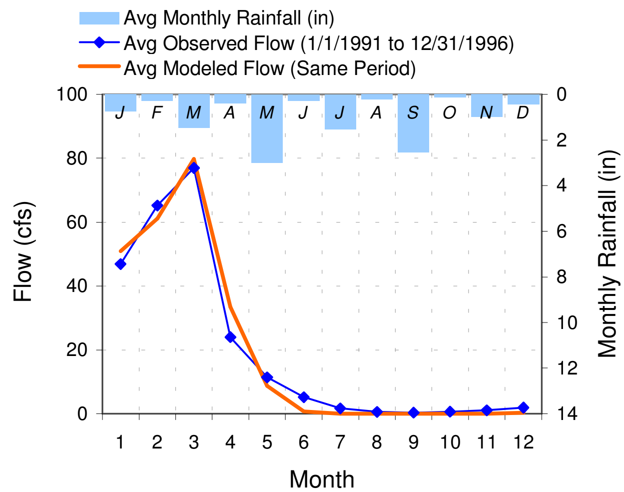
Summary statistics of model hydrology validation to USGS gage 11023340 (Appendix B, No. 3)

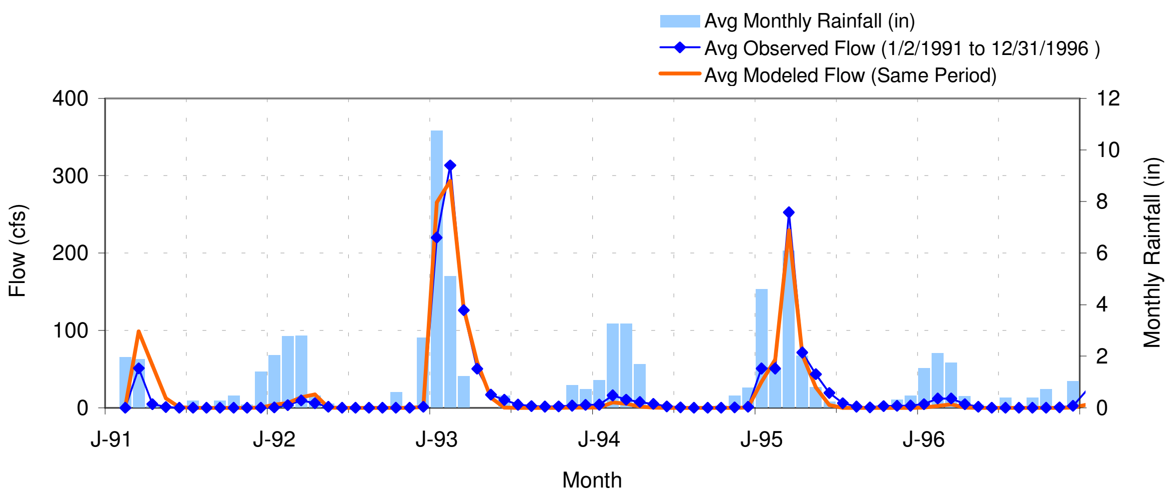


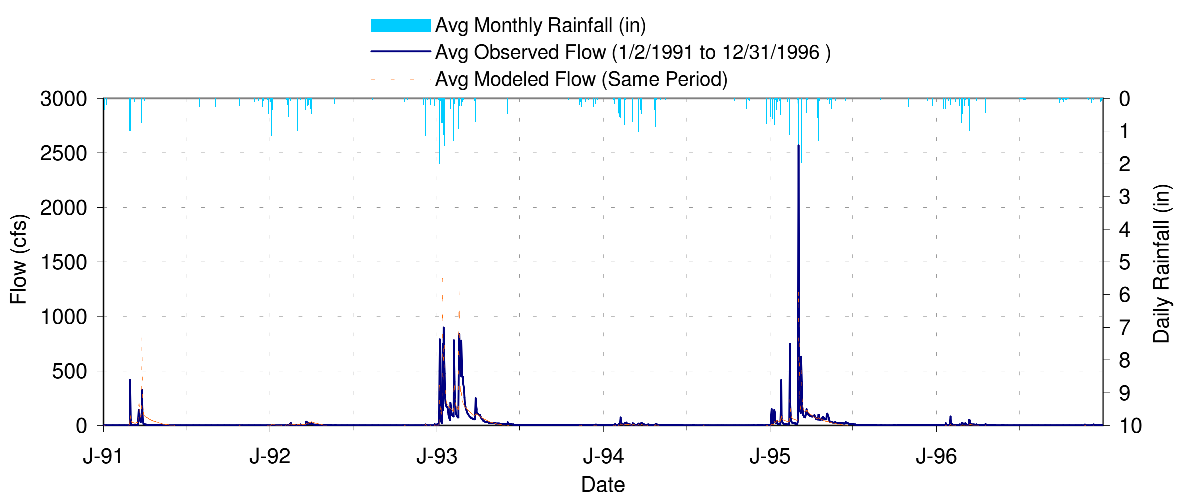
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1406 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11023340 LOS PENASQUITOS C NR POWAY CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°56' 35", Longitude 117°07' 15" NAD27 Drainage area 42.1 square miles		
Total Simulated In-stream Flow:	**4.68**	Total Observed In-stream Flow:		**5.10**
Total of simulated highest 10% flows:	**4.38**	Total of Observed highest 10% flows:		**3.95**
Total of Simulated lowest 50% flows:	**0.04**	Total of Observed Lowest 50% flows:		**0.38**
Simulated Summer Flow Volume (months 7-9):	**0.09**	Observed Summer Flow Volume (7-9):		**0.28**
Simulated Fall Flow Volume (months 10-12):	**0.45**	Observed Fall Flow Volume (10-12):		**0.67**
Simulated Winter Flow Volume (months 1-3):	**3.47**	Observed Winter Flow Volume (1-3):		**3.37**
Simulated Spring Flow Volume (months 4-6):	**0.67**	Observed Spring Flow Volume (4-6):		**0.78**
Total Simulated Storm Volume:	**4.39**	Total Observed Storm Volume:		**3.59**
Simulated Summer Storm Volume (7-9):	**0.04**	Observed Summer Storm Volume (7-9):		**0.10**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	9.91	15		
Error in storm volumes:	18.20	20		

Summary statistics of model hydrology calibration to USGS gage 11025500 (Appendix B, No. 3) (1 of 2)





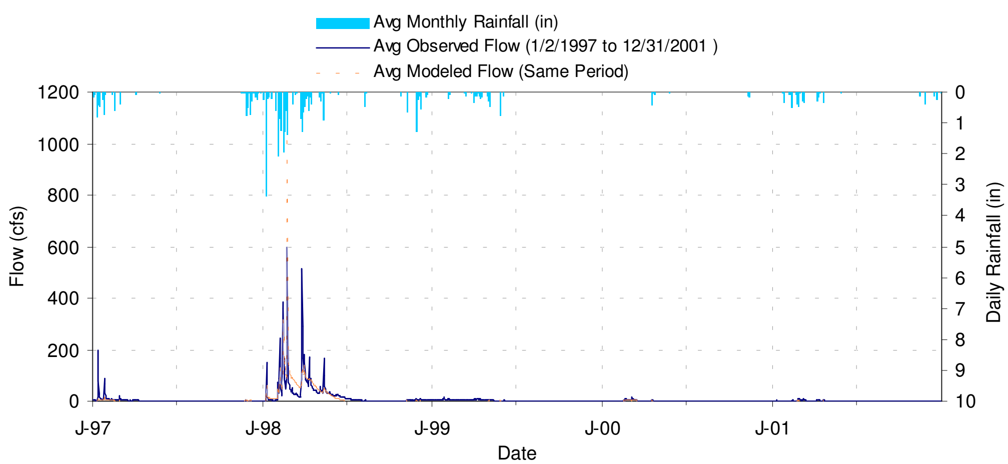




Summary statistics of model hydrology calibration to USGS gage 11025500 (Appendix B, No. 3) (2 of 2)

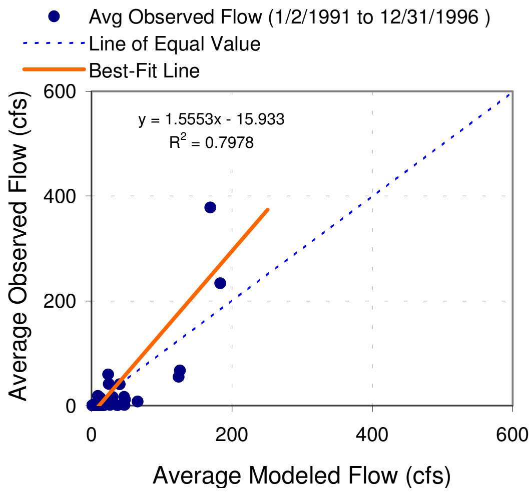
LSPC Simulated Flow		**Observed Flow Gage**		
REACH OUTFLOW FROM SUBBASIN 1316 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11025500 SANTA YSABEL C NR RAMONA CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 33°06' 25", Longitude 116°51' 55" NAD27 Drainage area 112 square miles		
Total Simulated In-stream Flow:	**11.52**	Total Observed In-stream Flow:		**11.54**
Total of simulated highest 10% flows:	**9.86**	Total of Observed highest 10% flows:		**9.74**
Total of Simulated lowest 50% flows:	**0.00**	Total of Observed Lowest 50% flows:		**0.09**
Simulated Summer Flow Volume (months 7-9):	**0.00**	Observed Summer Flow Volume (7-9):		**0.13**
Simulated Fall Flow Volume (months 10-12):	**0.02**	Observed Fall Flow Volume (10-12):		**0.19**
Simulated Winter Flow Volume (months 1-3):	**9.39**	Observed Winter Flow Volume (1-3):		**9.22**
Simulated Spring Flow Volume (months 4-6):	**2.10**	Observed Spring Flow Volume (4-6):		**2.00**
Total Simulated Storm Volume:	**3.52**	Total Observed Storm Volume:		**5.06**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.02**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	1.20	15		
Error in storm volumes:	-43.75	20		

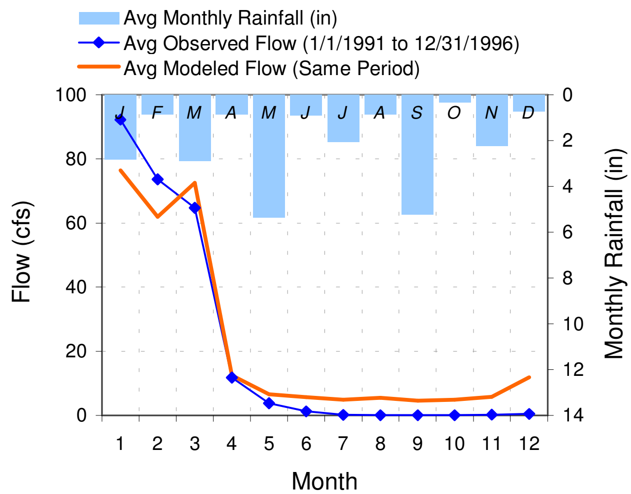
Summary statistics of model hydrology validation to USGS gage 11025500 (Appendix B, No. 3)

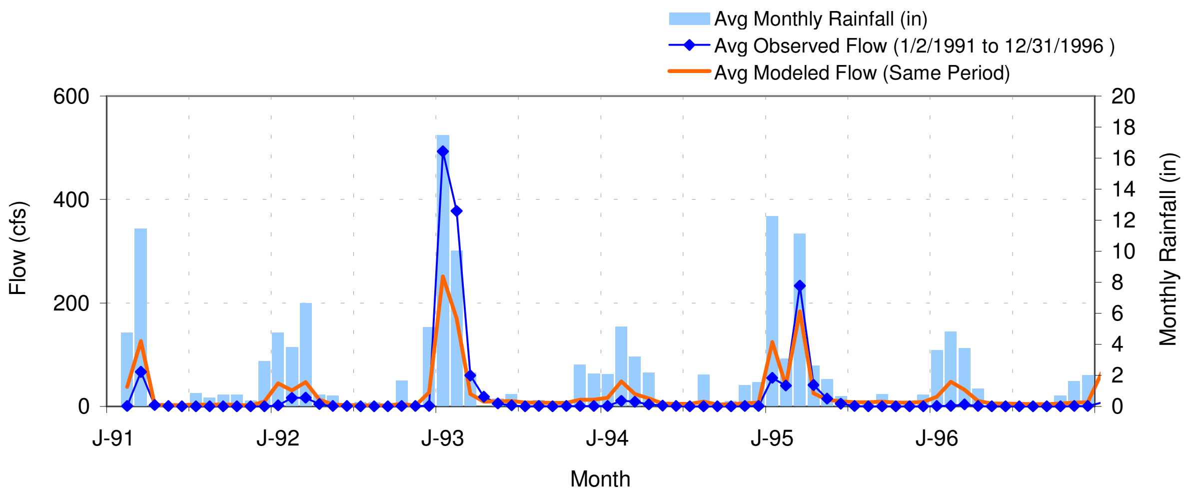


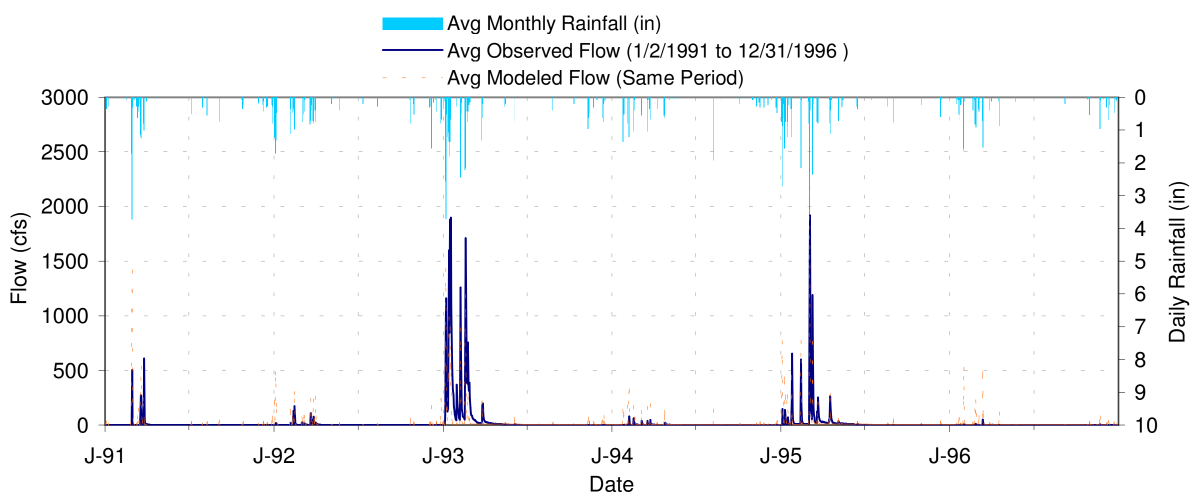
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1316 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11025500 SANTA YSABEL C NR RAMONA CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 33°06' 25", Longitude 116°51' 55" NAD27 Drainage area 112 square miles		
Total Simulated In-stream Flow:	**3.58**	Total Observed In-stream Flow:		**4.08**
Total of simulated highest 10% flows:	**3.45**	Total of Observed highest 10% flows:		**3.38**
Total of Simulated lowest 50% flows:	**0.00**	Total of Observed Lowest 50% flows:		**0.01**
Simulated Summer Flow Volume (months 7-9):	**0.00**	Observed Summer Flow Volume (7-9):		**0.08**
Simulated Fall Flow Volume (months 10-12):	**0.03**	Observed Fall Flow Volume (10-12):		**0.10**
Simulated Winter Flow Volume (months 1-3):	**2.33**	Observed Winter Flow Volume (1-3):		**2.44**
Simulated Spring Flow Volume (months 4-6):	**1.22**	Observed Spring Flow Volume (4-6):		**1.46**
Total Simulated Storm Volume:	**0.92**	Total Observed Storm Volume:		**1.59**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	2.02	15		
Error in storm volumes:	-73.39	20		

Summary statistics of model hydrology calibration to USGS gage 11028500 (Appendix B, No. 3) (1 of 2)





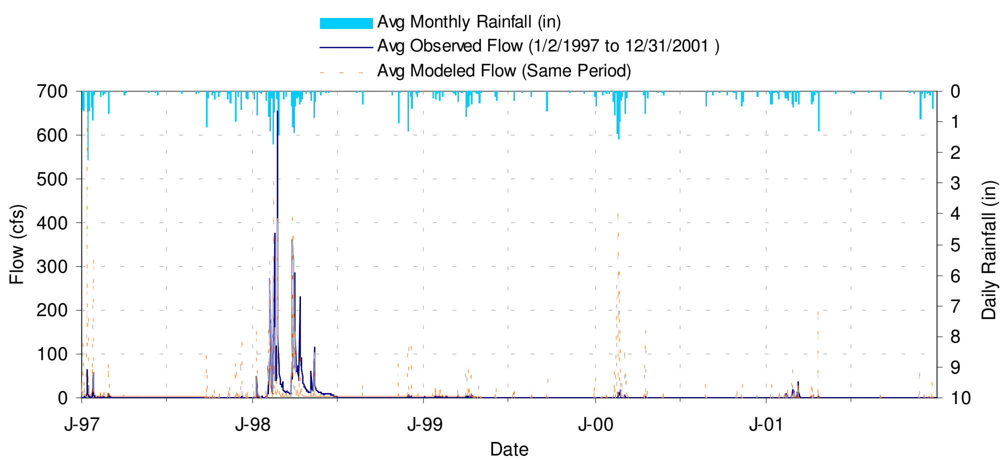




Summary statistics of model hydrology calibration to USGS gage 11028500 (Appendix B, No. 3) (2 of 2)

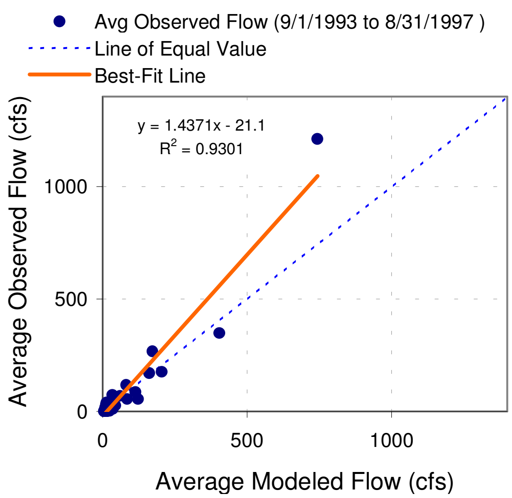
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1324 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11028500 SANTA MARIA C NR RAMONA CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 33°03' 08", Longitude 116°56' 41" NAD27 Drainage area 57.6 square miles		
Total Simulated In-stream Flow:	**13.43**	Total Observed In-stream Flow:		**12.15**
Total of simulated highest 10% flows:	**10.76**	Total of Observed highest 10% flows:		**11.48**
Total of Simulated lowest 50% flows:	**0.81**	Total of Observed Lowest 50% flows:		**0.02**
Simulated Summer Flow Volume (months 7-9):	**0.75**	Observed Summer Flow Volume (7-9):		**0.01**
Simulated Fall Flow Volume (months 10-12):	**1.13**	Observed Fall Flow Volume (10-12):		**0.04**
Simulated Winter Flow Volume (months 1-3):	**10.33**	Observed Winter Flow Volume (1-3):		**11.27**
Simulated Spring Flow Volume (months 4-6):	**1.21**	Observed Spring Flow Volume (4-6):		**0.83**
Total Simulated Storm Volume:	**9.56**	Total Observed Storm Volume:		**7.40**
Simulated Summer Storm Volume (7-9):	**0.12**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-6.62	15		
Error in storm volumes:	22.58	20		

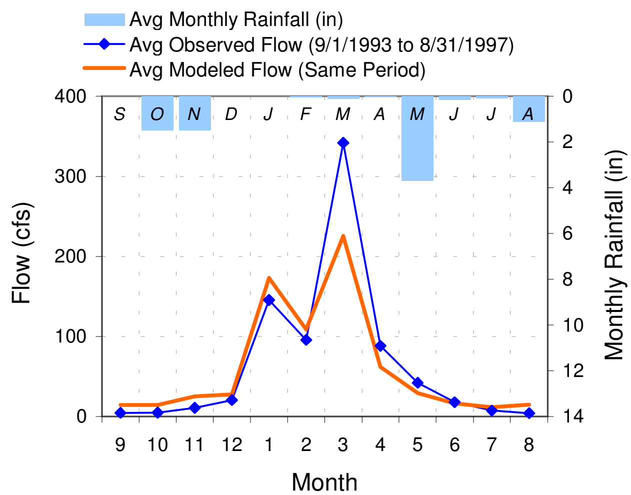
Summary statistics of model hydrology validation to USGS gage 11028500 (Appendix B, No. 3)

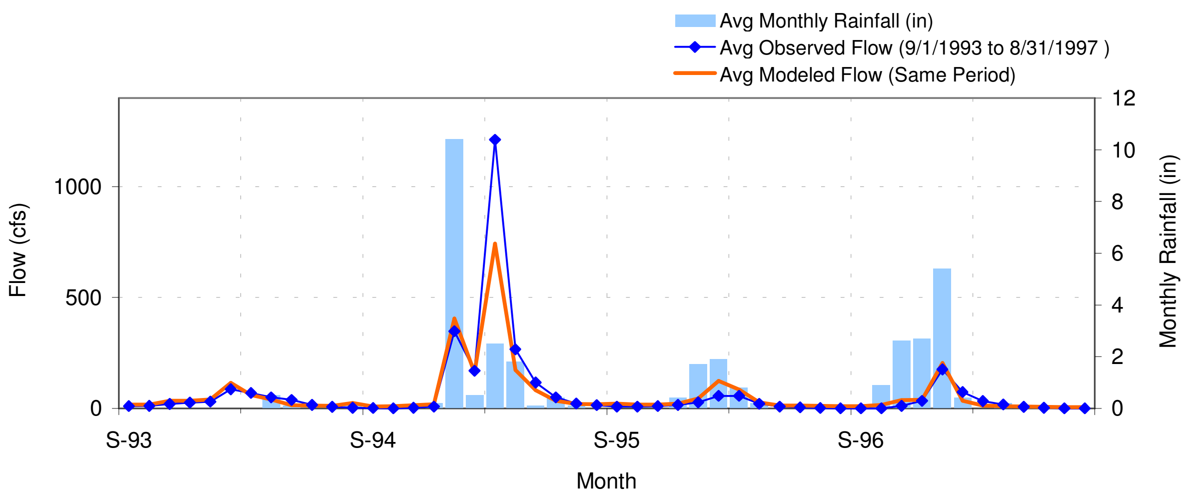


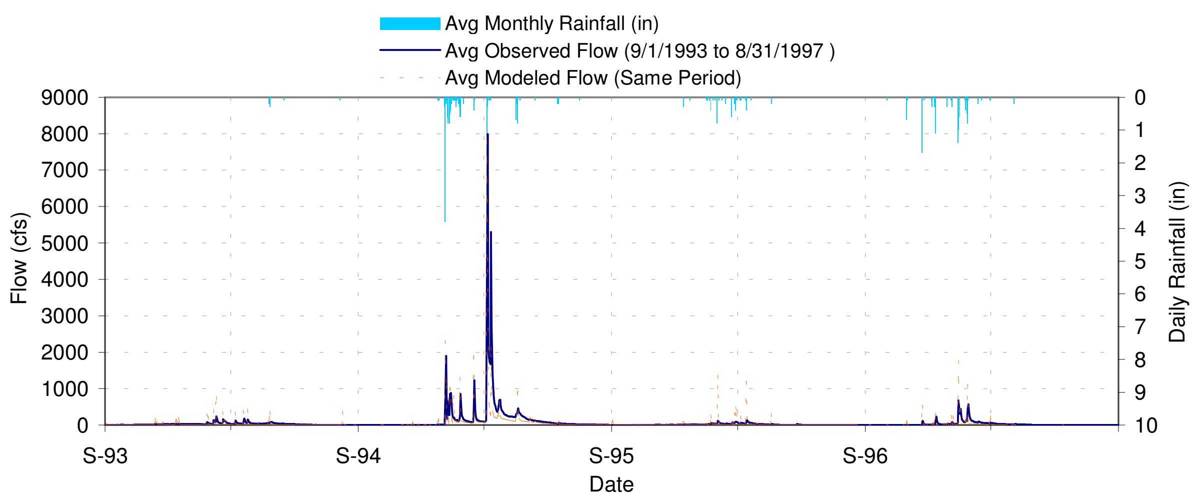
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1324 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11028500 SANTA MARIA C NR RAMONA CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 33°03' 08", Longitude 116°56' 41" NAD27 Drainage area 57.6 square miles		
Total Simulated In-stream Flow:	**4.28**	Total Observed In-stream Flow:		**2.68**
Total of simulated highest 10% flows:	**3.50**	Total of Observed highest 10% flows:		**2.55**
Total of Simulated lowest 50% flows:	**0.13**	Total of Observed Lowest 50% flows:		**0.00**
Simulated Summer Flow Volume (months 7-9):	**0.26**	Observed Summer Flow Volume (7-9):		**0.01**
Simulated Fall Flow Volume (months 10-12):	**0.49**	Observed Fall Flow Volume (10-12):		**0.02**
Simulated Winter Flow Volume (months 1-3):	**2.81**	Observed Winter Flow Volume (1-3):		**1.72**
Simulated Spring Flow Volume (months 4-6):	**0.72**	Observed Spring Flow Volume (4-6):		**0.93**
Total Simulated Storm Volume:	**3.19**	Total Observed Storm Volume:		**1.52**
Simulated Summer Storm Volume (7-9):	**0.09**	Observed Summer Storm Volume (7-9):		**0.00**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	27.19	15		
Error in storm volumes:	52.24	20		

Summary statistics of model hydrology calibration to USGS gage 11042000 (Appendix B, No. 3) (1 of 2)





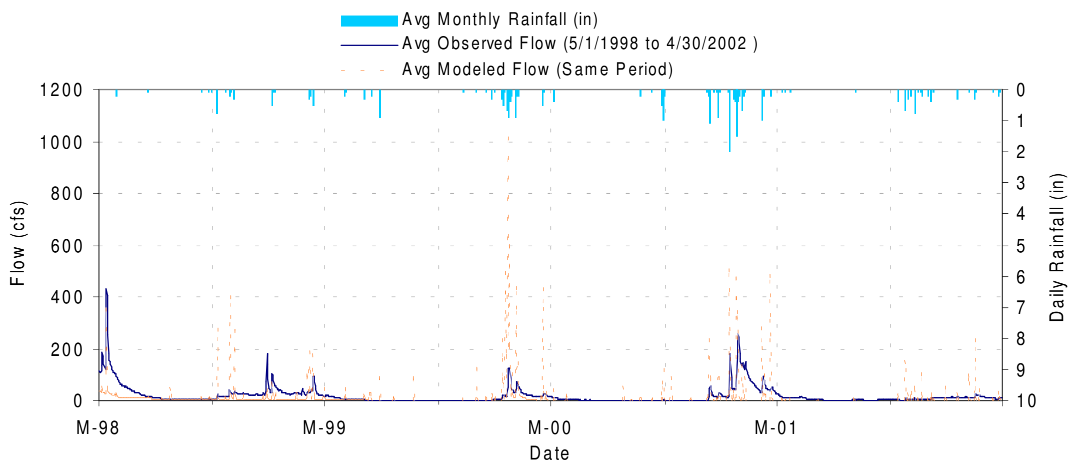




Summary statistics of model hydrology calibration to USGS gage 11042000 (Appendix B, No. 3) (2 of 2)

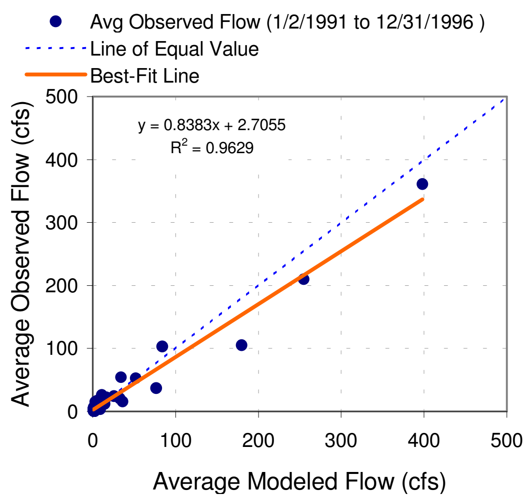
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 702 4-Year Analysis Period: 9/1/1993 - 8/31/1997 Flow volumes are (inches/year) for upstream drainage area		**USGS 11042000 SAN LUIS REY R A OCEANSIDE CA** San Diego County, California Hydrologic Unit Code 18070303 Latitude 33°13' 05", Longitude 117°21' 34" NAD27 Drainage area 557 square miles		
Total Simulated In-stream Flow:	**1.47**	Total Observed In-stream Flow:		**1.60**
Total of simulated highest 10% flows:	**1.07**	Total of Observed highest 10% flows:		**1.15**
Total of Simulated lowest 50% flows:	**0.12**	Total of Observed Lowest 50% flows:		**0.06**
Simulated Summer Flow Volume (months 7-9):	**0.08**	Observed Summer Flow Volume (7-9):		**0.03**
Simulated Fall Flow Volume (months 10-12):	**0.14**	Observed Fall Flow Volume (10-12):		**0.07**
Simulated Winter Flow Volume (months 1-3):	**1.03**	Observed Winter Flow Volume (1-3):		**1.19**
Simulated Spring Flow Volume (months 4-6):	**0.22**	Observed Spring Flow Volume (4-6):		**0.30**
Total Simulated Storm Volume:	**0.94**	Total Observed Storm Volume:		**0.77**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):		**0.00**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-7.69	15		
Error in storm volumes:	18.76	20		

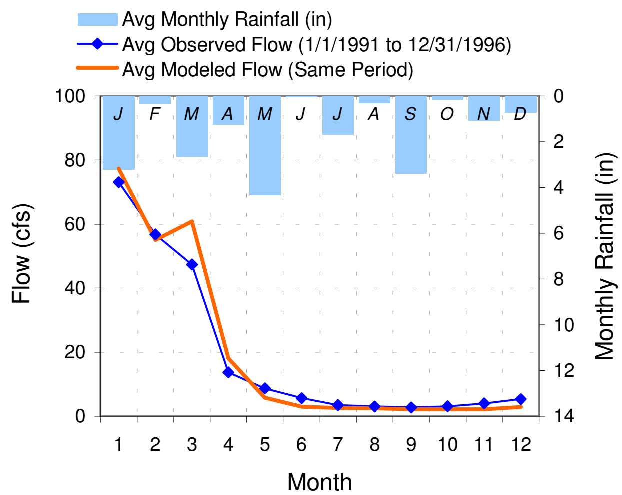
Summary statistics of model hydrology validation to USGS gage 11042000 (Appendix B, No. 3)

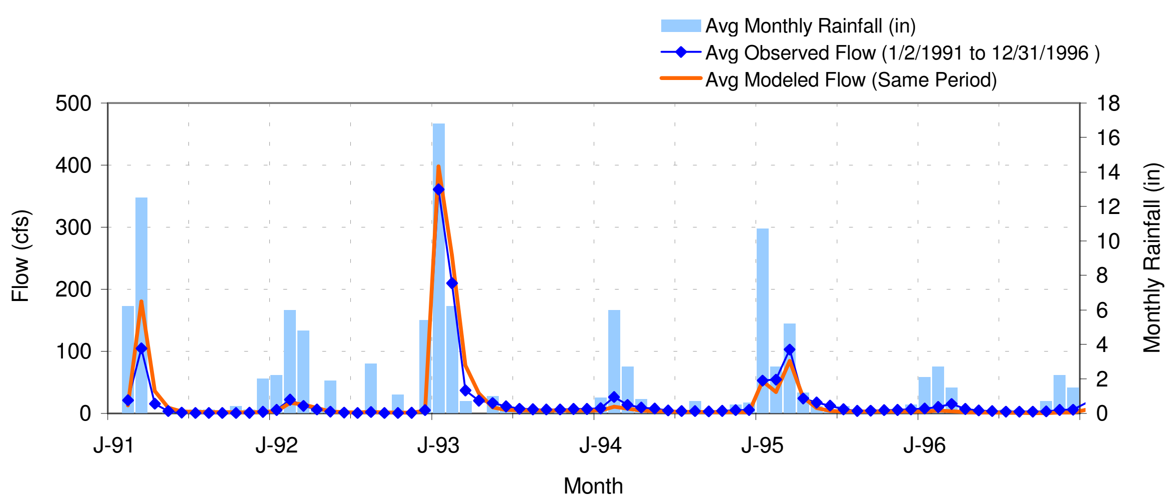


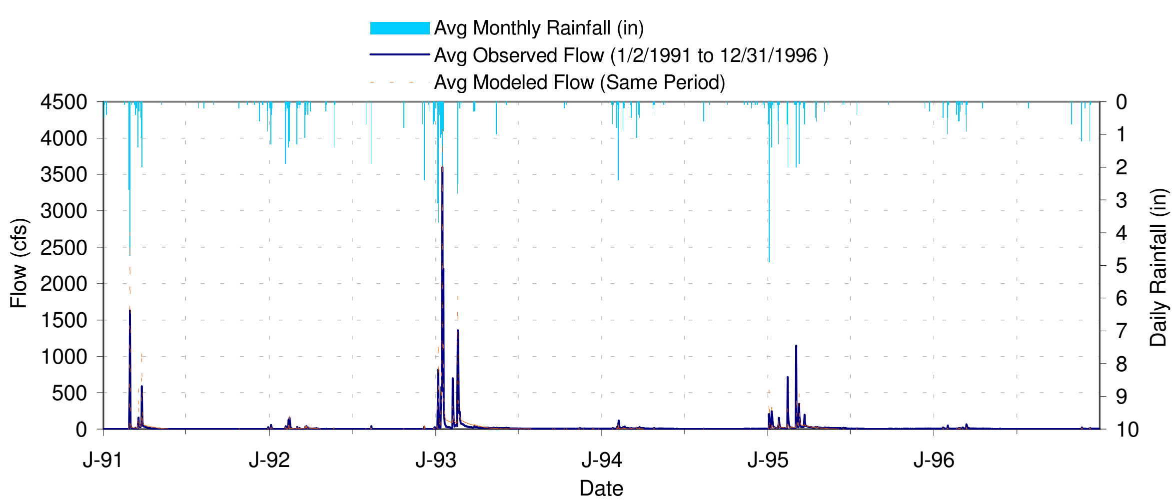
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 702 4-Year Analysis Period: 5/1/1998 - 4/30/2002 Flow volumes are (inches/year) for upstream drainage area		**USGS 11042000 SAN LUIS REY R A OCEANSIDE CA** San Diego County, California Hydrologic Unit Code 18070303 Latitude 33°13' 05", Longitude 117°21' 34" NAD27 Drainage area 557 square miles		
Total Simulated In-stream Flow:	**0.34**	Total Observed In-stream Flow:		**0.43**
Total of simulated highest 10% flows:	**0.27**	Total of Observed highest 10% flows:		**0.23**
Total of Simulated lowest 50% flows:	**0.01**	Total of Observed Lowest 50% flows:		**0.02**
Simulated Summer Flow Volume (months 7-9):	**0.03**	Observed Summer Flow Volume (7-9):		**0.02**
Simulated Fall Flow Volume (months 10-12):	**0.05**	Observed Fall Flow Volume (10-12):		**0.03**
Simulated Winter Flow Volume (months 1-3):	**0.17**	Observed Winter Flow Volume (1-3):		**0.20**
Simulated Spring Flow Volume (months 4-6):	**0.09**	Observed Spring Flow Volume (4-6):		**0.18**
Total Simulated Storm Volume:	**0.27**	Total Observed Storm Volume:		**0.11**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):		**0.00**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	12.00	15		
Error in storm volumes:	57.19	20		

Summary statistics of model hydrology calibration to USGS gage 11042400 (Appendix B, No. 3) (1 of 2)





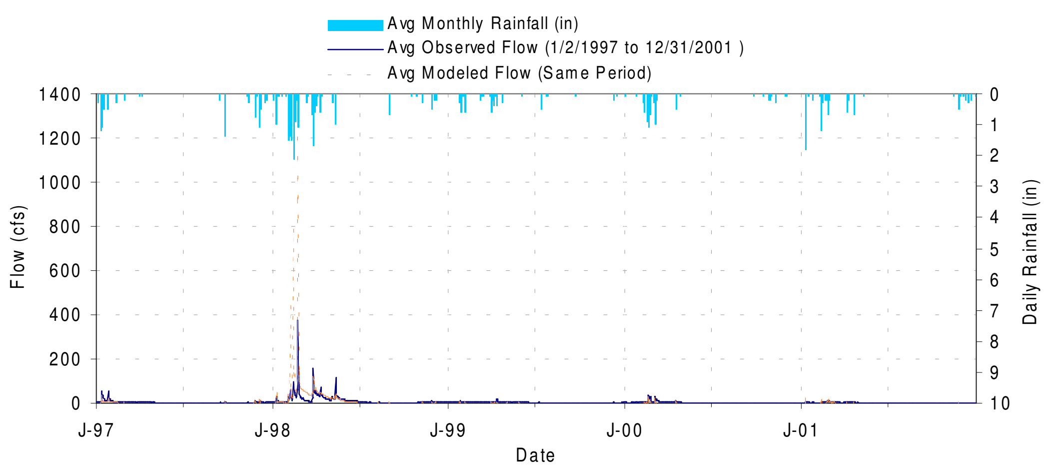




Summary statistics of model hydrology calibration to USGS gage 11042400 (Appendix B, No. 3) (2 of 2)

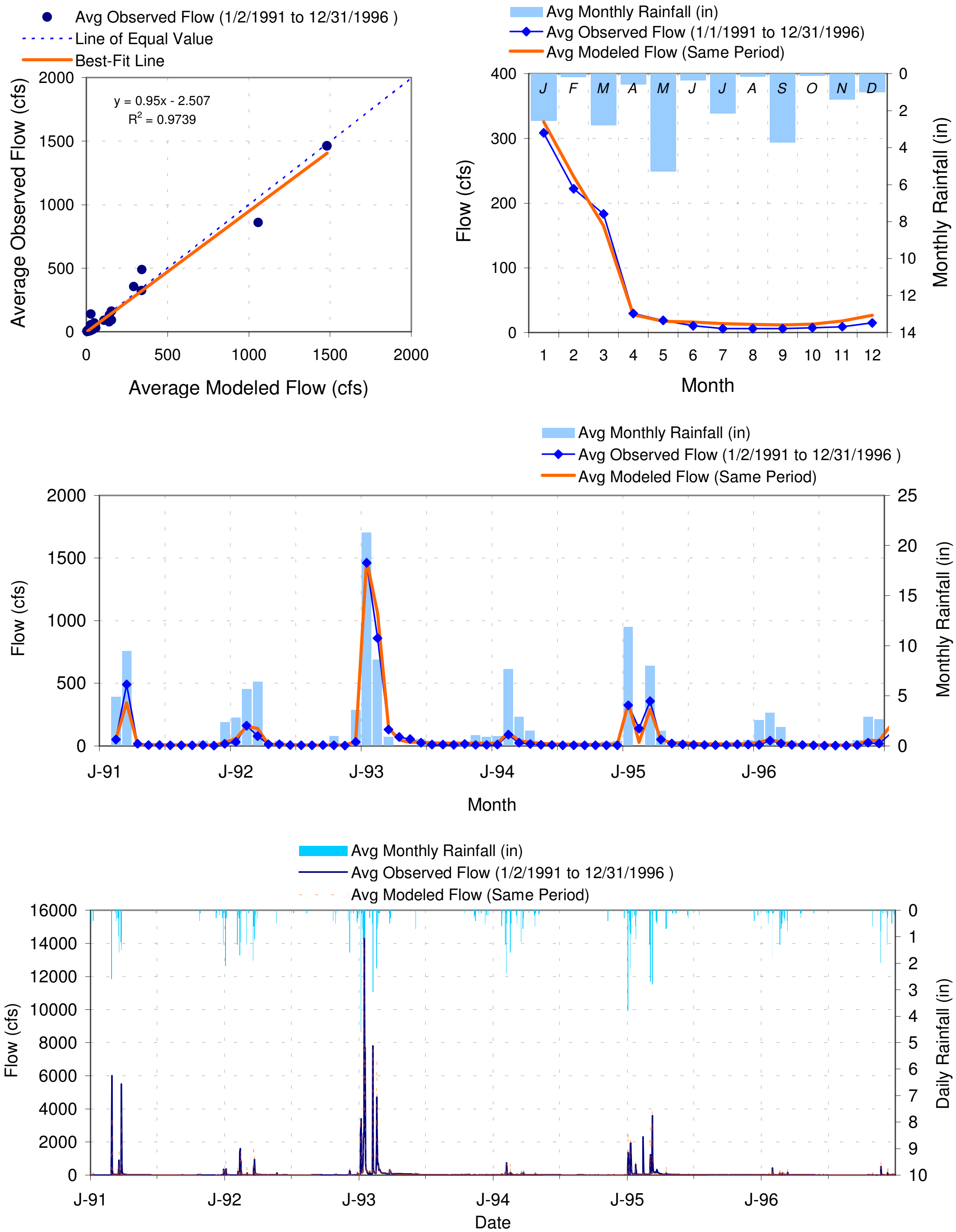
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 658 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11042400 TEMECULA C NR AGUANGA CA** Riverside County, California Hydrologic Unit Code 18070302 Latitude 33°27' 33", Longitude 116°55' 22" NAD27 Drainage area 131 square miles		
Total Simulated In-stream Flow:	**2.01**	Total Observed In-stream Flow:		**1.95**
Total of simulated highest 10% flows:	**1.64**	Total of Observed highest 10% flows:		**1.43**
Total of Simulated lowest 50% flows:	**0.08**	Total of Observed Lowest 50% flows:		**0.12**
Simulated Summer Flow Volume (months 7-9):	**0.06**	Observed Summer Flow Volume (7-9):		**0.08**
Simulated Fall Flow Volume (months 10-12):	**0.06**	Observed Fall Flow Volume (10-12):		**0.11**
Simulated Winter Flow Volume (months 1-3):	**1.66**	Observed Winter Flow Volume (1-3):		**1.51**
Simulated Spring Flow Volume (months 4-6):	**0.23**	Observed Spring Flow Volume (4-6):		**0.24**
Total Simulated Storm Volume:	**1.11**	Total Observed Storm Volume:		**1.19**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	12.78	15		
Error in storm volumes:	-7.18	20		

Summary statistics of model hydrology validation to USGS gage 11042400 (Appendix B, No. 3)



LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 658 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11042400 TEMECULA C NR AGUANGA CA** Riverside County, California Hydrologic Unit Code 18070302 Latitude 33°27' 33", Longitude 116°55' 22" NAD27 Drainage area 131 square miles		
Total Simulated In-stream Flow:	**0.58**	Total Observed In-stream Flow:		**0.55**
Total of simulated highest 10% flows:	**0.52**	Total of Observed highest 10% flows:		**0.29**
Total of Simulated lowest 50% flows:	**0.00**	Total of Observed Lowest 50% flows:		**0.07**
Simulated Summer Flow Volume (months 7-9):	**0.01**	Observed Summer Flow Volume (7-9):		**0.04**
Simulated Fall Flow Volume (months 10-12):	**0.02**	Observed Fall Flow Volume (10-12):		**0.06**
Simulated Winter Flow Volume (months 1-3):	**0.43**	Observed Winter Flow Volume (1-3):		**0.27**
Simulated Spring Flow Volume (months 4-6):	**0.12**	Observed Spring Flow Volume (4-6):		**0.18**
Total Simulated Storm Volume:	**0.30**	Total Observed Storm Volume:		**0.16**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	43.86	15		
Error in storm volumes:	47.39	20		

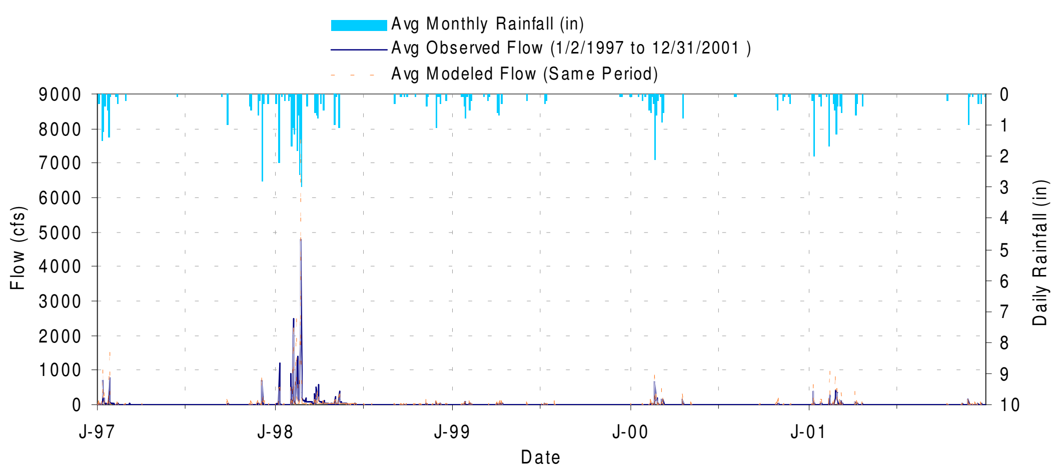
Summary statistics of model hydrology calibration to USGS gage 11044300 (Appendix B, No. 3) (1 of 2)



Summary statistics of model hydrology calibration to USGS gage 11044300 (Appendix B, No. 3) (2 of 2)

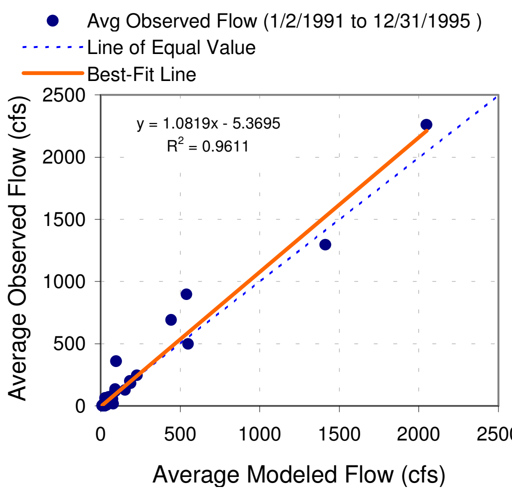
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 615 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11044300 SANTA MARGARITA R A FPUD SUMP NR FALLBROOK CA** San Diego County, California Hydrologic Unit Code 18070302 Latitude 33°24' 49", Longitude 117°14' 25" NAD27 Drainage area 620 square miles		
Total Simulated In-stream Flow:	**1.69**	Total Observed In-stream Flow:		**1.57**
Total of simulated highest 10% flows:	**1.40**	Total of Observed highest 10% flows:		**1.35**
Total of Simulated lowest 50% flows:	**0.10**	Total of Observed Lowest 50% flows:		**0.05**
Simulated Summer Flow Volume (months 7-9):	**0.07**	Observed Summer Flow Volume (7-9):		**0.03**
Simulated Fall Flow Volume (months 10-12):	**0.11**	Observed Fall Flow Volume (10-12):		**0.06**
Simulated Winter Flow Volume (months 1-3):	**1.39**	Observed Winter Flow Volume (1-3):		**1.36**
Simulated Spring Flow Volume (months 4-6):	**0.12**	Observed Spring Flow Volume (4-6):		**0.11**
Total Simulated Storm Volume:	**1.26**	Total Observed Storm Volume:		**1.22**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.00**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	3.57	15		
Error in storm volumes:	3.40	20		

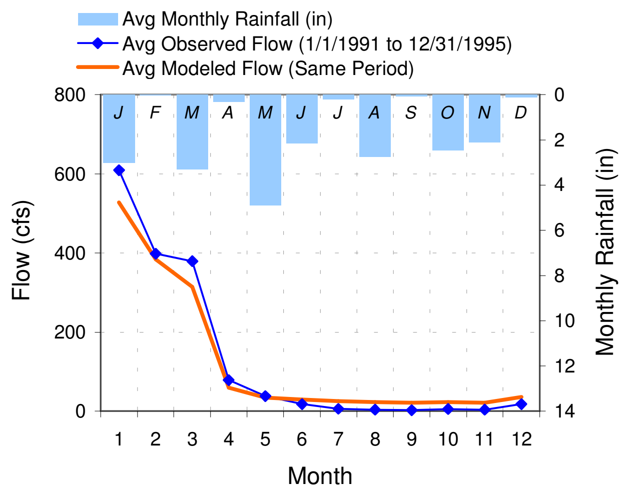
Summary statistics of model hydrology validation to USGS gage 11044300 (Appendix B, No. 3)

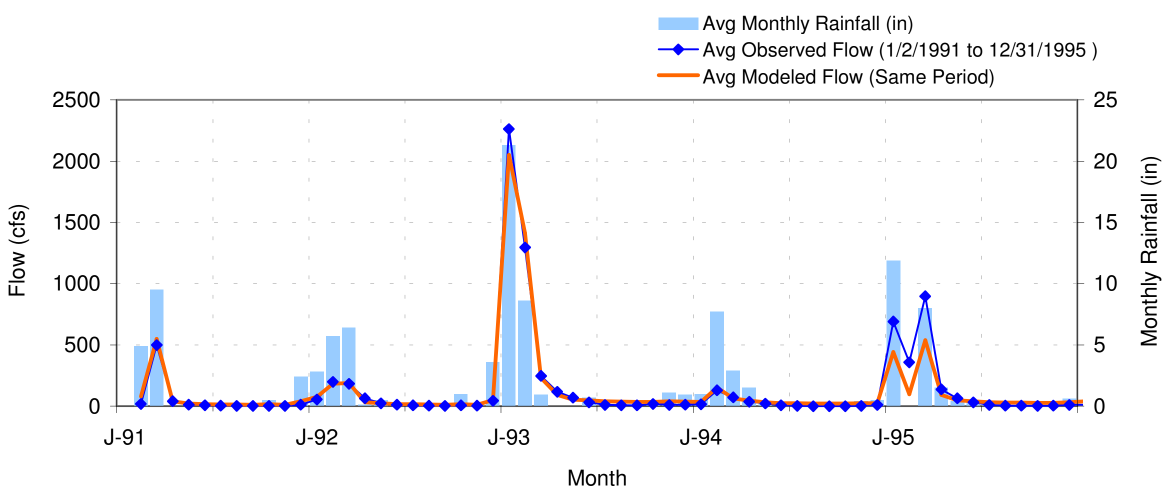


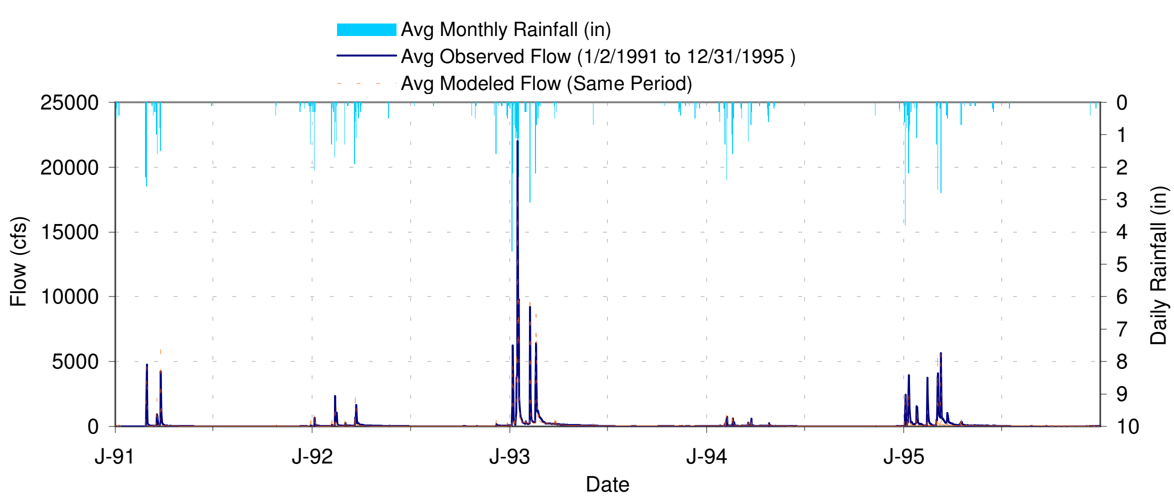
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 615 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11044300 SANTA MARGARITA R A FPUD SUMP NR FALLBROOK CA** San Diego County, California Hydrologic Unit Code 18070302 Latitude 33°24' 49", Longitude 117°14' 25" NAD27 Drainage area 620 square miles		
Total Simulated In-stream Flow:	**0.74**	Total Observed In-stream Flow:		**0.63**
Total of simulated highest 10% flows:	**0.55**	Total of Observed highest 10% flows:		**0.50**
Total of Simulated lowest 50% flows:	**0.07**	Total of Observed Lowest 50% flows:		**0.04**
Simulated Summer Flow Volume (months 7-9):	**0.06**	Observed Summer Flow Volume (7-9):		**0.03**
Simulated Fall Flow Volume (months 10-12):	**0.08**	Observed Fall Flow Volume (10-12):		**0.05**
Simulated Winter Flow Volume (months 1-3):	**0.51**	Observed Winter Flow Volume (1-3):		**0.47**
Simulated Spring Flow Volume (months 4-6):	**0.09**	Observed Spring Flow Volume (4-6):		**0.09**
Total Simulated Storm Volume:	**0.54**	Total Observed Storm Volume:		**0.47**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	8.70	15		
Error in storm volumes:	12.74	20		

Summary statistics of model hydrology calibration to USGS gage 11046000 (Appendix B, No. 3) (1 of 2)





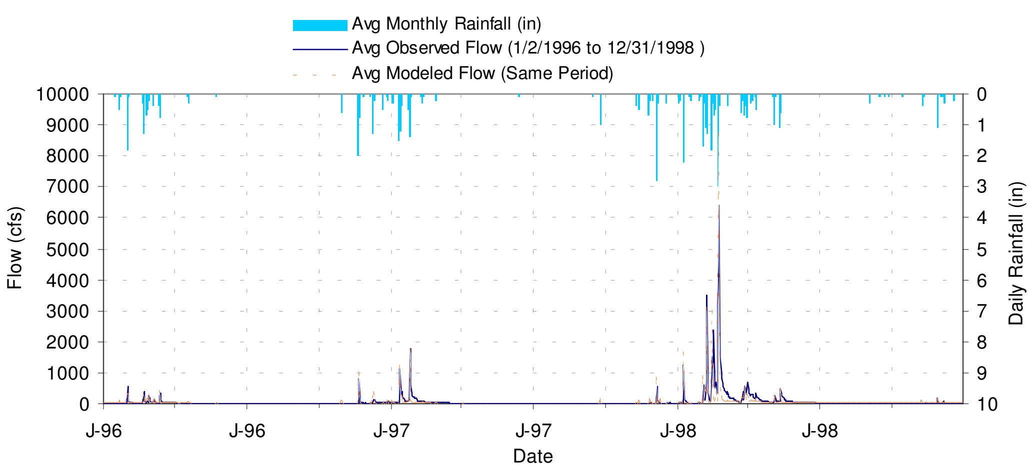




Summary statistics of model hydrology calibration to USGS gage 11046000 (Appendix B, No. 3) (2 of 2)

LSPC Simulated Flow		**Observed Flow Gage**		
REACH OUTFLOW FROM SUBBASIN 602 5-Year Analysis Period: 1/1/1991 - 12/31/1995 Flow volumes are (inches/year) for upstream drainage area		**USGS 11046000 SANTA MARGARITA R A YSIDORA CA** San Diego County, California Hydrologic Unit Code 18070302 Latitude 33°14' 13", Longitude 117°23' 14" NAD27 Drainage area 723 square miles		
Total Simulated In-stream Flow:	**2.32**	Total Observed In-stream Flow:		**2.42**
Total of simulated highest 10% flows:	**1.84**	Total of Observed highest 10% flows:		**2.05**
Total of Simulated lowest 50% flows:	**0.16**	Total of Observed Lowest 50% flows:		**0.04**
Simulated Summer Flow Volume (months 7-9):	**0.11**	Observed Summer Flow Volume (7-9):		**0.02**
Simulated Fall Flow Volume (months 10-12):	**0.13**	Observed Fall Flow Volume (10-12):		**0.04**
Simulated Winter Flow Volume (months 1-3):	**1.89**	Observed Winter Flow Volume (1-3):		**2.15**
Simulated Spring Flow Volume (months 4-6):	**0.19**	Observed Spring Flow Volume (4-6):		**0.21**
Total Simulated Storm Volume:	**1.63**	Total Observed Storm Volume:		**1.75**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.00**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-11.53	15		
Error in storm volumes:	-7.48	20		

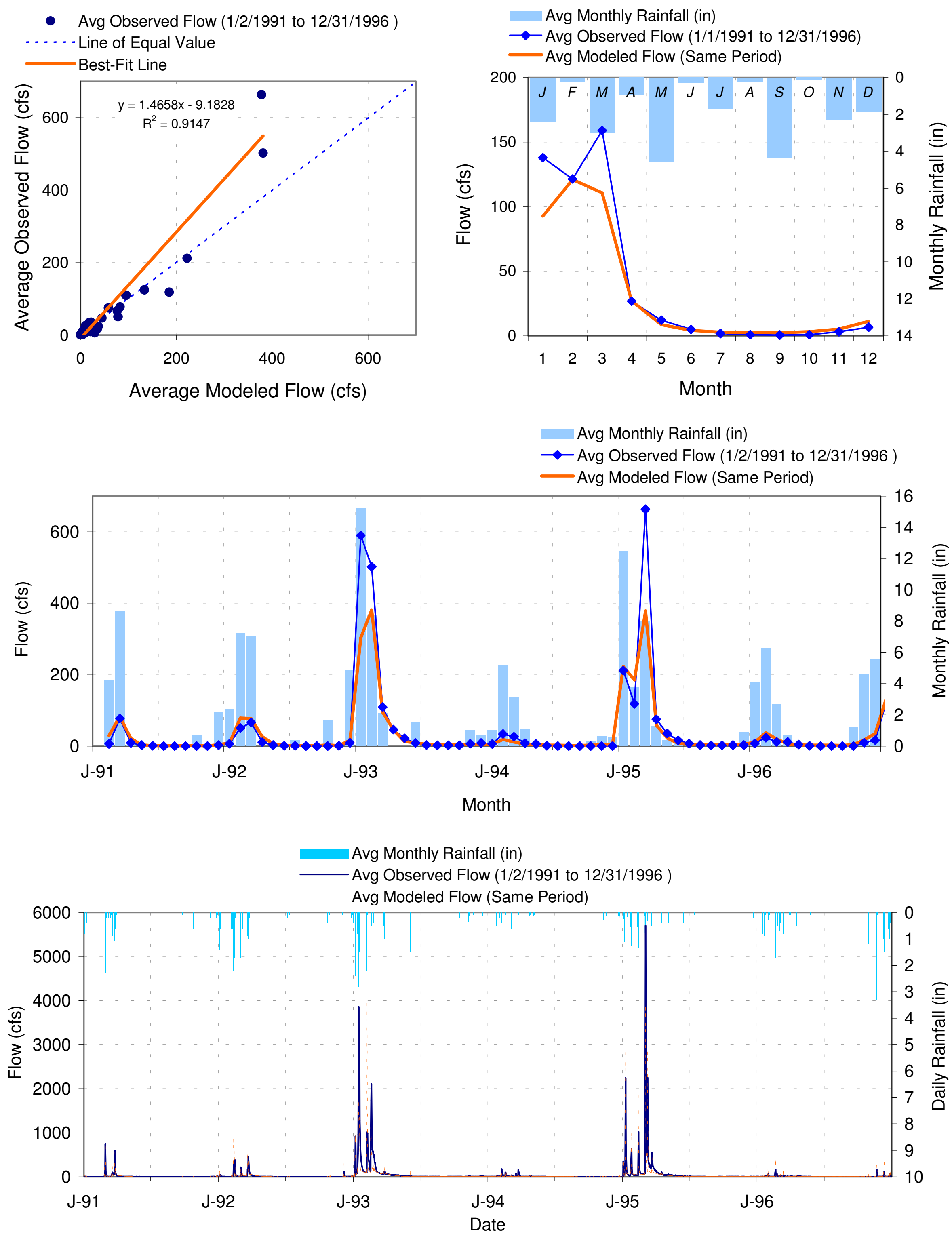
Summary statistics of model hydrology validation to USGS gage 11046000 (Appendix B, No. 3)



LSPC Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM SUBBASIN 602 3-Year Analysis Period: 1/1/1996 - 12/31/1998 Flow volumes are (inches/year) for upstream drainage area		**USGS 11046000 SANTA MARGARITA R A YSIDORA CA** San Diego County, California Hydrologic Unit Code 18070302 Latitude 33°14' 13", Longitude 117°23' 14" NAD27 Drainage area 723 square miles	
Total Simulated In-stream Flow:	**1.28**	Total Observed In-stream Flow:	**1.29**
Total of simulated highest 10% flows:	**0.90**	Total of Observed highest 10% flows:	**1.03**
Total of Simulated lowest 50% flows:	**0.13**	Total of Observed Lowest 50% flows:	**0.02**
Simulated Summer Flow Volume (months 7-9):	**0.09**	Observed Summer Flow Volume (7-9):	**0.01**
Simulated Fall Flow Volume (months 10-12):	**0.17**	Observed Fall Flow Volume (10-12):	**0.09**
Simulated Winter Flow Volume (months 1-3):	**0.86**	Observed Winter Flow Volume (1-3):	**0.99**
Simulated Spring Flow Volume (months 4-6):	**0.16**	Observed Spring Flow Volume (4-6):	**0.20**
Total Simulated Storm Volume:	**0.85**	Total Observed Storm Volume:	**0.85**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):	**0.00**

Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-14.13	15		
Error in storm volumes:	0.84	20		

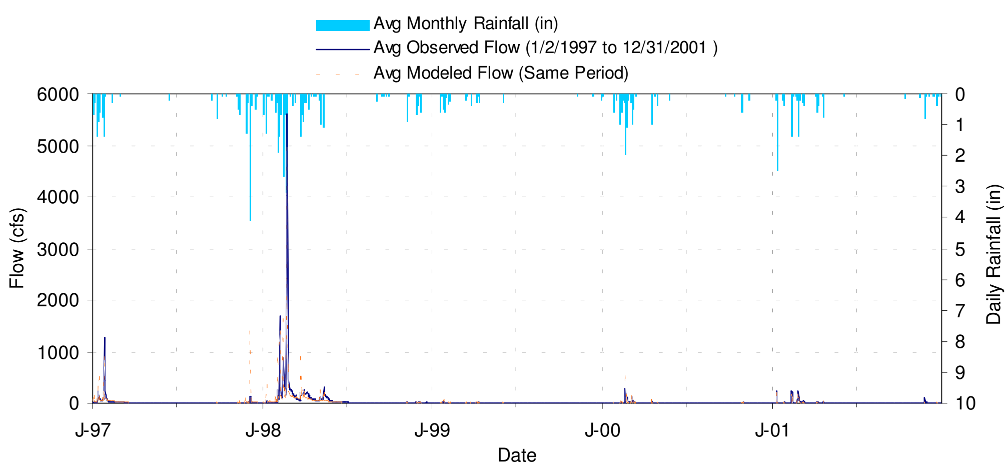
Summary statistics of model hydrology calibration to USGS gage 11046530 (Appendix B, No. 3) (1 of 2)



Summary statistics of model hydrology calibration to USGS gage 11046530 (Appendix B, No. 3) (2 of 2)

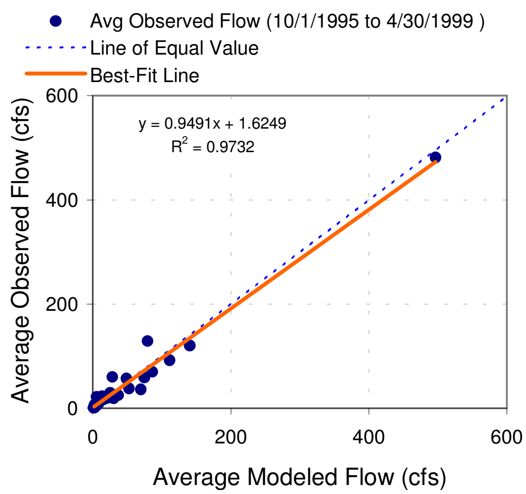
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 411 6-Year Analysis Period: 1/1/1991 - 12/31/1996 Flow volumes are (inches/year) for upstream drainage area		**USGS 11046530 SAN JUAN C AT LA NOVIA ST BR AT SAN JUAN CAPIS CA** Orange County, California Hydrologic Unit Code 18070301 Latitude 33°30' 09", Longitude 117°38' 50" NAD27 Drainage area 109 square miles		
Total Simulated In-stream Flow:	**4.02**	Total Observed In-stream Flow:		**4.90**
Total of simulated highest 10% flows:	**3.26**	Total of Observed highest 10% flows:		**4.22**
Total of Simulated lowest 50% flows:	**0.12**	Total of Observed Lowest 50% flows:		**0.05**
Simulated Summer Flow Volume (months 7-9):	**0.08**	Observed Summer Flow Volume (7-9):		**0.03**
Simulated Fall Flow Volume (months 10-12):	**0.21**	Observed Fall Flow Volume (10-12):		**0.11**
Simulated Winter Flow Volume (months 1-3):	**3.32**	Observed Winter Flow Volume (1-3):		**4.31**
Simulated Spring Flow Volume (months 4-6):	**0.41**	Observed Spring Flow Volume (4-6):		**0.45**
Total Simulated Storm Volume:	**2.59**	Total Observed Storm Volume:		**2.95**
Simulated Summer Storm Volume (7-9):	**0.00**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-29.36	15		
Error in storm volumes:	-13.85	20		

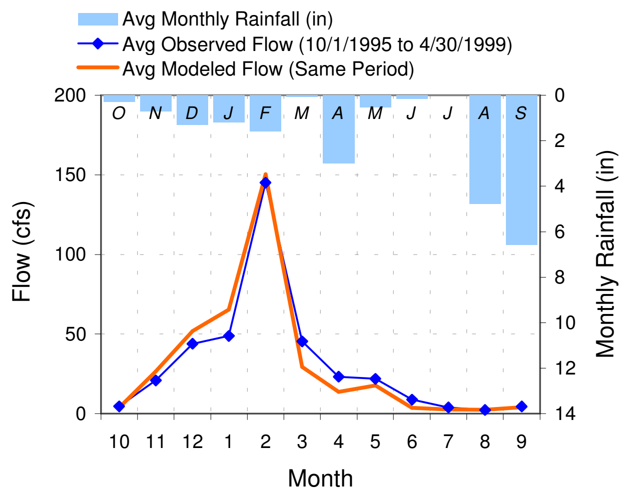
Summary statistics of model hydrology validation to USGS gage 11046530 (Appendix B, No. 3)

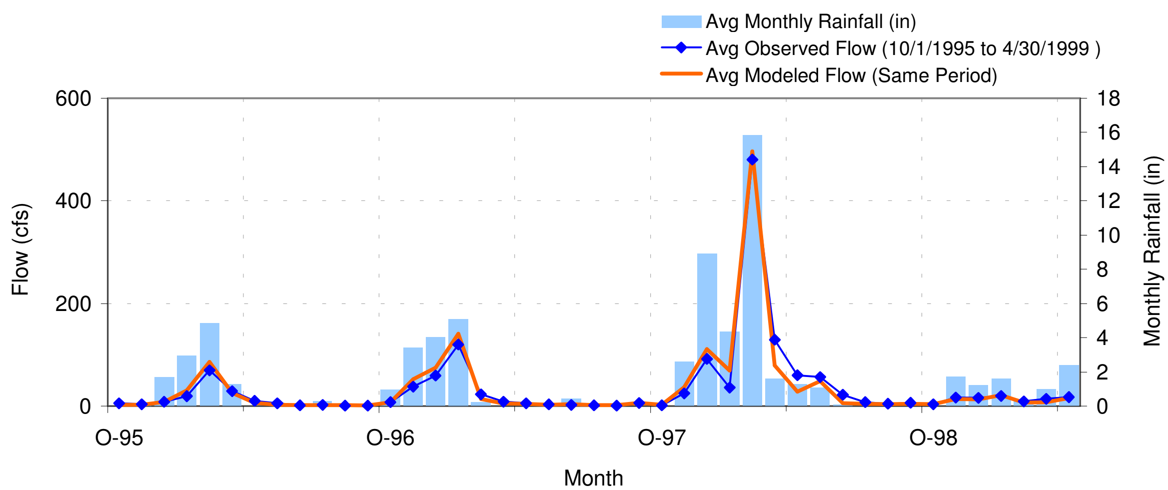


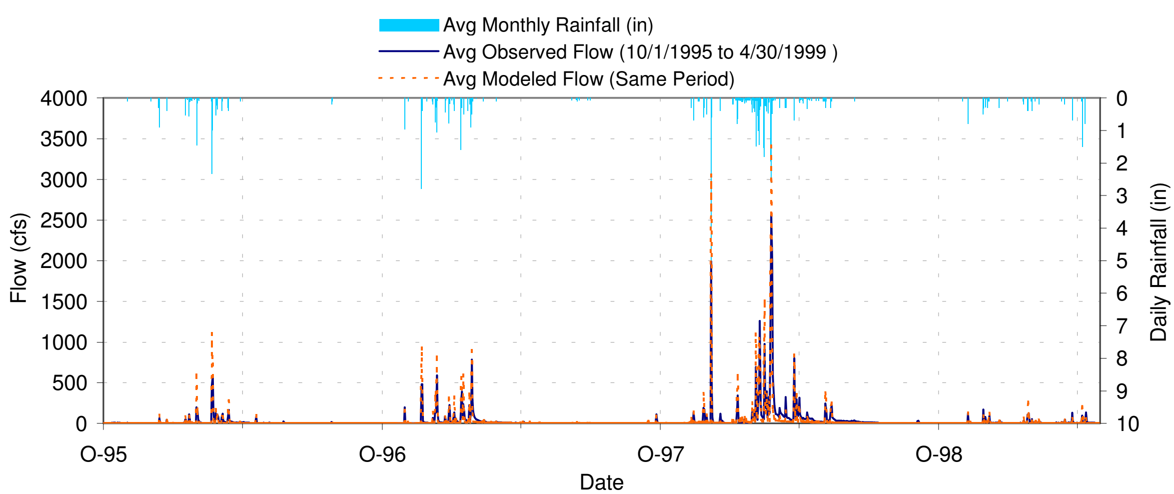
LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 411 5-Year Analysis Period: 1/1/1997 - 12/31/2001 Flow volumes are (inches/year) for upstream drainage area		**USGS 11046530 SAN JUAN C AT LA NOVIA ST BR AT SAN JUAN CAPIS CA** Orange County, California Hydrologic Unit Code 18070301 Latitude 33°30' 09", Longitude 117°38' 50" NAD27 Drainage area 109 square miles		
Total Simulated In-stream Flow:	**3.14**	Total Observed In-stream Flow:		**3.21**
Total of simulated highest 10% flows:	**2.57**	Total of Observed highest 10% flows:		**2.82**
Total of Simulated lowest 50% flows:	**0.12**	Total of Observed Lowest 50% flows:		**0.02**
Simulated Summer Flow Volume (months 7-9):	**0.09**	Observed Summer Flow Volume (7-9):		**0.03**
Simulated Fall Flow Volume (months 10-12):	**0.24**	Observed Fall Flow Volume (10-12):		**0.10**
Simulated Winter Flow Volume (months 1-3):	**2.39**	Observed Winter Flow Volume (1-3):		**2.51**
Simulated Spring Flow Volume (months 4-6):	**0.42**	Observed Spring Flow Volume (4-6):		**0.57**
Total Simulated Storm Volume:	**1.92**	Total Observed Storm Volume:		**1.93**
Simulated Summer Storm Volume (7-9):	**0.01**	Observed Summer Storm Volume (7-9):		**0.01**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-9.98	15		
Error in storm volumes:	-0.53	20		

Summary statistics of model hydrology calibration to USGS gage 11047300 (Appendix B, No. 3) (1 of 2)





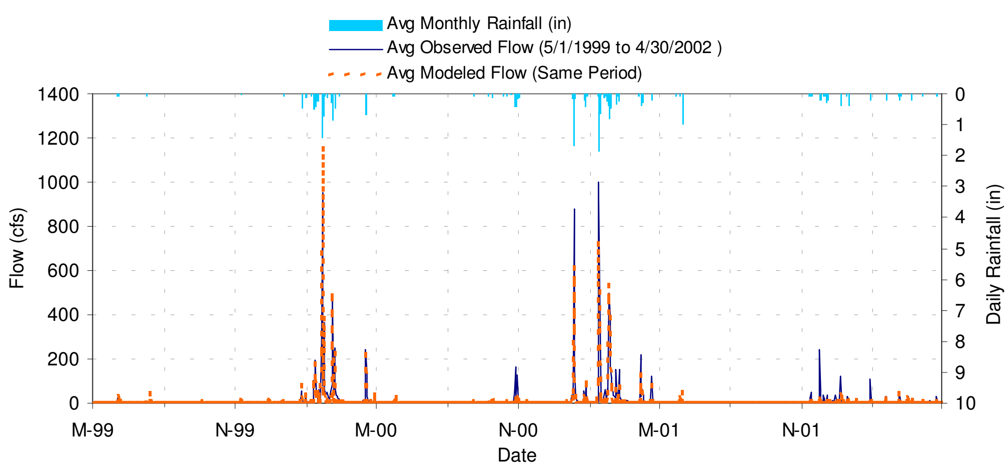




Summary statistics of model hydrology calibration to USGS gage 11047300 (Appendix B, No. 3) (2 of 2)

LSPC Simulated Flow		Observed Flow Gage			
REACH OUTFLOW FROM SUBBASIN 403 3.58-Year Analysis Period: 10/1/1995 - 4/30/1999 Flow volumes are (inches/year) for upstream drainage area		**USGS 11047300 ARROYO TRABUCO A SAN JUAN CAPISTRANO CA** Orange County, California Hydrologic Unit Code 18070301 Latitude 33°29' 54", Longitude 117°39' 54" NAD27 Drainage area 54.1 square miles			
Total Simulated In-stream Flow:	**8.31**	Total Observed In-stream Flow:			**8.28**
Total of simulated highest 10% flows:	**7.15**	Total of Observed highest 10% flows:			**6.32**
Total of Simulated lowest 50% flows:	**0.28**	Total of Observed Lowest 50% flows:			**0.36**
Simulated Summer Flow Volume (months 7-9):	**0.16**	Observed Summer Flow Volume (7-9):			**0.19**
Simulated Fall Flow Volume (months 10-12):	**1.94**	Observed Fall Flow Volume (10-12):			**1.63**
Simulated Winter Flow Volume (months 1-3):	**5.51**	Observed Winter Flow Volume (1-3):			**5.39**
Simulated Spring Flow Volume (months 4-6):	**0.70**	Observed Spring Flow Volume (4-6):			**1.08**
Total Simulated Storm Volume:	**7.07**	Total Observed Storm Volume:			**5.72**
Simulated Summer Storm Volume (7-9):	**0.03**	Observed Summer Storm Volume (7-9):			**0.06**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*		*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	11.71	15			
Error in storm volumes:	18.99	20			

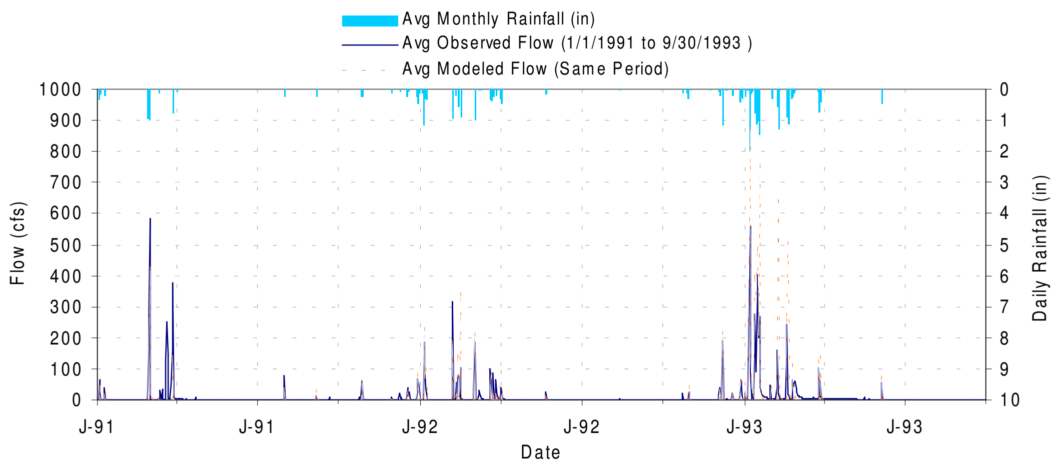
Summary statistics of model hydrology validation to USGS gage 11047300 (Appendix B, No. 3)



LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 403 3-Year Analysis Period: 5/1/1999 - 4/30/2002 Flow volumes are (inches/year) for upstream drainage area		**USGS 11047300 ARROYO TRABUCO A SAN JUAN CAPISTRANO CA** Orange County, California Hydrologic Unit Code 18070301 Latitude 33°29' 54", Longitude 117°39' 54" NAD27 Drainage area 54.1 square miles		
Total Simulated In-stream Flow:	**2.28**	Total Observed In-stream Flow:		**3.35**
Total of simulated highest 10% flows:	**1.93**	Total of Observed highest 10% flows:		**2.57**
Total of Simulated lowest 50% flows:	**0.13**	Total of Observed Lowest 50% flows:		**0.23**
Simulated Summer Flow Volume (months 7-9):	**0.11**	Observed Summer Flow Volume (7-9):		**0.10**
Simulated Fall Flow Volume (months 10-12):	**0.15**	Observed Fall Flow Volume (10-12):		**0.45**
Simulated Winter Flow Volume (months 1-3):	**1.71**	Observed Winter Flow Volume (1-3):		**2.32**
Simulated Spring Flow Volume (months 4-6):	**0.30**	Observed Spring Flow Volume (4-6):		**0.47**
Total Simulated Storm Volume:	**1.91**	Total Observed Storm Volume:		**2.33**
Simulated Summer Storm Volume (7-9):	**0.02**	Observed Summer Storm Volume (7-9):		**0.01**

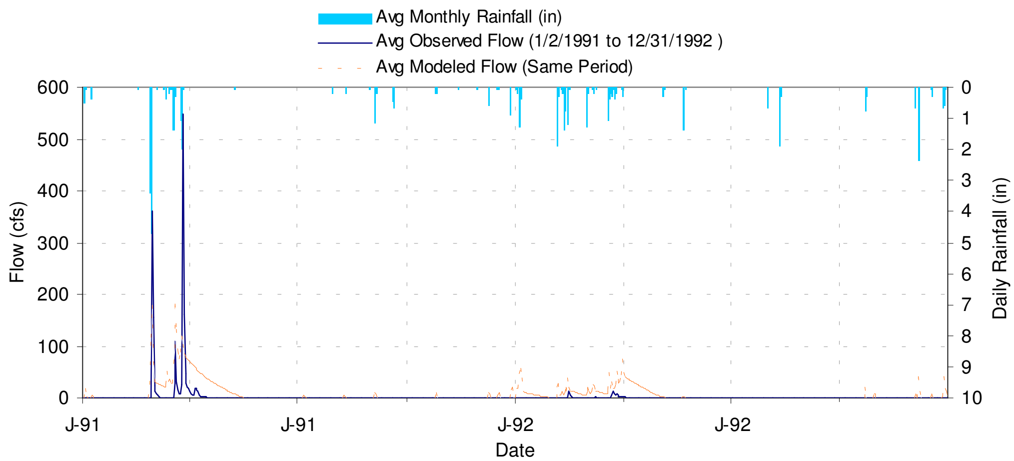
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	-33.27	15		
Error in storm volumes:	-21.87	20		

Summary statistics of model hydrology validation to USGS gage 11022350 (Appendix B, No. 3)



LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1843 2.75-Year Analysis Period: 1/1/1991 - 9/30/1993 Flow volumes are (inches/year) for upstream drainage area		**USGS 11022350 FORESTER C A EL CAJON CA** San Diego County, California Hydrologic Unit Code 18070304 Latitude 32°49' 16", Longitude 116°58' 32" NAD27 Drainage area 21.3 square miles		
Total Simulated In-stream Flow:	**6.50**	Total Observed In-stream Flow:		**5.96**
Total of simulated highest 10% flows:	**6.37**	Total of Observed highest 10% flows:		**5.32**
Total of Simulated lowest 50% flows:	**0.03**	Total of Observed Lowest 50% flows:		**0.13**
Simulated Summer Flow Volume (months 7-9):	**0.07**	Observed Summer Flow Volume (7-9):		**0.13**
Simulated Fall Flow Volume (months 10-12):	**0.50**	Observed Fall Flow Volume (10-12):		**0.55**
Simulated Winter Flow Volume (months 1-3):	**5.77**	Observed Winter Flow Volume (1-3):		**4.96**
Simulated Spring Flow Volume (months 4-6):	**0.16**	Observed Spring Flow Volume (4-6):		**0.32**
Total Simulated Storm Volume:	**5.58**	Total Observed Storm Volume:		**4.87**
Simulated Summer Storm Volume (7-9):	**0.05**	Observed Summer Storm Volume (7-9):		**0.07**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*	*Run (n-2)*
Error in 10% highest flows:	16.45	15		
Error in storm volumes:	12.64	20		

Summary statistics of model hydrology validation to USGS gage 11039800 (Appendix B, No. 3)



LSPC Simulated Flow		**Observed Flow Gage**			
REACH OUTFLOW FROM SUBBASIN 711 2-Year Analysis Period: 1/1/1991 - 12/31/1992 Flow volumes are (inches/year) for upstream drainage area		**USGS 11039800 SAN LUIS REY R A COUSER CYN BR NR PALA CA** San Diego County, California Hydrologic Unit Code 18070303 Latitude 33°20' 26", Longitude 117°07' 50" NAD27 Drainage area 364 square miles			
Total Simulated In-stream Flow:	**4.77**	Total Observed In-stream Flow:			**1.48**
Total of simulated highest 10% flows:	**3.30**	Total of Observed highest 10% flows:			**1.48**
Total of Simulated lowest 50% flows:	**0.00**	Total of Observed Lowest 50% flows:			**0.00**
Simulated Summer Flow Volume (months 7-9):	**0.03**	Observed Summer Flow Volume (7-9):			**0.00**
Simulated Fall Flow Volume (months 10-12):	**0.23**	Observed Fall Flow Volume (10-12):			**0.00**
Simulated Winter Flow Volume (months 1-3):	**2.75**	Observed Winter Flow Volume (1-3):			**1.36**
Simulated Spring Flow Volume (months 4-6):	**1.77**	Observed Spring Flow Volume (4-6):			**0.12**
Total Simulated Storm Volume:	**1.41**	Total Observed Storm Volume:			**1.24**
Simulated Summer Storm Volume (7-9):	**0.03**	Observed Summer Storm Volume (7-9):			**0.00**
Errors (Simulated-Observed)	*Current Run (n)*	*Recommended Criteria*	*Run (n-1)*		*Run (n-2)*
Error in 10% highest flows:	55.14	15			
Error in storm volumes:	11.54	20			

Appendix N
Comparison of LSPC Modeling Results to Observed Concentrations

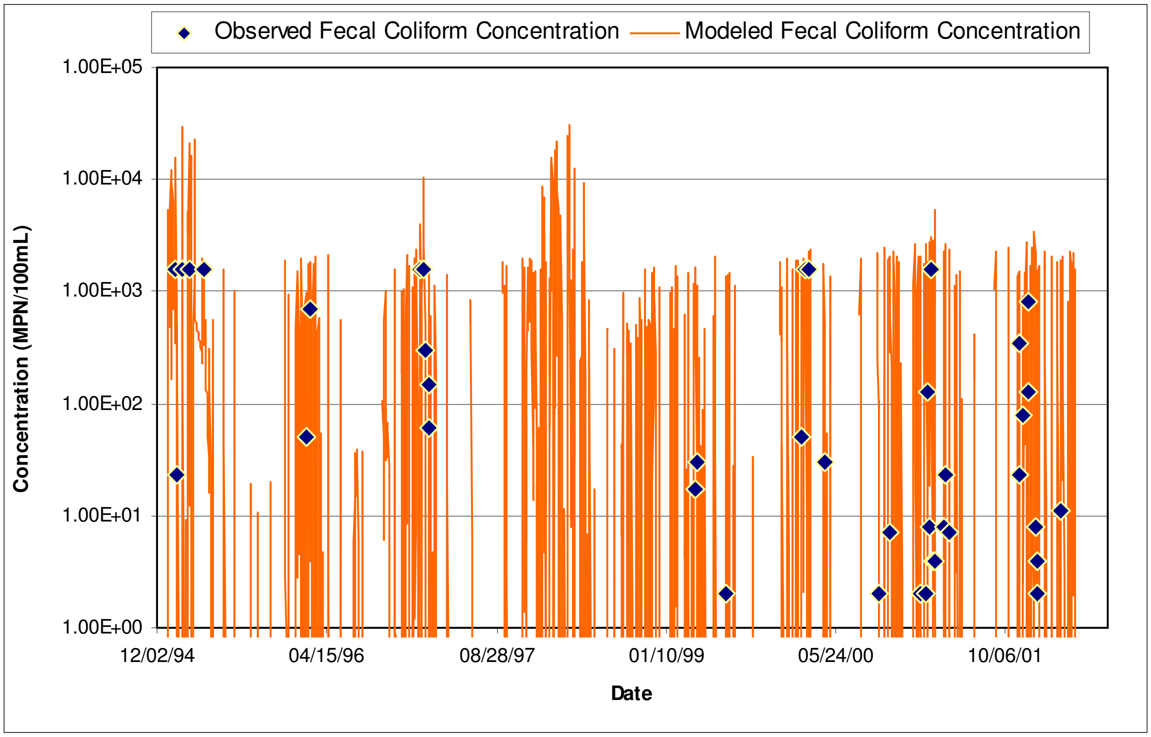


Figure N-1. Time-series comparison of modeled and observed wet weather fecal coliform concentrations in the Santa Margarita River watershed (Appendix M, No. 8 [station #4] and No. 9 [plant #13])

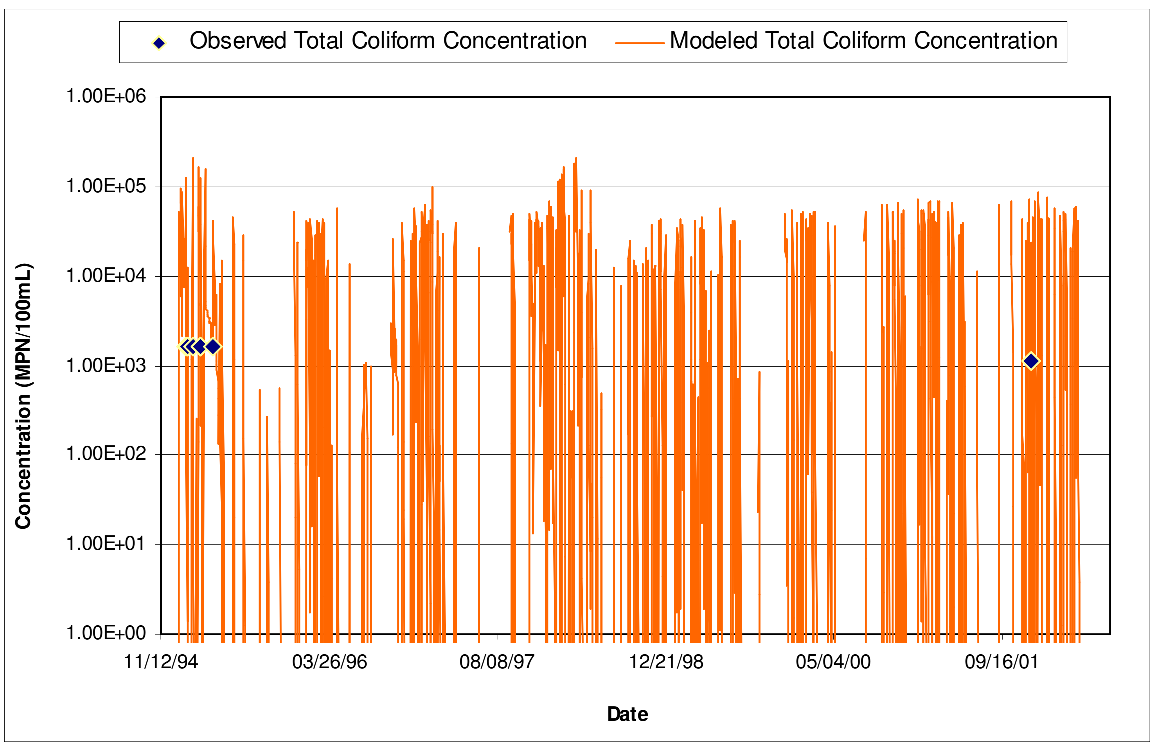


Figure N- 2. Time-series comparison of modeled and observed wet weather total coliform concentrations in the Santa Margarita River watershed (Appendix M, No. 8 [station #4] and No. 9 [plant #13])

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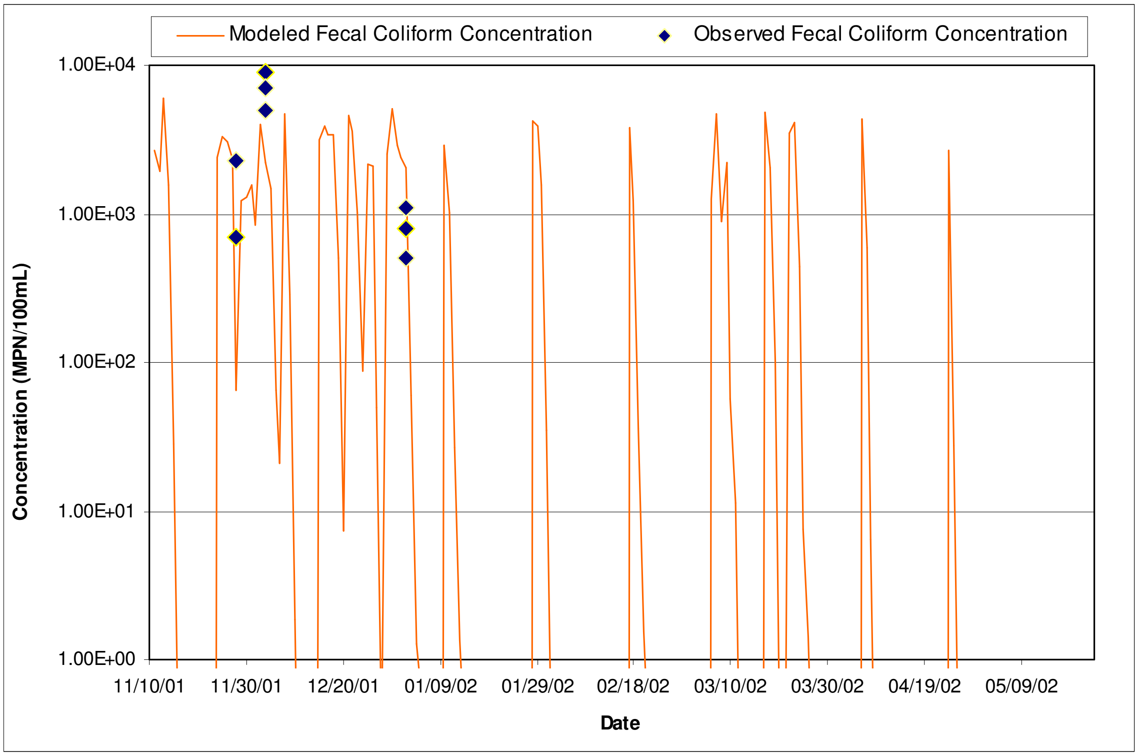

Figure N-3. Time-series comparison of modeled and observed wet weather fecal coliform concentrations in the Aliso Creek watershed (Appendix M, No. 10 [station J01 @ TP and U/S J01/J02])

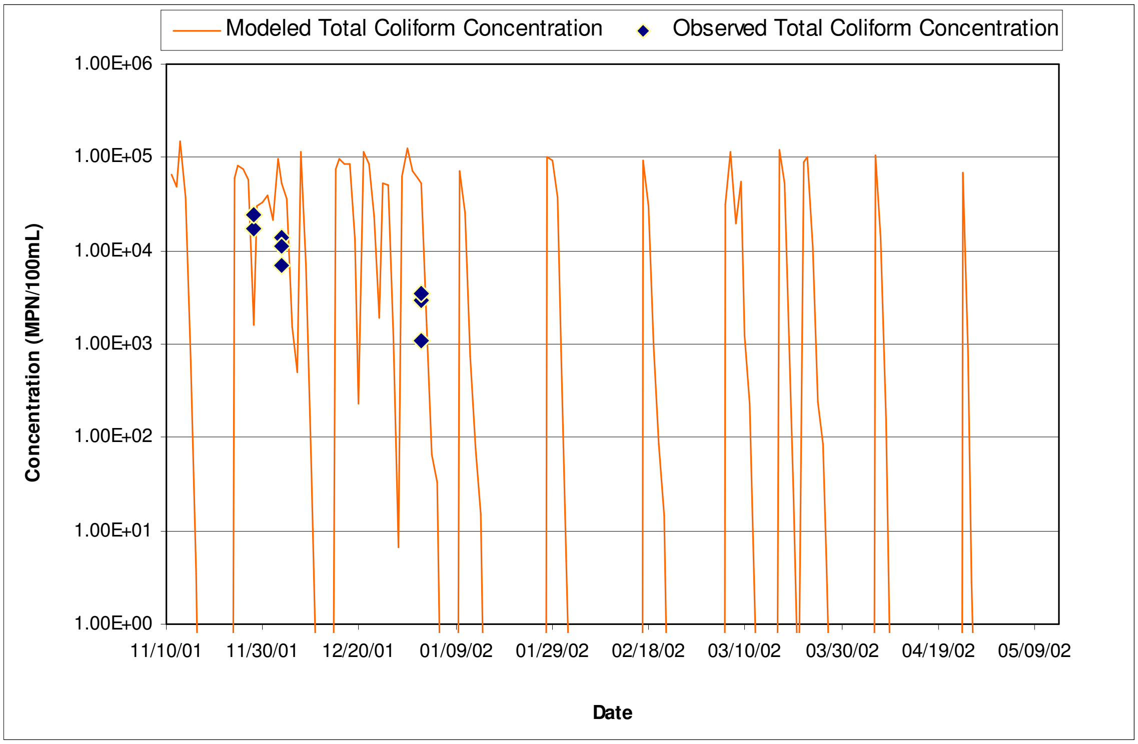

Figure N-4. Time-series comparison of modeled and observed wet weather total coliform concentrations in the Aliso Creek watershed for stations (Appendix M, No. 10 [station J01 @ TP and U/S J01/J02])

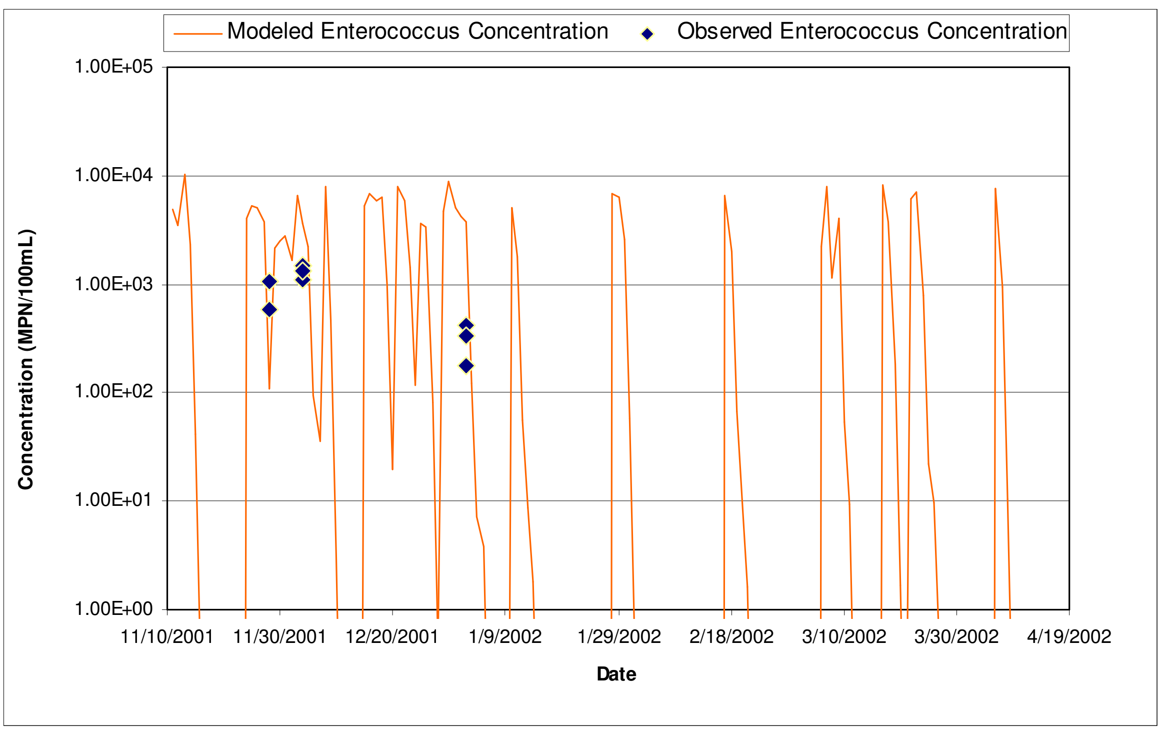

Figure N-5. Time-series comparison of modeled and observed wet weather enterococcus concentrations in the Aliso Creek watershed for stations (Appendix M, No. 10 [station J01 @ TP and U/S J01/J02])

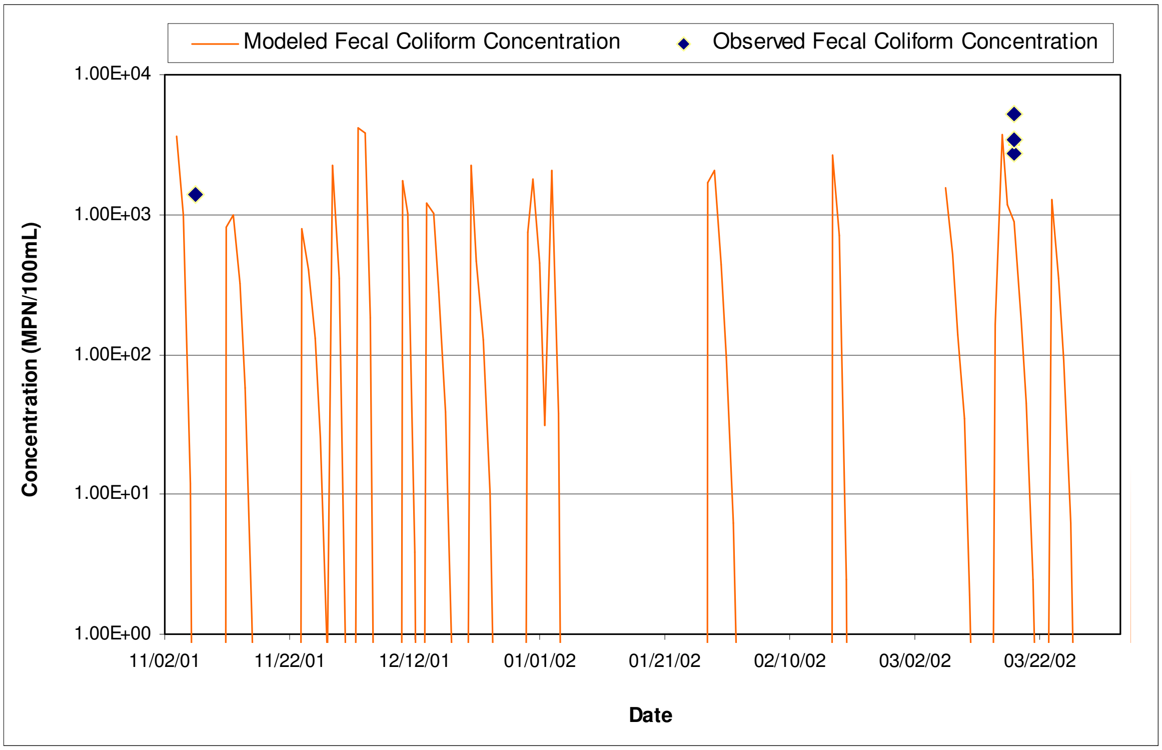

Figure N-6. Time-series comparison of modeled and observed wet weather fecal coliform concentrations in the Rose Creek watershed (Appendix M, No. 12 [stations MBW 20 and MBW 21])

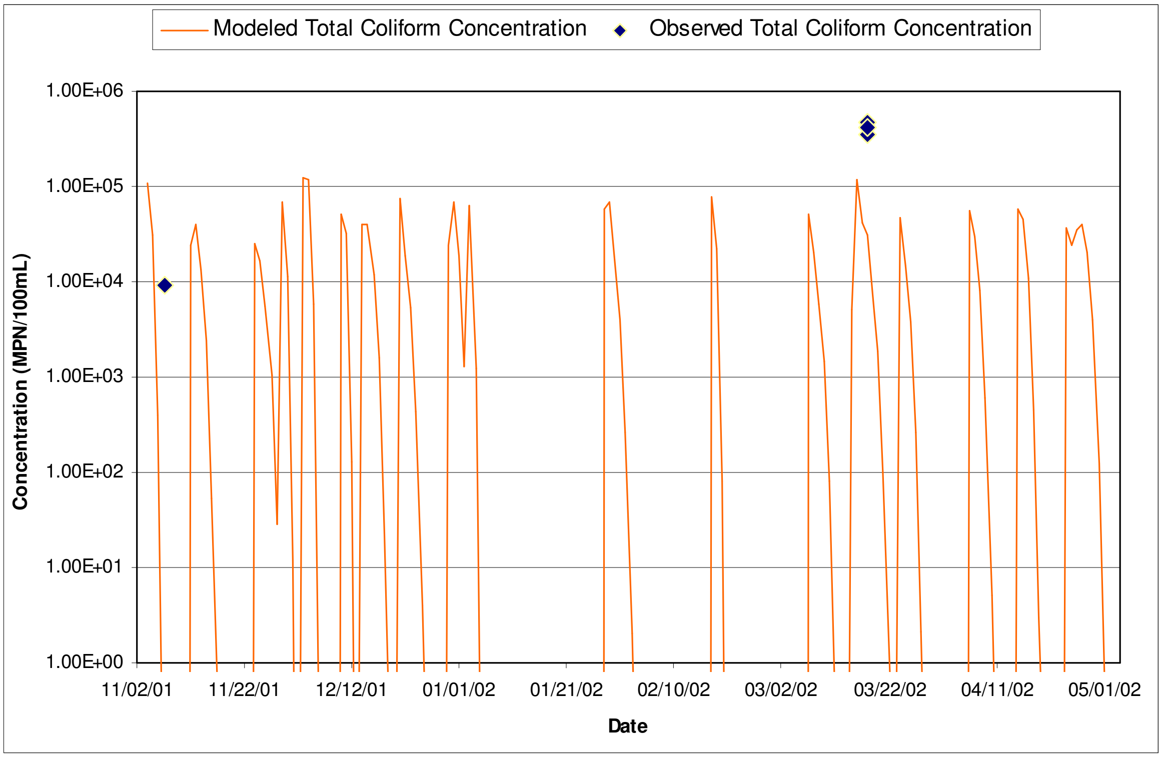

Figure N-7. Time-series comparison of modeled and observed wet weather total coliform concentrations in the Rose Creek watershed (Appendix M, No. 12 [stations MBW 19, MBW 20 and MBW 21]).

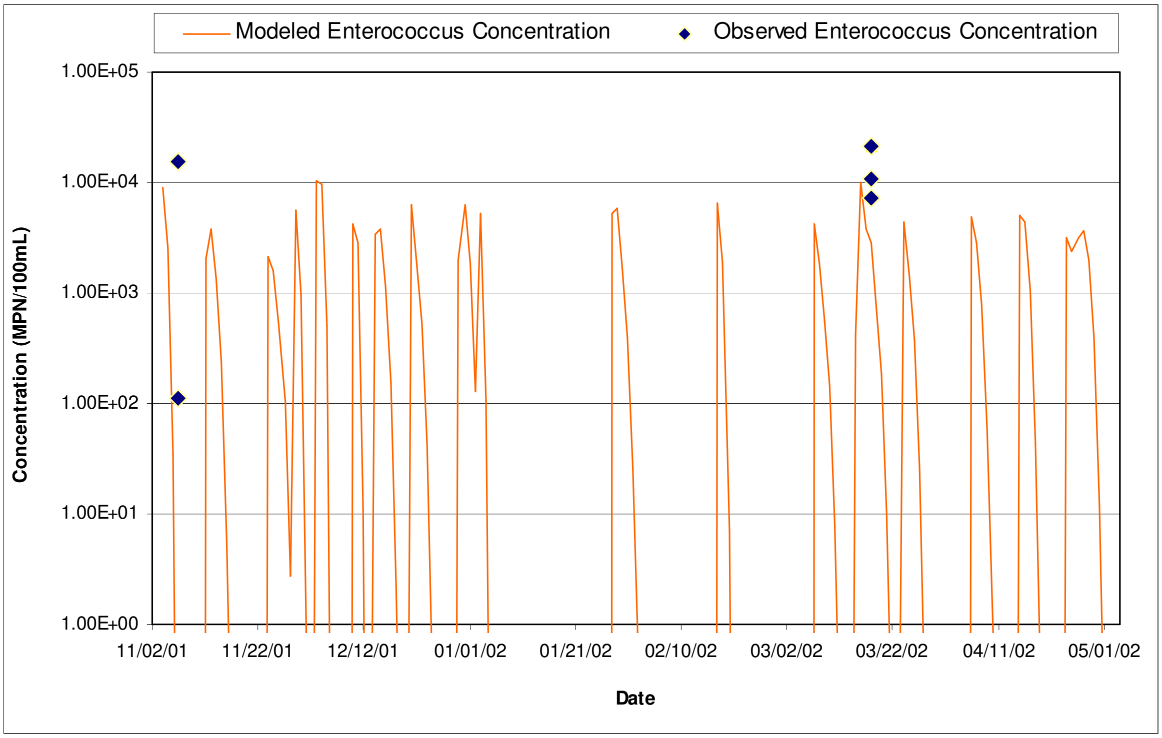

Figure N-8. Time-series comparison of modeled and observed wet weather enterococcus concentrations in the Rose Creek watershed (Appendix M, No. 12 [stations MBW 19, MBW 20 and MBW 21])

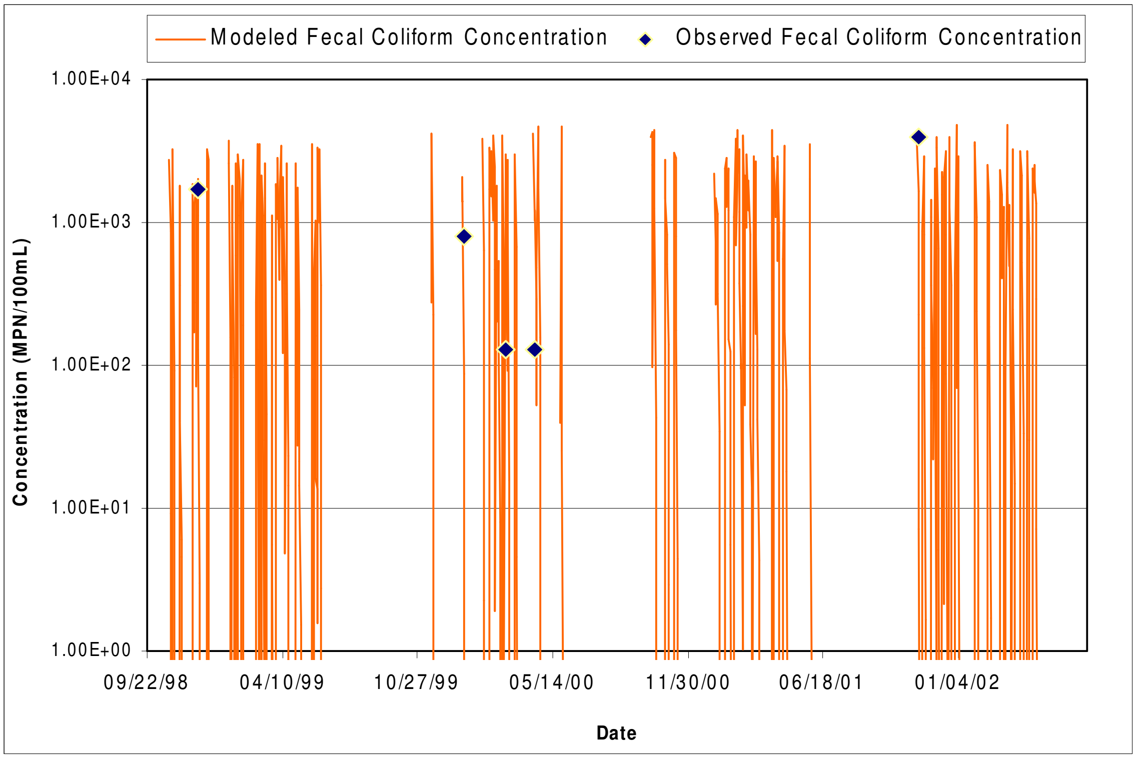

Figure N-9. Time-series comparison of modeled and observed wet weather fecal coliform concentrations in the San Diego River watershed (Appendix M, No. 13 [station 1]).

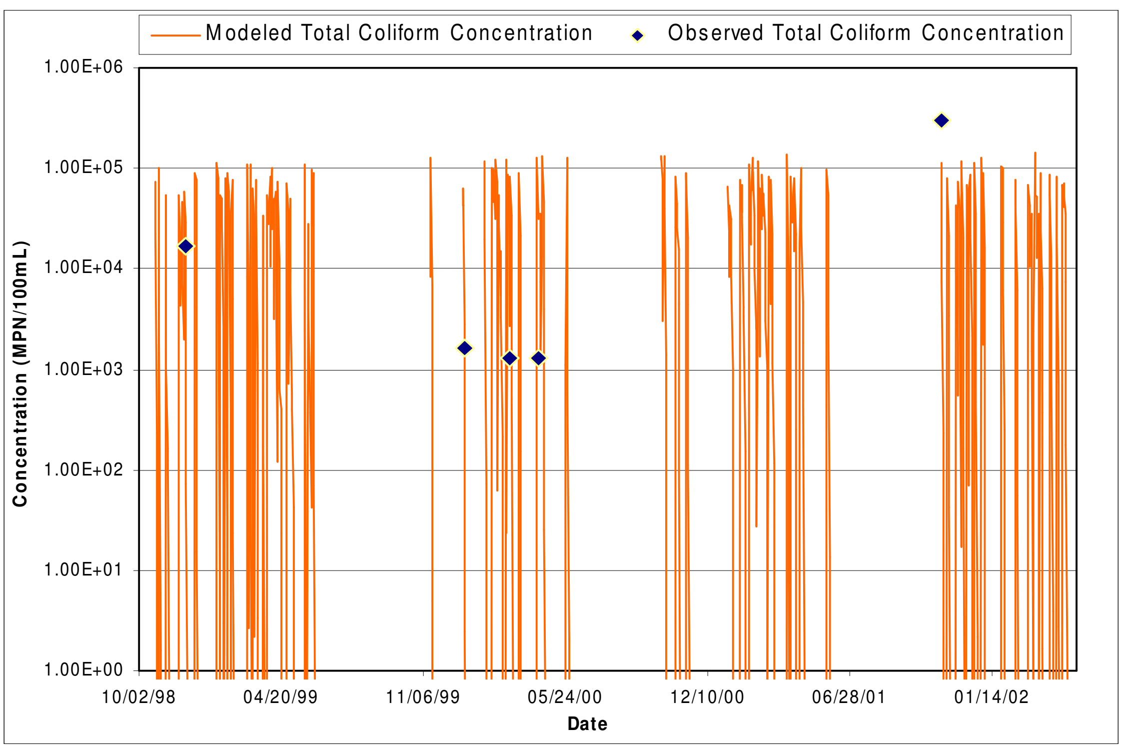

Figure N-10. Time-series comparison of modeled and observed wet weather total coliform concentrations in the San Diego River watershed (Appendix M, No. 13 [station 1])

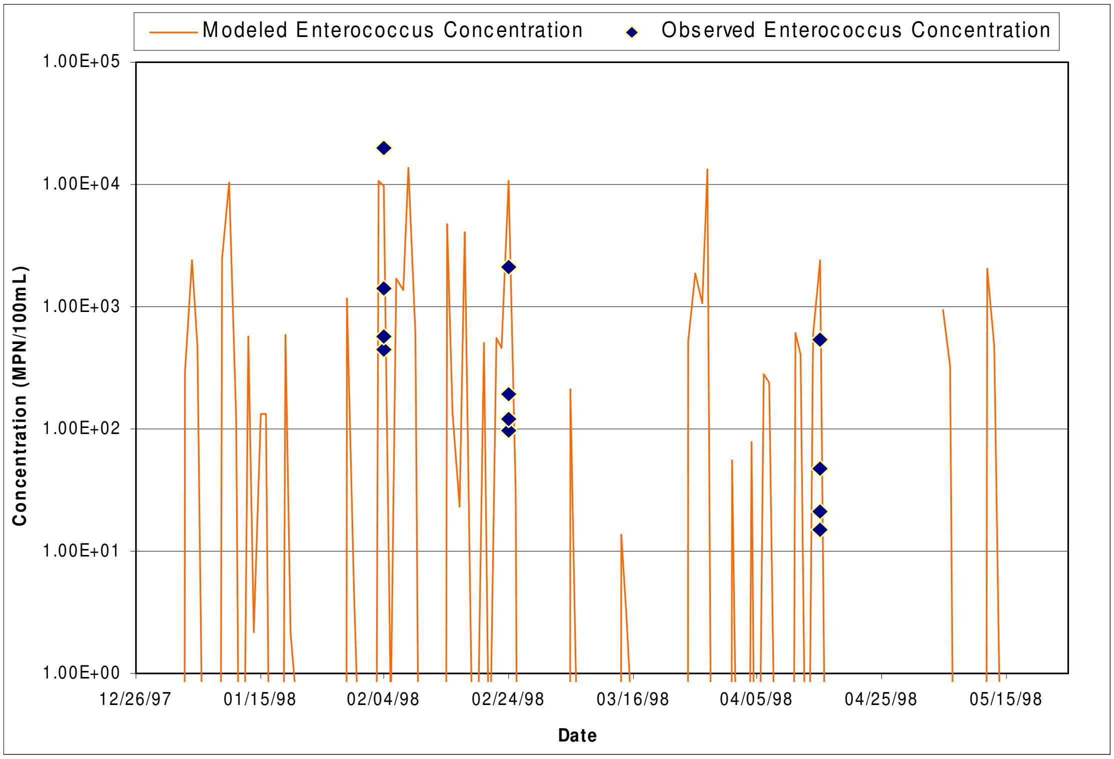

Figure N-11. Time-series comparison of modeled and observed wet weather enterococcus concentrations in the Pine Valley watershed (Appendix M, No.14 [stations NPC3C, NPC3D, and PVC1A])

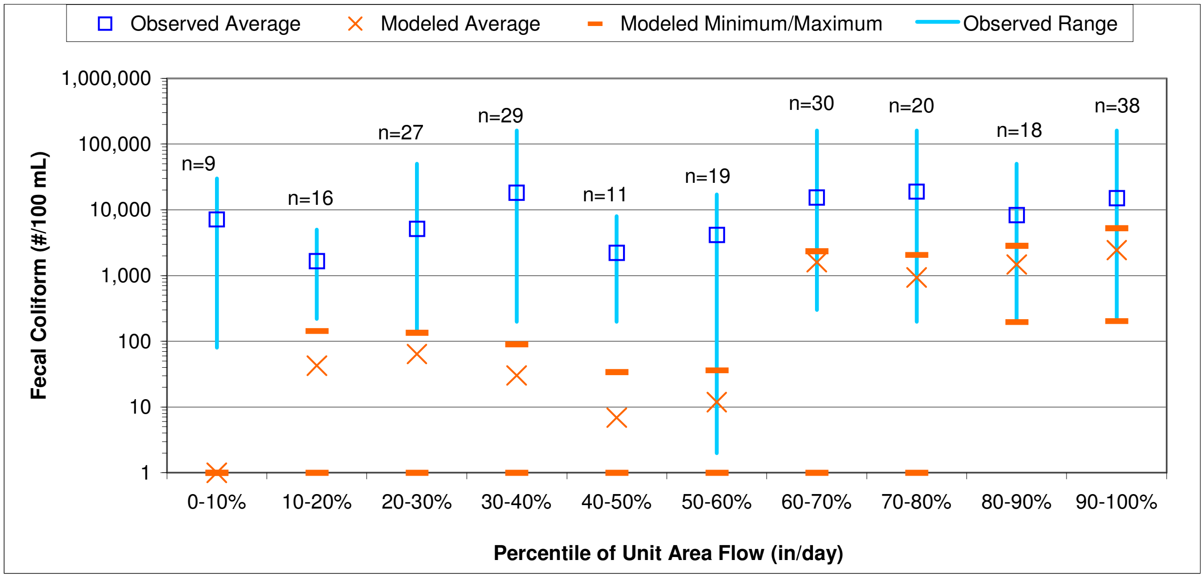

Figure N-12. Graphical comparison of LSPC model results and observed fecal coliform data in the Aliso Creek watershed (Appendix M, No.10).

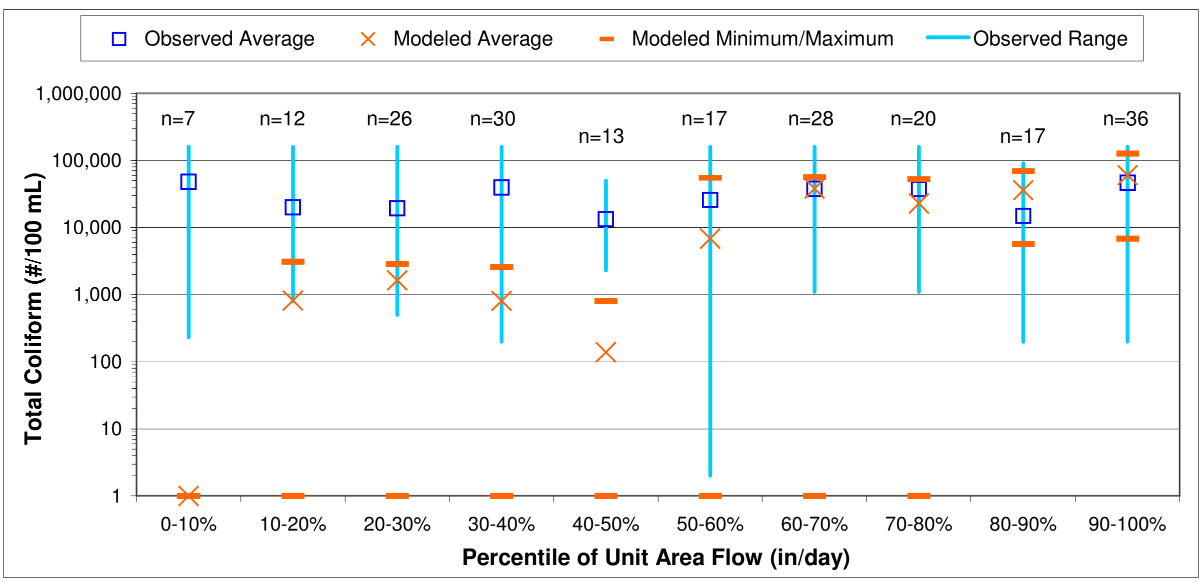

Figure N-13. Graphical comparison of LSPC model results and observed total coliform data in the Aliso Creek watershed (Appendix M, No.10).

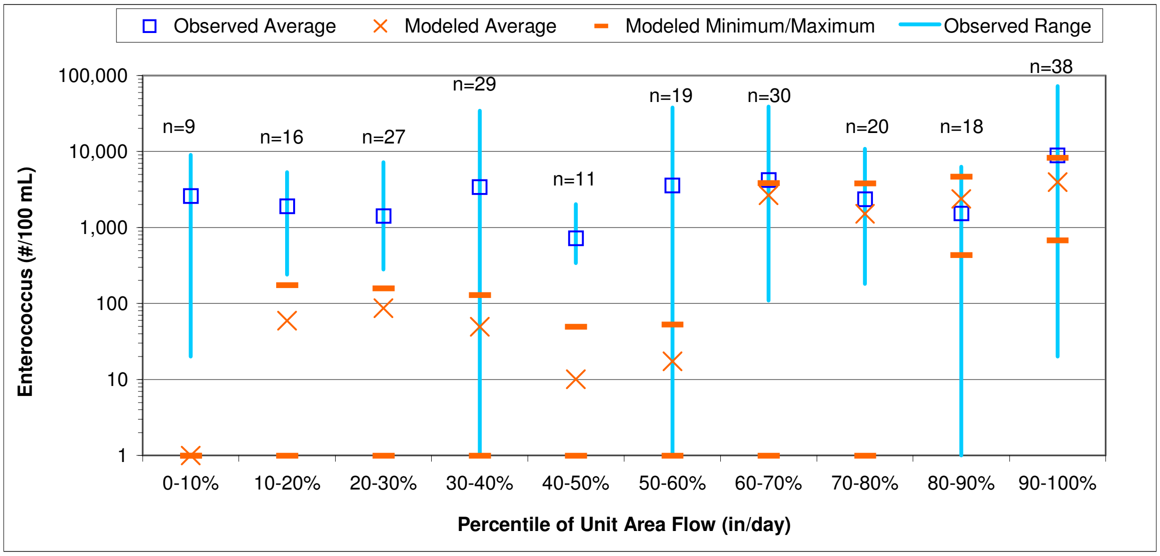

Figure N-14. Graphical comparison of LSPC model results and observed enterococcus data in the Aliso Creek watershed (Appendix M, No.10)

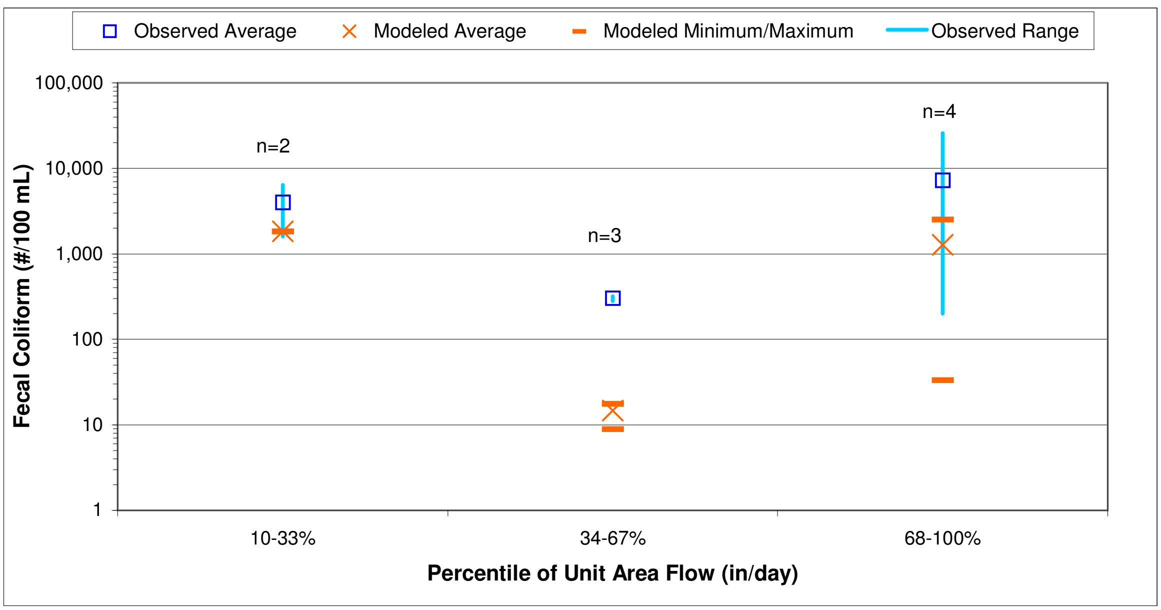

Figure N-15. Graphical comparison of LPSC model results and observed fecal coliform data in the San Juan Creek watershed (Appendix M, No 11)

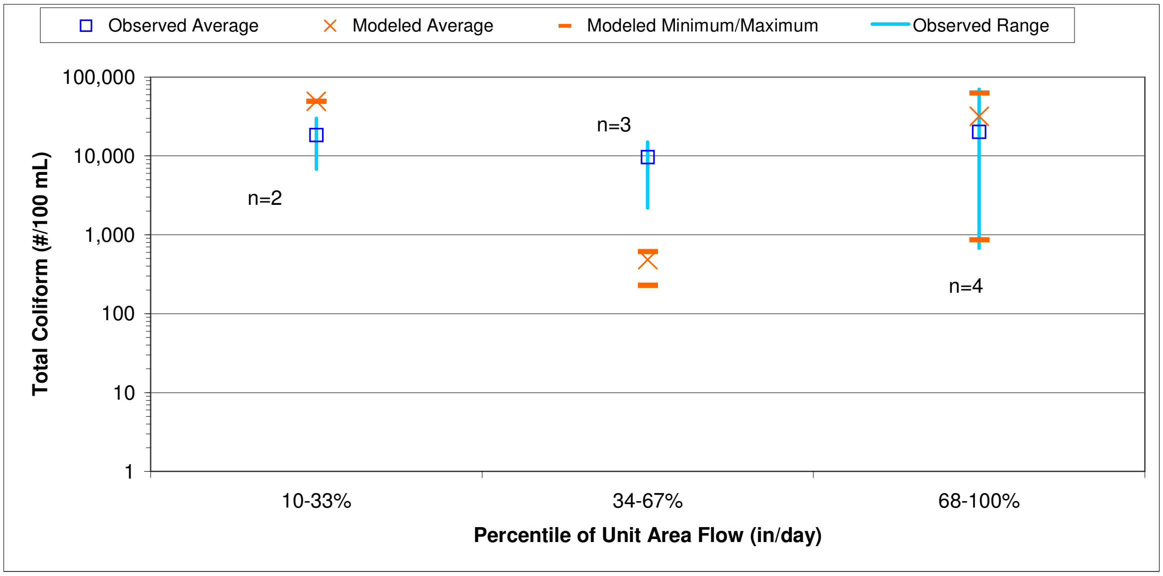

Figure N-16. Graphical comparison of LPSC model results and observed total coliform data in the San Juan Creek watershed (Appendix M, No 11)

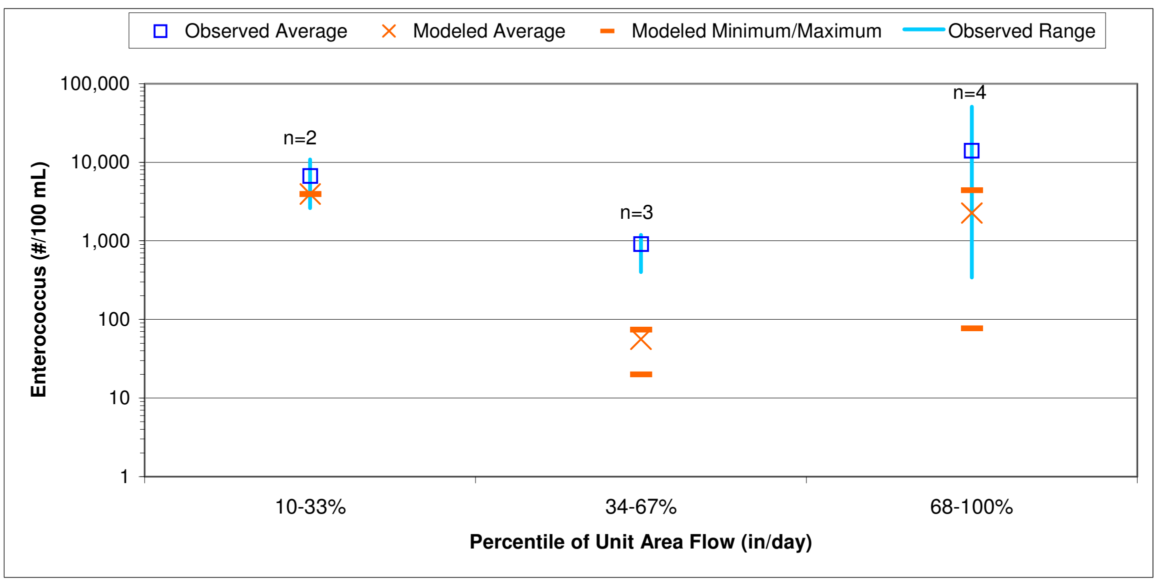

Figure N-17. Graphical comparison of LPSC model results and observed enterococcus data in the San Juan Creek watershed (Appendix M, No 11)

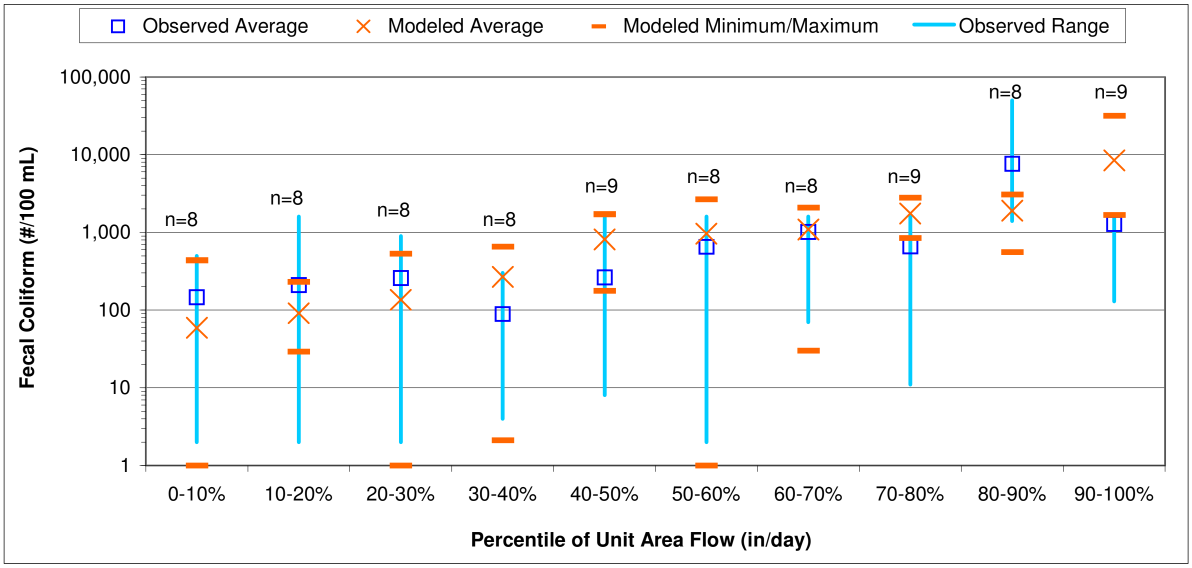

Figure N-18. Graphical comparison of LPSC model results and observed fecal coliform data in the Santa Margarita River watershed (Appendix M, No. 8 and 9)

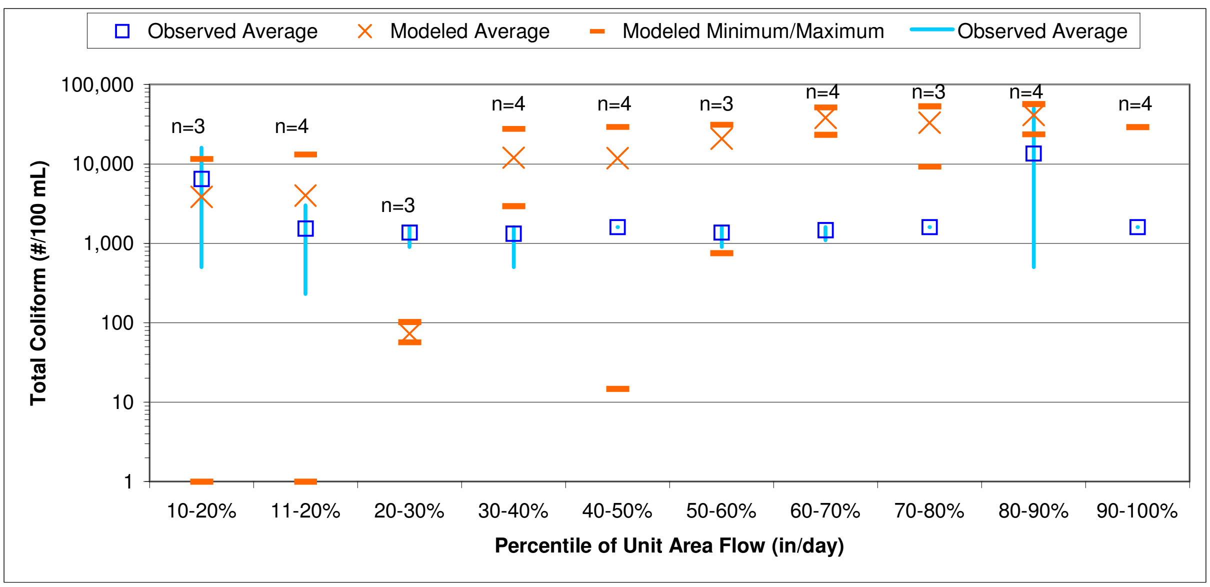

Figure N-19. Graphical comparison of LPSC model results and observed total coliform data in the Santa Margarita River watershed (Appendix M, No. 8 and 9)

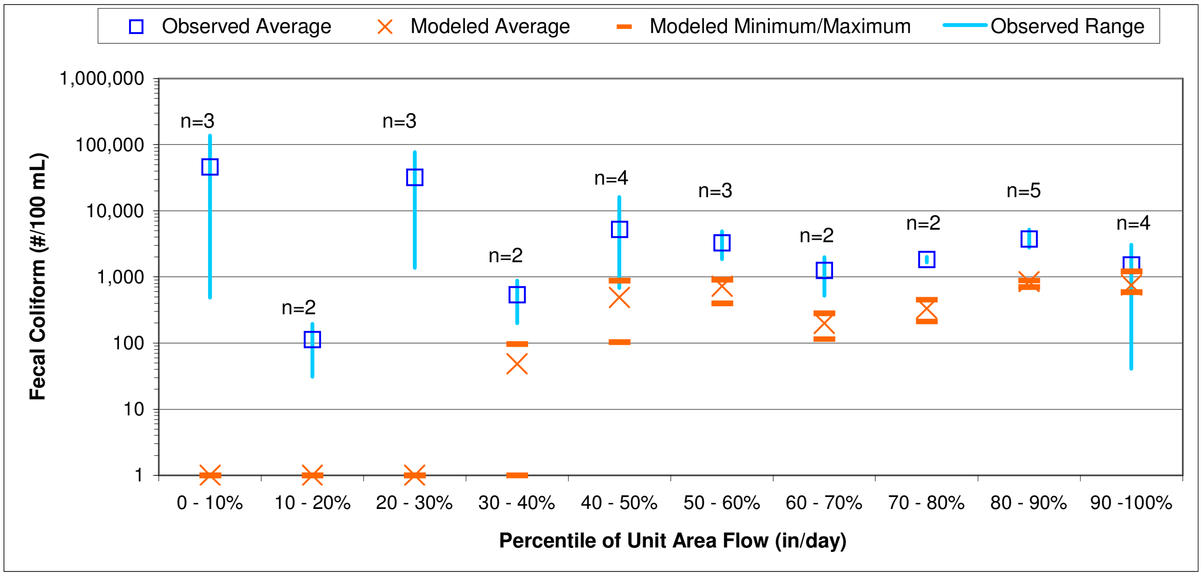

Figure N-20. Graphical comparison of LPSC model results and observed fecal coliform data in the Rose Creek and Tecolote Creek watersheds (Appendix M, No. 12).

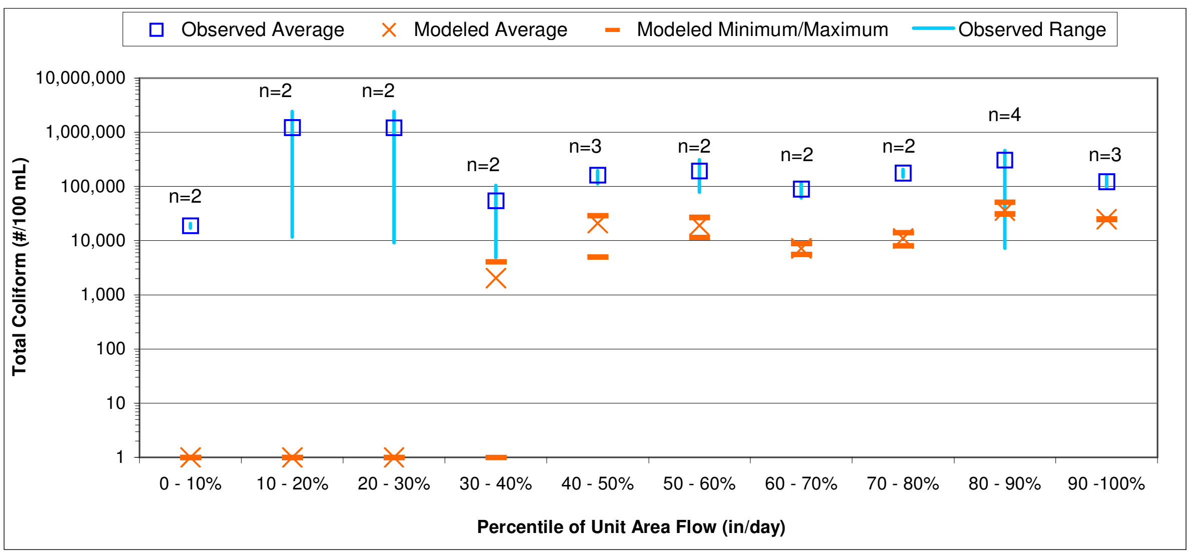

Figure 21. Graphical comparison of LPSC model results and observed total coliform data in the Rose Creek and Tecolote Creek watersheds (Appendix M, No. 12).

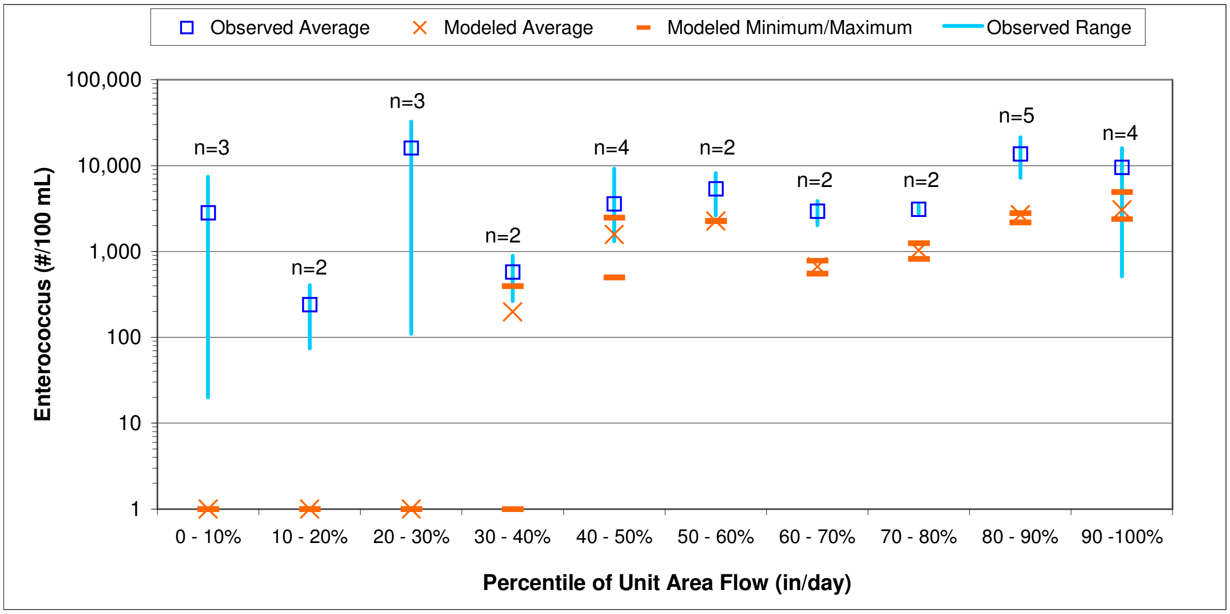

Figure N-22. Graphical comparison of LPSC model results and observed enterococcus data in the Rose Creek and Tecolote Creek watersheds (Appendix M, No. 12).

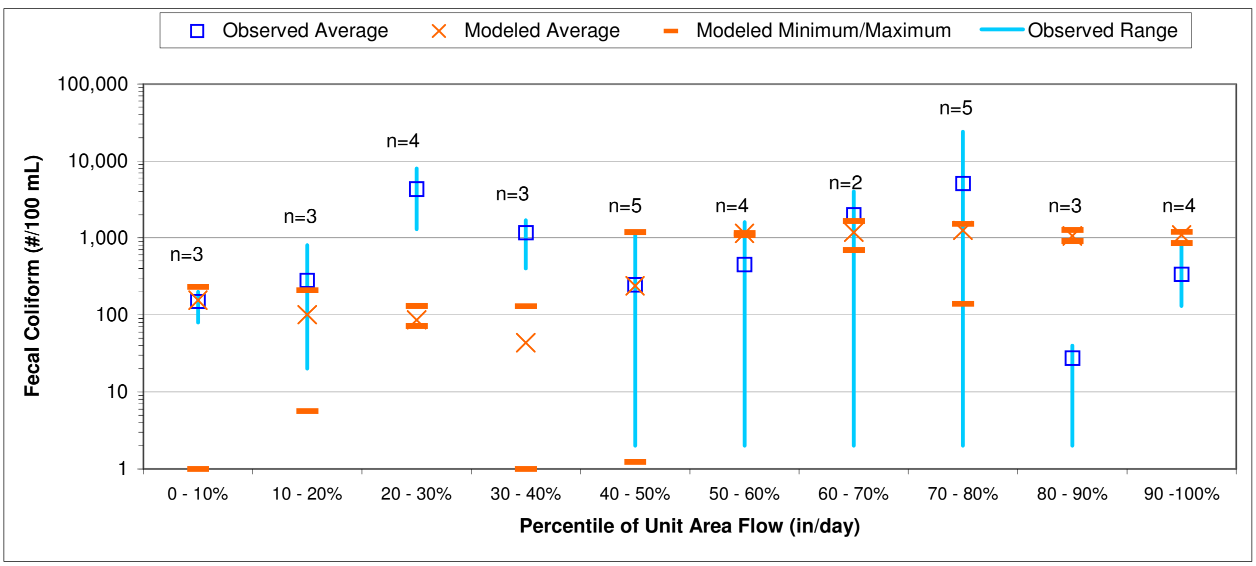

Figure N-23. Graphical comparison of LPSC model results and observed fecal coliform data in the San Diego River watershed (Appendix M, No. 13).

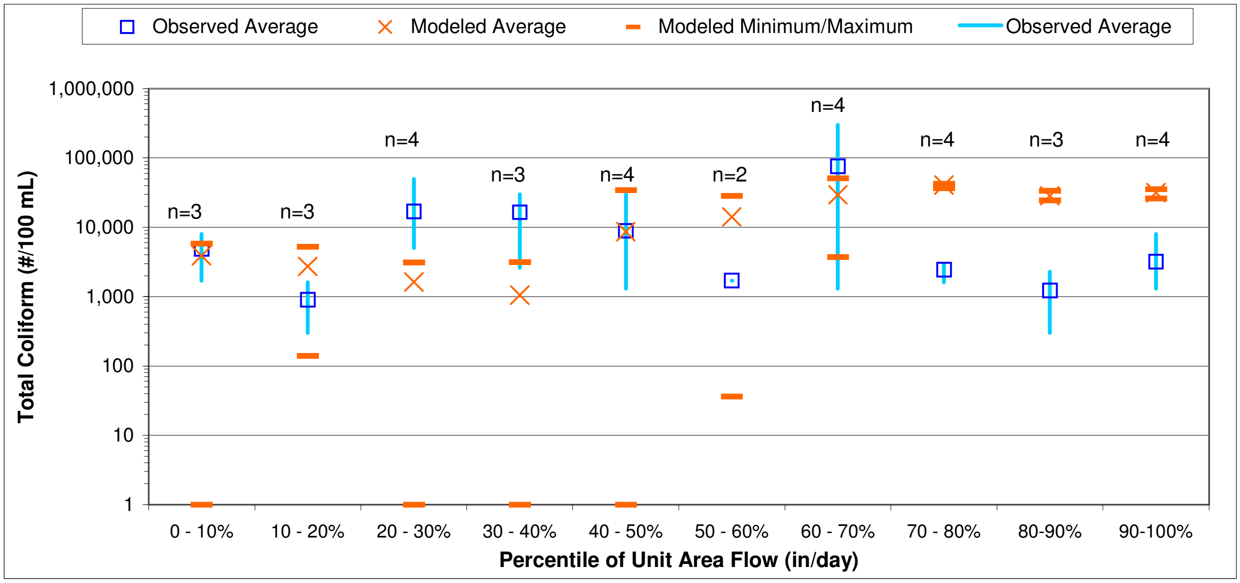

Figure N-24. Graphical comparison of LPSC model results and observed total coliform data in the San Diego River watershed (Appendix M, No. 13).

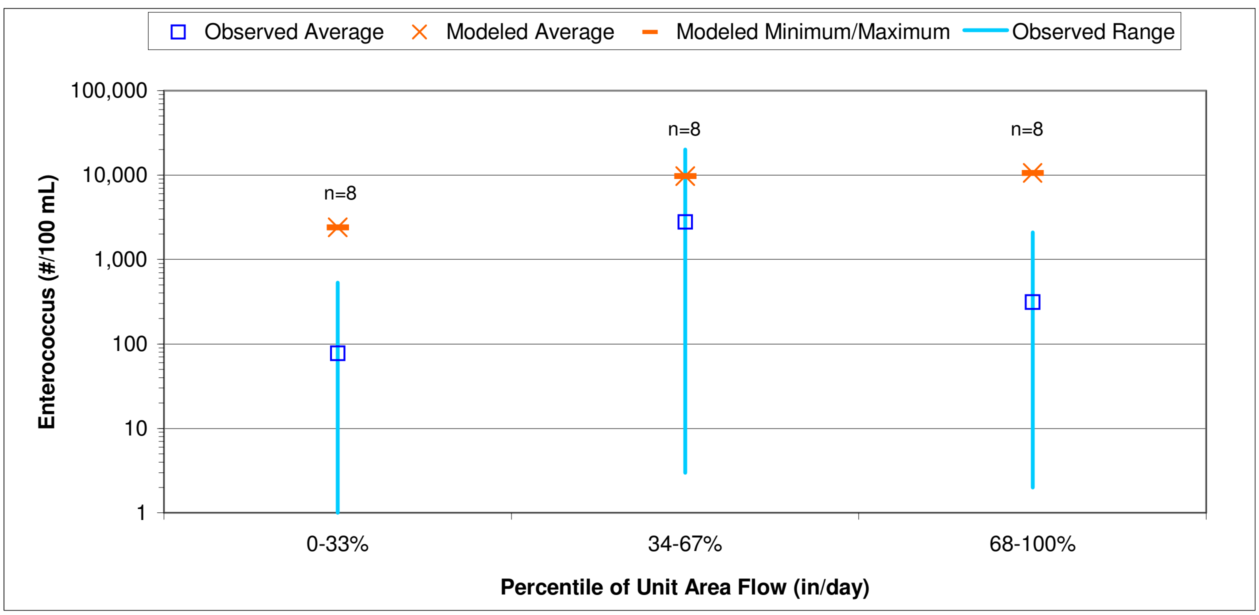

Figure N-25. Graphical comparison of LPSC model results and observed enterococcus data in the Pine Valley watershed (Appendix M, No. 14).