Reconsideration of Certain Technical Matters of the Malibu Creek and Lagoon Bacteria TMDL

STAFF REPORT

California Regional Water Quality Control Board
Los Angeles Region
320 West Fourth Street, Suite 200
Los Angeles, California 90013

March 2012

Table of Contents:

List of Tables

List of Figures

Appendices

A. Integrated Total Maximum Daily Load Implementation Plan for the Malibu Creek Watershed

B. Total Maximum Daily Load for Bacteria – Malibu Creek Watershed

C. Data used to Calculate Freshwater Reference System Exceedance Probabilities

D. Critical Year (Reference Year) Table as Measured at LAX, 1948-2008

E. Critical Year (Reference Year) Table as Measured at Zuma Beach, 1948-2010

F. Data used to Evaluate Different Alternatives for Calculating the Geometric Mean

G. Rainfall at LAX Rain Gauging Station

1. Overview and Current Status of the Malibu Creek and Lagoon Bacteria TMDL

This staff report presents technical analysis in support of recommendations to reconsider aspects of the Total Maximum Daily Load (TMDL) for bacterial indicator densities in the Malibu Creek watershed (hereinafter Malibu Bacteria TMDL). Fecal indicator bacteria (including total coliform, *E. coli*, fecal coliform, and *enterococci*) are used to monitor the water quality of freshwater and marine and lagoon waters designated for water contact recreation because local and national epidemiological studies have documented a linkage between elevated bacterial densities and adverse human health effects.

The goal of the Malibu Bacteria TMDL is to establish water quality targets and waste load and load allocations for sources of bacteria within the watershed that are protective of the designated water contact recreation use, and specify a program of implementation to address impairment of water quality due to elevated bacteria densities. The Malibu Bacteria TMDL covers the Malibu Creek watershed, including Malibu Lagoon, Malibu Creek and its tributaries (Stokes Creek, Las Virgenes Creek, Palo Comado Creek, Medea Creek, and Lindero Creek).

The Los Angeles Water Board adopted the Malibu Bacteria TMDL on December 13, 2004 (Resolution No. R04-019R). The Malibu Bacteria TMDL was approved by the State Water Resources Control Board (State Water Board) on September 22, 2005, the Office of Administrative Law on December 1, 2005, and the United States Environmental Protection Agency (USEPA) on January 10, 2006. The TMDL became effective on January 24, 2006, when the Certificate of Fee Exemption was filed with the Department of Fish and Game. The regulatory background, beneficial uses to be protected, geographical setting, and required TMDL elements along with supporting analysis were described in the 2004 staff report and amendment to the Water Quality Control Plan for the Los Angeles Region (Basin Plan). These documents are available on the Los Angeles Water Board website at:
http://www.waterboards.ca.gov/losangeles/water_issues/programs/tmdl/tmdl_list.shtml

The first bacteria TMDL adopted by the Los Angeles Water Board was the Santa Monica Bay Beaches Bacteria TMDL, adopted first for dry weather on January 24, 2002 (Resolution No. R02-004) and then for wet weather on December 12, 2002 (Resolution No. R02-022). Both Santa Monica Bay Beaches Bacteria TMDLs became effective on July 15, 2003. Flow from Malibu Creek watershed drains into Malibu Lagoon and ultimately into Santa Monica Bay at Surfrider Beach when the lagoon is breached. Since the Malibu Creek watershed is a subwatershed of the Santa Monica Bay watershed management area, the technical approaches and implementation schedule proposed in this reconsideration of the Malibu Bacteria TMDL are consistent with the approaches and schedule being proposed in the reconsideration of the Santa Monica Bay Beaches Dry- and Wet-Weather Bacteria TMDLs.

1.1 Implementation Tasks Specified in the Basin Plan

The Malibu Bacteria TMDL requires responsible jurisdictions and responsible agencies to implement tasks adhering to the schedule provided in Table 7-10.3 of the Basin Plan. These tasks are summarized in the following paragraphs.

120 days after the effective date of this TMDL (i.e., May 24, 2006)
Responsible jurisdictions and responsible agencies must submit, for Regional Board approval, a comprehensive bacteria water quality monitoring plan for the Malibu Creek watershed.

1 year after the effective date of this TMDL (i.e., January 24, 2007)
Responsible jurisdictions and agencies shall provide an Implementation Plan to the Regional Board outlining how each intends to cooperatively achieve the 3-year summer dry weather compliance schedule.

If the responsible jurisdiction or agency is requesting an extension of the summer dry-weather compliance schedule, the plan must include a description of all local ordinances necessary to implement the detailed workplan and assurances that such ordinances have been adopted before the request for an extension is granted.

Local agencies regulating on-site wastewater treatment systems shall provide a written report to the Regional Board detailing the rationale and criteria used to identify high-risk areas where on-site systems have a potential to impact surface waters in the Malibu Creek watershed.

If a responsible jurisdiction or agency is requesting an extension to the wet-weather compliance schedule, the plan must include a description of the integrated water resources (IRP) approach to be implemented, identification of potential markets for water re-use, an estimate of the percentage of collected stormwater that can be re-used, identification of new local ordinances that will be required, a description of new infrastructure required, a list of potential adverse environmental impacts that may result from the IRP, and a workplan and schedule with significant milestones identified.

2 year after the effective date of this TMDL (i.e., January 24, 2008)
The California Department of Parks and Recreation (State Parks) shall provide the Regional Board Executive Officer, a report quantifying the bacteria loading from birds to the Malibu Lagoon.

The responsible jurisdictions and agencies shall provide the Regional Board with a reference watershed study.

3 years after the effective date of this TMDL (i.e., January 24, 2009)
Achieve compliance with applicable Load Allocations (LAs) and Waste Load Allocations (WLAs) during summer dry-weather (April 1 to October 31). The Executive Officer of

the Regional Board may extend the compliance date for the summer dry-weather allocations from 3 years to up to 6 years from the effective date of this TMDL.

6 years after the effective date of this TMDL (i.e., January 24, 2012)
Achieve compliance with applicable LAs and WLAs during winter dry-weather (November 1 to March 31).

10 years after the effective date of this TMDL (i.e., January 24, 2016)
Achieve compliance with applicable LAs and WLAs during wet weather (defined as days of 0.1 inch of rain or more plus three days following the rain event).

The Regional Board may extend the wet-weather compliance date up to July 15, 2021, where supported by the Implementation Plan.

1.2 Compliance with Implementation Tasks

The status of compliance with these implementation tasks is summarized below:

Coordinated Monitoring Plans

On May 24, 2006, the Malibu Creek and Lagoon Bacteria Total Maximum Daily Load Compliance Monitoring Plan (CMP) was first submitted to the Regional Board by the Los Angeles County Department of Public Works (LACDPW) on behalf of the Counties of Los Angeles and Ventura; the Los Angeles County Flood Control District; the California Department of Transportation; and the Cities of Agoura Hills, Calabasas, Hidden Hills, Malibu, Thousand Oaks, and Westlake Village. The CMP was submitted to comply with the 120-day requirement contained in the Malibu Bacteria TMDL to submit a water quality monitoring plan for the Malibu Creek watershed. On August 16, 2005, the Regional Board removed the City of Simi Valley as a responsible agency for the Malibu Bacteria TMDL due to the fact that the City has little to no potential to cause or contribute to water quality impairments in Malibu Creek or its tributaries. Therefore, the City of Simi Valley is not a responsible agency for the Malibu Bacteria TMDL.

The Regional Board made comments on the CMP and the responsible jurisdictions and agencies submitted a revised CMP on September 5, 2007. The Regional Board approved the revised CMP on September 11, 2007. Under the CMP, LACDPW along with other responsible agencies and jurisdictions began water quality monitoring on March 11, 2008. On April 8, 2008, the Regional Board approved a modification of the CMP requested by LACDPW. The revised CMP clarified changes in the overall monitoring responsibilities and other issues. The revised CMP documents that seven (7) out of the 14 monitoring stations (i.e., MCW-8b, MCW-9, MCW-12, MCW-14b, MCW-15b(c), MCW-17, and MCW-18) were developed and are monitored by the Ventura County Watershed Protection District (VCWPD) in coordination with the County of Ventura, the VCWPD, and the City of Thousand Oaks.

Implementation Plan

On January 24, 2007, a coordinated implementation plan (IP) was first submitted by LACDPW on behalf of the Counties of Los Angeles and Ventura; the Los Angeles County Flood Control District; the California Department of Transportation; and the Cities of Agoura Hills, Calabasas, Hidden Hills, Malibu, Thousand Oaks, and Westlake Village, as required by Malibu Bacteria TMDL. On February 26, 2007, a revised draft IP was submitted to the Regional Board to quantitatively evaluate the anticipated benefits of the plan and is included as Appendix A to this report. On April 17, 2009, the Executive Officer issued a letter declining the request for extension of the summer-dry-weather and wet-weather compliance date.

Identification of High-Risk Areas for On-Site Wastewater Treatment Systems

The City of Malibu completed the study "Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas" in 2004 to address the high-risk areas for on-site wastewater treatment systems (OWTS). The Ventura County Environmental Health Division submitted a report dated June 12, 2007 in compliance with the Malibu Bacteria TMDL and determined that there are no OWTS located within 100 feet of a waterbody on the 303(d) list for bacteria; the shortest distance from an OWTS to a bacteria-impaired waterbody in the Malibu Creek watershed is greater than one mile. On March 10, 2008, the Regional Board approved the proposed methodology submitted by the City of Agoura Hills to identify high-risk areas for OWTS. However, the City of Agoura Hills has not submitted a report identifying high-risk areas in compliance with the Malibu Bacteria TMDL (due on April 14, 2008 as specified in the letter dated March 10, 2008). The Los Angeles County Department of Public Health – Environmental Health Division submitted a report "Malibu Creek Watershed Surface Water Monitoring Plan" on August 20, 2009 in compliance with the TMDL to determine whether discharges from OWTS are contributing to the impairment of water quality in Triunfo, Medea, Stokes, and Cold creeks. The data showed that many *E. coli* exceedances were observed in Cold Creek due to the density of OWTS in the area, but the County of Los Angeles did not draw conclusions about whether or not Cold Creek was a high-risk area. The Cities of Calabasas and Westlake Village have no on-site wastewater treatment systems (OWTS) within the Malibu Creek watershed. The Cities of Hidden Hills and Thousand Oaks do not regulate OWTS within their cities' boundaries. Therefore, these cities are not required to identify the high-risk areas for OWTS.

Special Study - Bacteria Reference Watershed Study

On January 31, 2008, the Regional Board received a reference watershed study, "Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams" from LACDPW in fulfillment of the special study requirement for the Malibu Bacteria TMDL. The data were used by the Regional Board to evaluate the freshwater reference system in this reconsideration.

Special Study – Bacteria Loading from Birds

State Parks is the owner of Malibu Creek State Park and Malibu Lagoon. In order to comply with the Malibu Bacteria TMDL, State Parks is required to submit a report to quantify the bacteria loading from birds to the Malibu Lagoon. The purpose of this report is to consider the impact of birds in the Lagoon and to revise the allowable exceedance days if necessary. The TMDL staff report states that no load reductions were given to birds because they are a natural part of the system, but that birds alone may be sufficient to cause an exceedance. The staff report states that if this proves to be the case, the Regional Board staff will recommend that the Regional Board consider re-evaluating the TMDL or incorporating a natural source exclusion. Under the Implementation Provisions for Water Contact Recreation Bacteria Objectives in the Basin Plan, the natural source exclusion approach specifies that once all anthropogenic sources of bacteria have been controlled such that they do not cause or contribute to an exceedance of the single sample objectives, and natural sources have been identified and quantified, a certain frequency of exceedance of the single sample objectives shall be permitted based on the residual exceedance frequency in the specific water body. Currently, not all anthropogenic sources of bacteria to the lagoon have been controlled. Therefore, consideration of a natural sources exclusion approach is premature at this time and a bird study is not yet necessary. Furthermore, the estimation of bacteria loadings from birds in the lagoon has already been described in the 2004 staff report and staff believes that an additional bird study conducted by State Parks at this point would not improve upon the estimates in the 2004 staff report. A further bird study to quantify the bacteria loading from birds may be required at the Regional Board's discretion in the future.

1.3 Extension of the Summer Dry-Weather and Wet-Weather Compliance Dates

In accordance with the requirements in Table 7-10.3 of the Basin Plan, three years after the effective date of the TMDL (i.e., January 24, 2009) or, if a request for extension is approved, up to January 24, 2012, the responsible jurisdictions and responsible agencies shall achieve compliance with the allowable exceedance days for summer dry-weather. Six years after the effective date of the TMDL (i.e., January 24, 2012), the responsible jurisdictions and responsible agencies shall achieve compliance with the allowable exceedance days for winter dry-weather. Ten years after the effective date of the TMDL (i.e., January 24, 2016) or, at the Regional Board's discretion if an Integrated Water Resources Approach is implemented, up to July 15, 2021, the responsible jurisdictions and responsible agencies shall achieve compliance with the allowable exceedance days during wet weather. There was no option for extension of the winter dry-weather compliance date.

As stated previously, on April 17, 2009, the Regional Board denied the request for an extension of the summer dry-weather and wet-weather compliance dates because the implementation plan did not include a revision of existing ordinances or plans. However, in that letter, staff determined that all other criteria required to justify the use of an integrated water resources approach had been satisfied. Therefore, staff proposes to allow responsible jurisdictions and agencies until July 15, 2021 to comply with wet-weather allowable exceedance days. The initial denial of an extension of the summer dry-weather compliance date remains in effect because the revision of local ordinances was the sole criterion for justifying an extension to the summer dry-weather compliance date. Therefore, the compliance dates are January 24, 2009 for summer dry-weather and July 15, 2021 for wet-weather.

Since submittal of the implementation plans, responsible jurisdictions and agencies have pursued integrated approaches. In addition, through implementation of the Los Angeles County MS4 permit, the Regional Board can ensure that responsible parties are implementing the integrated approaches that they have outlined in their implementation plans. For example, if a responsible party intends to pursue action-based interim limits in the MS4 permit, they must submit and obtain approval of a reasonable assurance plan, and then they must implement that plan, subject to enforcement and/or numeric effluent limits. Through this process, the Regional Board can ensure that responsible parties are making timely progress towards achieving TMDLs.

Based on the fact that responsible parties submitted implementation plans outlining integrated approaches, that they are continuing to pursue integrated approaches, and that the Regional Board can ensure the integrated approaches are implemented through the MS4 permitting process, an extended wet-weather schedule is justified. Staff finds that all responsible parties should receive the same extended schedule because the TMDLs were developed with the understanding that it would take a collective effort to achieve waste load allocations. This is evident in the fact that the waste load allocations are expressed as receiving water limits. By assigning all responsible jurisdictions the same implementation schedule, continued collaborative implementation efforts are encouraged.

Implementation Actions done by Responsible Agencies

As part of this reconsideration, staff conducted a brief review of implementation actions conducted to date by responsible agencies.

The Ventura County Watershed Protection District has prepared an additional implementation plan for unincorporated Ventura County to prioritize subwatersheds based on compliance monitoring results, to summarize existing non-structural and structural best management practices (BMPs), and to recommend additional non-structural BMPs and structural retrofits, several of which are highlighted as follows. In Oak Park, the Filterra™ biofiltration system has been installed to treat urban runoff. Initial monitoring results have demonstrated 88% reduction of *E. coli*. Currently, Ventura County is seeking a fund from the Proposition 84 Storm Water Grant to develop the Low Impact Development (LID) green streets retrofit project located along Medea Creek for the reduction and prevention of stormwater pollution to the upper Medea Creek.

1.4 Other Technical Studies

In addition to the required tasks in the Basin Plan, at the time the Malibu Bacteria TMDL was adopted and approved, there were certain on-going technical studies regarding the reference watershed, rainfall conditions, and reference year used in the calculation of allowable exceedance days. The Regional Board has incorporated findings from these studies to re-evaluate the allowable dry-weather and wet-weather exceedance days based on additional data.

2. Purpose of this Reconsideration

While the Regional Board can amend the Basin Plan to adjust a TMDL at any time, implementation schedules for TMDLs in the Los Angeles Region have often included scheduled "reconsiderations" by the Regional Board at a specific point during implementation. Specific reconsiderations have been included so that aspects of the TMDL, or the TMDL implementation schedule, could be adjusted based on anticipated new information or methods. This approach has allowed the Regional Board to establish TMDLs with all the required elements, including numeric targets, allocations, and implementation schedules, so that responsible parties could begin implementing the TMDL to improve water quality, while acknowledging the potential benefit to refining certain technical elements of the TMDL or the implementation schedule after additional study and data collection were completed.

This reconsideration is not a general reconsideration of all the elements of the Malibu Bacteria TMDL, but a re-examination of certain technical issues which, as recognized at the time of TMDL adoption, might need revision upon further data collection and analysis, study or experience. Table 1 outlines the technical matters to be reconsidered as specified in the Malibu Bacteria TMDL. The geographical extent, principal structure, and approach of this TMDL are not being reconsidered in this action. The technical basis of the Malibu Bacteria TMDL adopted by Resolution R04-019R is contained in the report entitled "Total Maximum Daily Load for Bacteria – Malibu Creek Watershed", and is included as Appendix B to this report.

Table 1. Summary of Reconsideration Elements Specified in the Malibu Bacteria TMDL

Date	Action
3 years after effective date of this TMDL (i.e., January 24, 2009)	The Regional Board shall reconsider this TMDL to: (1) Consider a natural source exclusion for bacteria loadings from birds in the Malibu Lagoon if all anthropogenic sources to the Lagoon have been controlled. (2) Reassess the allowable winter dry-weather and wet-weather exceedance days based on additional data on bacterial indicator densities, and an evaluation of site-specific variability in exceedance levels to determine whether existing water quality is better than water quality at the reference watershed,

	(3) Reassess the allowable winter dry-weather and wet-weather exceedance days based on a re-evaluation of the selected reference watershed and consideration of other reference watersheds that may better represent reaches of the Malibu Creek and Lagoon. (4) Consider whether the allowable winter dry-weather and wet-weather exceedance days should be adjusted annually dependent on the rainfall conditions and an evaluation of natural variability in exceedance levels in the reference system(s), (5) Re-evaluate the reference year used in the calculation of allowable exceedance days, and (6) Re-evaluate whether there is a need for further clarification or revision of the geometric mean implementation provision.

3. Technical Matters to be Reconsidered as Specified in the Malibu Bacteria TMDL

This section discusses the Regional Board's evaluation of each of the technical matters specified in Table 1.

3.1 Natural Source Exclusion

Birds in the Malibu Lagoon have been suggested to be an important source of bacteria loading to the Malibu Lagoon. This makes the lagoon a potential candidate waterbody for the natural sources exclusion implementation provision provided for by the bacteria objectives in Chapter 3 of the Basin Plan.

Under the natural sources exclusion implementation provision, after all anthropogenic sources of bacteria have been controlled such that they do not cause an exceedance of the single sample objectives, a certain frequency of exceedance of the single sample objectives shall be permitted based on the residual exceedance frequency in the specific waterbody. At this time, not all anthropogenic sources of bacteria to the lagoon have yet been controlled.

Recommendation

Staff does not recommend the application of the natural source exclusion approach to set the allowable exceedance frequency in Malibu Lagoon at this time. Until all anthropogenic sources of bacteria to the lagoon are controlled and there is a better understanding of the frequency of exceedance that may be due to natural sources, it is recommended that the lagoon continues to be subject to an allowable exceedance frequency based on the reference system / anti-degradation approach provided for the implementation of the bacteria objectives in Chapter 3 of the Basin Plan.

3.2 Site-Specific Exceedance Levels

This staff report reviews the recent bacteria monitoring data collected under the CMP and summarizes the number of days that the applicable single sample objective is exceeded for three time periods in order to assess current conditions. These three periods are (1) summer dry-weather (April 1 to October 31), (2) winter dry-weather (November 1 to March 31), and (3) wet-weather (defined as days of 0.1 inch of rain or more plus three days following the rain event). Table 2 shows the results of this analysis.

Table 2. Compliance Monitoring Data (from March, 2008 through September, 2011)

Sample Station	Subwatershed	Single Sample Exceedances		
		Summer Dry Weather	**Winter Dry Weather**	**Wet Weather**
MCW-1	Malibu Lagoon	29% (33/114)	40% (25/63)	67% (6/9)
MCW-2	Lower Malibu Creek	4.3% (4/92)	15% (9/60)	44% (4/9)
MCW-3	Middle Malibu Creek	18% (21/114)	16% (10/63)	56% (5/9)
MCW-4	Upper Malibu Creek	24% (14/59)	35% (18/51)	67% (6/9)
MCW-5	Cold Creek	39% (27/70)	27% (13/49)	57% (4/7)
MCW-6	Stokes Creek	36% (16/45)	23% (9/39)	57% (4/7)
MCW-7	Lower Las Virgenes Creek	45% (51/114)	35% (22/63)	89% (8/9)
MCW-10	Palo Comado Creek	76% (87/114)	78% (49/63)	67% (6/9)
MCW-11	Lower Medea Creek	25% (28/114)	19% (12/63)	56% (5/9)
MCW-13	Lower Lindero Creek	96% (109/114)	71% (45/63)	89% (8/9)
MCW-16	Triunfo Creek	9.0% (6/67)	11% (6/54)	78% (7/9)
*MCW-8b	Upper Las Virgenes Creek	45% (18/40)	25% (7/28)	50% (5/10)
*MCW-9	Cheseboro Creek	n/a	0% (0/4)	100% (2/2)
*MCW-12	Upper Medea Creek	48% (54/113)	41% (22/54)	74% (14/19)
*MCW-14b	Upper Lindero Creek	81% (91/113)	61% (33/54)	79% (15/19)
*MCW-15b	Westlake	49% (38/77)	49% (19/39)	55% (6/11)
*MCW-15c	Westlake	72% (26/36)	20% (3/15)	75% (6/8)
*MCW-17	Potrero Canyon Creek	15% (4/26)	9.4% (3/32)	25% (3/12)
*MCW-18	Hidden Valley Creek	n/a	n/a	100% (2/2)

*The VCWPD and the City of Thousand Oaks are responsible for these monitoring stations.

The allowable number of exceedance days specified in the Malibu Bacteria TMDL assumes that daily or weekly sampling is conducted. To determine the number of allowable exceedances for less frequent sampling, a ratio is used. Weekly samples were collected as part of the CMP. From March 2008 to September 2011, samples were collected during four (4) summer dry-weather periods, four (4) winter dry-weather periods, and 19 wet-weather days. For the purposes of assessing current conditions in this reconsideration, the calculated exceedance frequencies for the three time periods were compared with the allowable exceedance frequencies in the existing TMDL. The TMDL adopted by Resolution R04-019R allows a zero (0) percent exceedance frequency in summer dry weather, a three (3) percent exceedance frequency in winter dry weather, and a 22 percent exceedance frequency in wet weather. For example, in Table 2 the single sample exceedance frequency for the summer dry-weather period at MCW-1 is determined as follows:

(33 days exceedance during the summer dry-weather period) / (114 sampling days during summer dry-weather period) = 29% exceedance frequency during summer dry-weather period at MCW-1.

Existing compliance monitoring data indicates that the number of exceedance days for most of locations (except Cheseboro Creek) assessed in this TMDL were greater than the allowable exceedance days at the reference sites.

Recommendation

None of the Malibu Creek reaches or tributaries (except Cheseboro Creek) exhibit water quality better than the reference system for the three time periods based on an evaluation of available compliance monitoring data. Therefore, it is recommended that allocations (i.e., allowable exceedance days) for all sites are based on reference site exceedance levels.

3.3 Reference Watershed and Allowable Dry-Weather and Wet-Weather Exceedance Days

Reference Watershed

The reference watershed approach is based on a statistical analysis of the historical exceedance frequency observed at a reference system. The allowable number of exceedance days is based on the historical exceedance frequency (expressed as a percentage) multiplied by the number of dry and wet-weather days in the 90th percentile year (in terms of wet-weather days).

When the Malibu Bacteria TMDL was originally adopted in 2004, Leo Carrillo Beach was selected as the reference system to determine the allowable number of exceedance days for the Malibu Creek watershed due to the lack of bacteria data from a freshwater reference system in the Los Angeles region at that time. Arroyo Sequit Canyon, which drains to Leo Carrillo Beach, is approximately 12 square miles in size and is almost entirely undeveloped open space (98% of land use). This beach and corresponding drainage system was selected for three reasons: (1) Arroyo Sequit is the most undeveloped subwatershed in the Santa Monica Bay watershed management area, (2) there is a freshwater outlet (creek), which drains to the beach, and (3) a sufficient historical shoreline monitoring dataset for this system was available.

However, it was recognized that Leo Carrillo Beach might not be the most representative reference site for freshwater systems in the Los Angeles region. In this reconsideration, Regional Board staff proposes to use data from freshwater reference systems that are now available for southern California.

The Southern California Coastal Water Research Program (SCCWRP) has conducted monitoring and analysis of freshwater reference sites throughout southern California. The monitoring was conducted from the fall of 2004 to the spring of 2007. This monitoring was summarized in three studies, which include "Assessment of Water Quality Concentrations and Loads from Natural Landscapes" (Stein and Yoon, 2007; Technical Report 500), "Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams" (Tiefenthaler et al., 2008; Technical Report 542), and "Microbiological Water Quality at Reference Beaches in Southern California During Wet Weather" (Schiff et al., 2005; Technical Report 448).

The selection of reference sites in these studies was based on four criteria: (1) the sites have no less than 95% undeveloped drainage area; (2) the sites possess a "relatively homogeneous setting"; (3) the sites have "year-round or prolonged dry weather flow"; and (4) the sites are located in watersheds that have not experienced fire during the previous three years. Of the sites sampled in the FIB Study, three sites (i.e., Cheseboro Creek, Cajon Creek, and Stone Creek) were deemed minimally impacted; as such, data from these three sites were excluded. For example, Cheseboro Creek was subject to a fire and has heavily-used trails and Cajon Creek is nearby a major highway. The resulting data were compiled and used as the basis for determining the reference watershed exceedance probability for the single sample *E. coli* objective during dry weather and wet weather (see Table 3). The dry-weather exceedance probability is the probability that the single sample objective will be exceeded on a dry-weather day at a particular location. The wet-weather exceedance probability is the probability that the single sample objective will be exceeded on a wet-weather day at a particular location. The raw data used to calculate the exceedance probabilities are presented in Appendix C. These exceedance probabilities have also been used in the recently adopted Los Angeles River Watershed and Santa Clara River Estuary and Reaches 3, 5, 6 and 7 Bacteria TMDLs.

The reference system was based on all of the freshwater sites in the three SCCWRP studies (except the three minimally impacted sites) because this results in the most robust data set. The "Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams" study, which was submitted in compliance with the TMDL by responsible jurisdictions, was not used alone because it did not contain wet-weather data. Nor were sites specific to the Malibu Creek watershed or the Northern

Santa Monica Bay chosen from the larger Southern California data set to determine a reference system. This is because these localized sites are from first order streams and headwaters, or from smaller watersheds, and may not be representative of natural conditions throughout the Malibu Creek watershed.

For the Lagoon, staff considered calculating exceedance probabilities for the single sample marine objectives using the reference beach data collected by SCCWRP. This was the approach taken for the Santa Clara River Estuary Bacteria TMDL. This approach would lead to exceedances probabilities of 30% for wet weather, 13% for winter dry-weather, and 4.7% for summer dry weather. However, because the adjacent beach must not exceed the exceedances probabilities for the single sample marine objectives specified in the Santa Monica Bay Beaches Bacteria TMDL, which are 22% for wet weather, 10% for winter dry-weather, and 0% for summer dry weather, the SCCWRP reference beach exceedance probabilities were not selected for the Malibu Lagoon. Instead, the exceedances probabilities for *E. coli* are applied to the total coliform, fecal coliform, and *enterococcus* single sample objectives. This also keeps the two time periods for determining compliance (wet-weather and dry-weather) consistent throughout the watershed.

Table 3. Estimated Exceedance Probabilities from the Freshwater Reference Systems

Single Sample *E. coli* Exceedance Probability		
Water Quality Objective (bacterial density/100 mL)	**Dry Weather Exceedance Probability**	**Wet Weather Exceedance Probability**
235 /100 mL	**0.016**	**0.19**

Allowable Dry-Weather and Wet-Weather Exceedance Days

This Malibu Bacteria TMDL sets the number of allowable exceedance days for each reach or tributary to ensure that two criteria are met: (1) bacteriological water quality at any site is at least as good as at a designated reference site, and (2) there is no degradation of existing bacteriological water quality. As in previous bacterial TMDLs in the Los Angeles Region, allowable exceedance days were calculated with the smaller of the two exceedance probabilities, that of the targeted site or the reference site. In the case of this Malibu Bacteria TMDL, the smaller of the exceedance probabilities for all sites (Table 2) was that of the reference site and that value was used in subsequent calculations.

To translate the exceedance probabilities into allowable exceedance days, the number of wet weather days and the number of dry weather days in the 90th percentile storm year, based on historical rainfall data from the Los Angeles International Airport (LAX) meteorological station, were used. The wet-weather days are defined as days of 0.1 inch of rain or more plus three days following the rain event. The storm year is defined as November 1 to October 31.

The number of allowable exceedance days during the critical condition (reference year) was calculated for the reference system by multiplying the site-specific exceedance probability by the number of dry or wet days in the reference year, as follows:

Allowable Exceedance Days

= Exceedance Probability in a Reference System × Number of Days in a Reference Year (Equation 3.1)

The site-specific exceedance probability is taken directly from the data analysis presented in Table 2. Based on rainfall data from the LAX meteorological station, 1993 is the reference year. As described in previous documents, the exceedance probability is appropriate, since the weekly sampling is systematic and the rain events are randomly distributed; therefore, sampling will be evenly spread over the dry- and wet-weather events (i.e., the rain day, day after, 2^{nd} day after, 3^{rd} day after) (Schiff et al., 2002).

Using Equation 3.1, the exceedance probability of the reference system is translated to exceedance days as follows. The exceedance probability of 0.016 for dry weather is multiplied by 290 days, the number of dry-weather days in the 1993 storm year, resulting in five (5) exceedance days (4.64 rounded to the next whole integer) when daily sampling is conducted. The exceedance probability of 0.19 for wet weather is multiplied by 75 days, the number of wet-weather days in the 1993 storm year, resulting in 15 exceedance days (14.3 rounded to the next whole integer) when daily sampling is conducted.

To estimate the number of exceedance days at the reference system in the reference year under a weekly sampling regime for dry weather and wet weather, the number of days was adjusted by solving for x and y in Equation 3.2 and 3.3, respectively, as follows:

$$\frac{290\ \textit{days}}{365\ \textit{days}} = \frac{x}{52\ \textit{weeks}} \qquad \text{(Equation 3.2 for dry weather)}$$

$$\frac{75\ \textit{days}}{365\ \textit{days}} = \frac{y}{52\ \textit{weeks}} \qquad \text{(Equation 3.3 for wet weather)}$$

For dry weather, solving for x equals 41.3, which is then multiplied by 0.016, resulting in one (1) exceedance day (0.66 rounded to the next whole integer) during dry weather when weekly sampling is conducted. For wet weather, y equals 10.7 multiplied by 0.19, results in two (2) exceedance days (2.03 rounded to the previous whole integer) during wet weather when weekly sampling is conducted. Consistent with the Santa Monica Bay Beaches Bacteria TMDL, where the fractional remainder for the calculated allowable exceedance days equals or exceeds $1/10^{th}$, then the number of days are rounded up (e.g., 14.3 is rounded up to 15). In instances where the tenths decimal place for the allowable exceedance days (or weeks or months) is lower than $1/10^{th}$, then the number of days are rounded down (e.g., 2.03 is rounded down to 2). The dry- and wet-weather allocations for the single sample targets are listed in Table 4.

Table 4. Allowable Exceedance Days for Daily and Weekly Sampling based on the Reference Year

Allowable Number of Exceedance Days	Daily Sampling	Weekly Sampling
Dry weather	**5**	**1**
Wet Weather	**15**	**2**

Recommendation

It is recommended that the exceedance probabilities for freshwater reference systems in Table 3 are used to determine the allowable exceedance days in this TMDL reconsideration. Based on these exceedance probabilities, the recommended allowable dry- and wet-weather exceedance days for the single sample targets, shown in Table 4, are applied to this TMDL reconsideration.

3.4 Exceedance Days Adjusted Annually Dependent on the Rainfall Conditions

Regional Board staff recognizes that the number of dry-weather and wet-weather days will change from year to year and, therefore, the exceedance probability of 0.016 for dry weather and 0.19 for wet weather will not always equate to the same number of exceedance days.

Allowable exceedance days were set using the exceedance rates for dry and wet weather at the reference system and the number of days of dry and wet weather in the reference year. An alternative method that could be used to set allowable exceedance days is to use the actual number of wet and dry days from the current year and not a reference year.

This approach could use the actual number of wet and dry days or a rolling average of wet and dry days over several years. This approach would be more tailored to the unique conditions during each year, but would not provide as much certainty with regard to addressing the critical wet-weather condition.

This approach may be considered more protective during wet weather as it would allow fewer wet weather exceedances in years with less precipitation (most years would have fewer wet weather days than the 90th percentile year). On the other hand, under drier conditions, the approach would allow a greater number of exceedances during dry weather. Generally, it is expected that the reference year conditions will be used for implementation planning, therefore, while fewer wet weather exceedances might be allowed under this approach, measures to address the 90th percentile reference year conditions should be adequate to address wet weather in drier years, too.

Recommendation

Staff does not recommend adjusting the allowable number of exceedance days annually based on the number of dry- and wet-weather days in a particular year. This is because it would be difficult to design BMPs and diversion or treatment facilities to address such variability from year to year. Staff expects that by designing facilities for the 90th percentile year, during drier years there will most likely be fewer exceedance days than the maximum allowable. Therefore, staff proposes no change to the approach of setting the allowable number of exceedance days based on the 90th percentile year.

3.5 Reference Year (Critical Condition)

The Malibu Bacteria TMDL identified the critical condition generally as wet weather and further defined a critical condition within wet weather in order to set the allowable number of exceedance days of the single sample limit. The 90th percentile storm year in terms of wet days was defined as the specific wet weather critical condition, and is referred to as the ‘reference year’.

Based on an examination of historical rainfall data from the LAX meteorological station, 1993 was chosen as the reference year because it is the 90th percentile year in terms of wet weather days, based on 54 storm years (1948-2001) of rainfall data from LAX. In the 1993 storm year, there were 75 wet-weather days and 290 dry days.

For this reconsideration, staff evaluated additional rain data, from 1948 to 2008 (Appendix D), and determined that the 90th percentile year in this expanded dataset is 1958. The year 1958 storm year had 74 wet days in comparison to the 75 wet days of 1993.

Staff finds that the number of allowable exceedance days during wet weather, as calculated using the exceedance probability for the freshwater reference system, would not change using 74 wet days instead of 75 wet days in the calculation.

Data from the freshwater reference system show that the wet-weather exceedance probability is 0.19. This exceedance probability multiplied by 75 wet days results in 15 allowable exceedance days (14.3 rounded to the next whole integer). This exceedance probability multiplied by 74 wet days results in 15 exceedance days (14.1 rounded to the next whole integer).

Staff also evaluated the historical rainfall data from the Zuma Beach meteorological station from 1948 to 2010 (Appendix E), and determined that the 90th percentile year in this dataset is 1969. This station is nearby the Malibu Creek watershed. In the 1969 storm year, there were 79 wet-weather days and 286 dry days. The wet-weather exceedance probability (0.19) multiplied by 79 wet days results in 15 allowable exceedance days. Therefore, the number of allowable exceedance days calculated with data from the Zuma station is no different than the allowable exceedance days calculated with data collected from the LAX meteorological station.

Recommendation

Due to the value of continuity for planning and design of BMPs, and the lack of impact on allowable exceedance days, staff does not recommend changing the reference year of 1993 as the critical condition.

The critical condition and number of wet days (or dry days) to be used in calculations of allowable exceedances will stay the same.

3.6 Revision of the Geometric Mean Calculation

The geometric mean, or geomean, is a method of calculating a mean which uses the log-transformation of the bacteria concentration data. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values. Because bacterial concentrations can often vary by orders of magnitude, this calculation returns a parameter which is a better representation of the central tendency of the data and more meaningful in statistical evaluations than an arithmetic mean.

The geometric mean objective for bacteria is usually a more reliable measure of long term water quality than single sample criteria. It is also directly linked to the underlying epidemiological studies upon which the bacteria water quality objectives were based.

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

a. Total coliform density shall not exceed 1,000/100 ml.
b. Fecal coliform density shall not exceed 200/100 ml.
c. *Enterococcus* density shall not exceed 35/100 ml.

The Basin Plan geometric mean objective for fresh waters designated for Water Contact Recreation (REC-1) is:

- *E. coli* density shall not exceed 126/100 ml.

In addition, the Basin Plan includes an implementation provision for the geometric mean objectives: *"The geometric mean values should be calculated based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period)."*

USEPA's 1986 Ambient Water Quality Criteria for Bacteria (USEPA, 1986) also specifies "...a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period)...." USEPA's draft Recreational Water Criteria (USEPA, 2011) does not specify the number of samples but recommends periods of 30 to 90 days.

The following is a discussion of the analysis regarding number of samples required and rolling calculations versus discrete calculations to provide further clarification or revision of the geometric mean implementation provision.

Calculation of Rolling Geometric Means

The current standard method used in the Malibu Bacteria TMDL is:

The rolling 30-day geometric mean is calculated on a daily basis. All data including wet-weather data are included in the geometric mean calculations. The calculation is rolled forward on a daily basis and a geometric mean value is computed given 5 samples or more within that 30-day time frame.

Sampling data as analyzed in the laboratory may typically include both an upper and lower bound sample detection limit depending on the testing method used or the limitations of the testing laboratory. Where the sample result exceeded the method upper limit, that data point is taken as the method upper limit; where the sample result fell below the method lower detection limit, that data point is taken as the lower detection limit. (Other alternative values to the lower detection limit are discussed in the next section.)

In some cases, geometric means have been calculated just for the summer or winter weather period for comparison. In that case, the first geometric mean value has been calculated on April 30th for the summer period in order to include only data collected during the defined summer period, which begins April 1.

In this re-consideration, six alternative methods of calculating geometric means were evaluated and are presented in detail in Appendix F. Four alternative methods are contrasted in the following discussion.

Method (1): <u>Calendar month</u> (30-day periods, any number of samples per period, one calculation every month). In this calculation method, a discrete calendar month is used for the time period and 4 or 5 samples are used to calculate one geometric mean result for the month. Geometric means do not roll forward and each calculated geometric mean is independent of others. However, information regarding increases or decreases during the month is lost. This method is the same as is usually applied for 303(d) listing purposes under the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) list (SWRCB, 2004).

Method (2): Standard method (rolling 30-day period, 5 or more samples per 30 days, a calculation every day). This is the method used in the development of this TMDL and that is in use, currently, for compliance.

Method (3): Calculation only on sampled days (rolling 30-day period, 5 or more samples per 30 days, a calculation every *sampled* day).

Method (4): Four samples/calculation only on sampled days (rolling 30-day period, 4 or more samples per 30 days, a calculation every *sampled* day).

Data from the Santa Monica Bay Beaches reconsideration were used to determine the appropriate method for calculating the geometric mean in the Malibu Bacteria TMDL. Data from five different shoreline sites in the Los Angeles Region were used in the analysis (Table 5). In addition, data from Dockweiler Beach were compiled in two different ways:

CL) County Line Beach, one day per week sampled, 54 months
SP) Surfers Point, one day per week sampled, 54 months
SK) Surfers Knoll, one day per week sampled, 54 months
LB) Long Beach-Mothers Beach, one day per week sampled, 30 months
D5) Dockweiler, 5 days a week sampled, 49 months
DW) Dockweiler, one day of sampling per week analyzed, i.e. Wednesdays only, 49 months

Table 5. Percent of Exceedances of Geometric Mean, at Selected Shoreline Monitoring Sites

	Method:			
Site:	1	2	3	4
CL	**1.9**	0.0	0.0	0.0
SP	39.6	**45.3**	30.5	30.3
SK	18.9	**28.2**	15.1	15.8
LB	63.3	69.6	**70.3**	66.2
D5	59.2	61.1	**63.1**	63.0
DW	57.1	58.7	58.7	**59.6**

The highest percent geometric mean exceedance per site is in bold

The calculation method does not result in largely different estimations of exceedances percentages. While Surfers Knoll differs by 13.1% (15.1% to 28.2%) depending on the method of geometric mean calculation, Dockweiler Beach has very similar exceedance percentages for each method (57.1% to 59.6%). Additionally, the discrete, calendar month method, resulted in similar exceedance percentages as the rolling methods. This conclusion is in keeping with the comparison of rolling averages or calendar month averages for compliance determination conducted by the State Water Resources Control Board for several contaminants other than bacteria (Saiz, 2005).

Any of these calculation methods could be used to measure long term water quality.

The standard method is conservative. The Regional Board standard method often results in the highest or second highest exceedance percentage.

As observed before, the number and percentage of single sample exceedances are fewer and less than the number and percentage of geometric mean exceedances (data not shown in this summary, see Appendix F).

Any method that curtails the frequency with which the geometric mean is calculated such as a method where the geometric mean is calculated on sampled days only (Method 3), lowers the total number of exceedances in comparison to methods where the geometric mean is calculated everyday (Method 2) even where the exceedance *rate* of the different methods is virtually the same (data not shown in this summary, see Appendix F). Therefore, if the method of calculation of geomeans includes calculating geomeans only on sampled days, the method may disincentivize more frequent sampling, especially on beaches with a high geometric mean exceedance rate where the high exceedance rate ensures that more calculations means more exceedances/violations.

One way to reduce the disincentive for more frequent sampling when using a calculation method which calculates on only sampled days would be to calculate at the same frequency as regular sampling without adding additional calculations for additional or accelerated samples. For example, Method 3 (calculation only on sampled days (rolling 30 day period, 5 or more samples per 30 days, a calculation every *sampled* day), would be instead **Method 3a**, calculation weekly (rolling 30 day period, 5 or more samples per 30 days, a calculation every *week*). Additional samples would be included in the geometric mean calculations, but no additional calculations would be made. A weekly calculation is many fewer calculations than a daily calculation, but there is no disincentive for accelerated samples or disadvantage to beaches which conduct daily samples routinely.

It is common when examining beach bacteria data in Southern California to divide the data into summer dry-, winter dry- and wet-weather data. Heal the Bay uses these ‘seasons’ to calculate and present beach grades in their Beach Report Card. In addition, these seasons are used in a regulatory fashion by this Regional Board to determine compliance with allowable exceedance days of the bacteria single sample objectives.

For the single sample objectives, there are different allowable exceedance rates in summer dry, winter dry and wet weather. However, unlike the single sample objectives, there is no allowable exceedance rate for the geometric mean objectives and therefore, no difference between seasons. The rolling geometric mean rolls through the calendar or seasonal boundaries and is held to the same standard (zero exceedances) in all seasons. In addition, as the geometric means expresses the overall risk of exposure during a 30-day period including dry and wet weather, if any, a dry weather-only calculation is artificial. USEPA's draft Recreational Water Criteria (USEPA, 2011) recommends use of both wet and dry weather, stating, "Sampling of waterbodies should be representative of meteorological conditions (e.g., wet and dry weather)."

While the rate of exceedance of the geometric mean standards does not change very much depending on method, the number of exceedances, and, potentially, violations of a permit requirement, may differ greatly depending on the geometric mean calculation method. For example, in this 2.5 year data set, at Dockweiler Beach, a beach which has a high exceedance rate of the geometric mean, the standard method (Method 2) resulted in 252 exceedances of the geometric mean objective for the three bacterial indicators; the sample days only method (Method 3) resulted in 126 exceedances; and the non-rolling calendar month method (Method 1) resulted in 49 exceedances. See Appendix F.

The Basin Plan Chapter 3, Implementation Provisions for Water Contact Recreation Bacteria Objectives specifies "*generally not less than 5 samples equally spaced over a 30 day period*..." The standard method used by this Regional Board has explicitly required at least 5 samples. When 5 samples are required under a weekly sampling regime, the occasional missed sampling day or sample lost during analysis may mean that a geometric mean cannot be calculated at all for that 30-day period because there are fewer than 5 samples to include in the calculation. Requiring only 4 samples increases the ability to consistently calculate geometric means, but, also, results in some loss of the accuracy of the calculation. Alternatively, using a longer than 30 day period for the calculation of the geometric mean can also ensure sufficient samples for a minimum 5 sample geometric mean under a weekly sampling regime.

It is important to note that some beaches do not exceed the geometric mean criteria. County Line beach, for example, had zero exceedances of the geometric mean criteria by the standard method.

Dockweiler Beach data was compiled two different ways before analysis; the full data set with 49 months of five-day-a-week data was analyzed, and also a data set of one-day-a-week data (just Wednesday data) was analyzed. Little difference was found, suggesting that with sufficient data, weekly sampling is sufficient to characterize the exceedance rates and variability in water quality in a beach.

Recommendation

To calculate *rolling* geometric means, calculate a geometric mean weekly using 5 or more samples (Method 3a) for rolling six week periods. For consistency, start all calculation weeks on Sunday.

Calculation of Non-Rolling Geometric Means

Previously the Regional Board has required the use of rolling 30-day geometric means. This was due in part to USEPA's stated expectation that most states will calculate the geometric mean as a rolling average. However, USEPA has given states discretion to consider discrete calendar or seasonal geometric means. USEPA's draft Recreational Water Criteria (USEPA, 2011) does not specify rolling or discrete geomentric means. In addition, USEPA, through their current re-evaluation of the Recreational Waterbody standards, has explored the application of non-rolling, seasonal geometric means.

Non-rolling or discrete calculations such as a monthly or seasonal calculation are temporally independent of each other. With a rolling calculation, one calculation will use much the same data as the previous calculation which used much the same data as the calculation previous to that. The State Water Resources Control Board's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) (SWRCB, 2004) requires that data used for listing decisions be temporally independent.

Staff considered assessing the geometric mean objectives on a purely seasonal basis (winter and summer for southern California), but found that given the length of the southern California summer season (April through October) and the differences in precipitation and flow patterns between months within the seven-month summer season in particular, it was justifiable to assessing geometric means on a more frequent, sub-season, basis. Since the exceedances are largely driven by precipitation and/or flow from streams or storm drains, staff considered several sub-seasonal alternatives, which group the months of the year into sub-seasons on the basis of precipitation.

Data from the Santa Monica Bay Beaches reconsideration were used to assess the use of seasonal and monthly geometric means for the Malibu Bacteria TMDL. Tables 7, 8, and 9 show the number of exceedances of geometric means at Leo Carrillo Beach based on different seasonal and monthly periods.

These alternatives split the seasons differently. These values were also compared to the number of monthly precipitation days at the LAX rain gage. The monthly precipitation day charts and tables for the LAX rain gauge are included in the Appendix G.

This analysis used 6 years of data in discrete (i.e., non-rolling) calculations; therefore for each period considered, there were 6 calculations for each objective, total coliform, fecal coliform and *enterococcus*. For example, in Alternative 1, Table 6, there were 6 April-May periods in the 6 years of data, so the geometric means for total coliform, fecal coliform and *enterococcus* were calculated 6 times each revealing two exceedances of the *enterococcus* geometric mean standard.

Alternative One includes two summer "shoulder" sub-seasons of early summer: April - May and late summer: September - October, a mid-summer sub-season of June through August, and one winter season.

Table 6. Seasonal Geometric Means at Leo Carrillo Beach, Alternative 1

Leo Carrillo Beach Seasonal Geometric Mean November 2004 to October 2010					
Month	**Total Coliform**	**Fecal Coliform**	***enterococcus* MDL10[1]**	***enterococcus* MDL3.7[2]**	**Sum of Number of Precipitation days[3]**
April – May	0	0	2	2	15
June-August	0	0	0	0	1
September - October	0	0	0	0	14
November – March	0	0	1	1	101

[1]MDL 10 refers *enterococcus* calculated with a method detection limit of 10 Most Probable Number per 100 milliliters
[2]MDL 3.7 refers *enterococcus* calculated assuming a method detection limit of 3.7 Most Probable Number per 100 milliliters
[3]Precipitation day refers to any day with 0.1 inch of rain or greater

Alternative Two includes two summer “shoulder” sub-seasons of early summer; April - May and late summer: September - October, includes a separate geometric mean for the mid-summer months of June, July and August and two winter seasons.

Table 7. Seasonal Geometric Means at Leo Carrillo Beach, Alternative 2

Leo Carrillo Beach Seasonal Geometric Mean November 2004 to October 2010					
Month	**Total Coliform**	**Fecal Coliform**	***enterococcus* MDL10[1]**	***enterococcus* MDL3.7[2]**	**Sum of Number of Precipitation days[3]**
April - May	0	0	2	2	15
June	1	1	2	1	0
July	0	0	0	0	1
August	0	0	0	0	0
September - October	0	0	0	0	14
November – December	0	0	0	0	30
January - March	2	0	1	1	71

[1]MDL 10 refers *enterococcus* calculated with a method detection limit of 10 Most Probable Number per 100 milliliters
[2]MDL 3.7 refers *enterococcus* calculated assuming a method detection limit of 3.7 Most Probable Number per 100 milliliters
[3]Precipitation day refers to any day with 0.1 inch of rain or greater

Alternative Three includes a separate geometric mean for all-summer months and three winter sub-seasons. In this alternative, April is treated as a winter month.

Table 8. Seasonal Geometric Means at Leo Carrillo Beach, Alternative 3

Leo Carrillo Beach Seasonal Geometric Mean November 2004 to October 2010					
Month	**Total Coliform**	**Fecal Coliform**	***enterococcus* MDL10[1]**	***enterococcus* MDL3.7[2]**	**Number of Precipitation days**
May	1	0	2	2	5
June	1	1	2	1	0
July	0	0	0	0	1
August	0	0	0	0	0
September	0	0	0	0	3
October	0	0	0	0	11
November – December	0	0	0	0	30
January – February	1	0	1	1	65
March – April	1	0	1	0	16

[1]MDL 10 refers *enterococcus* calculated with a method detection limit of 10 Most Probable Number per 100 milliters
[2]MDL 3.7 refers *enterococcus* calculated assuming a method detection limit of 3.7 Most Probable Number per 100 milliters

Seasonal geometric means are consistent with the intent of the reference system/antidegradation approach and USEPA's current thinking on the expression of the recreational water quality criteria. USEPA's draft Recreational Water Criteria (USEPA, 2011) recommends geometric mean calculation periods of 30 to 90 days. Both alternatives Two and Three include periods between 30 and 90 days and no greater than 90 days.

Higher concentrations of bacteria are associated with wet weather and winter months experience wet weather more frequently. In many cases, the higher levels of bacteria experienced in wet weather are *much* higher than typical dry-weather concentrations (e.g. 100 times more or 1,000 times more). For that reason, calculating the geometric mean over the longer periods (i.e., the 60 day or 90 day periods) during winter will express the overall risk of exposure during the period more accurately and will be a more appropriate calculation for geometric mean compliance.

This Region's reference system approach allows more frequent exceedances of the single sample objective during winter and during wet weather (principally in winter). Using a longer period for geometric mean calculation during the times when more excursions above the single sample objective are allowed, corresponds, then, to the approach taken for compliance with the single sample objectives.

Alternative Three differs from Alternative Two in that no period of calculation is longer than 60 days and that April, a summer month for single sample exceedance day allowances, is grouped with March, a winter month. Staff has included April with the winter periods in Alternative Three because of the frequent wet- weather events and resulting higher exceedance day frequency in April.

This comparison of calculation methods used data from Leo Carillo, so it was expected that the geometric mean exceedance rate would be low and exceedances infrequent. Depending on the method, the exceedance rate of the geometric mean (including potential exceedances of total coliform, fecal coliform and *enterococcus*) varied between 4 and 6 percent.

Staff continues to recommend allowing no exceedances of the geometric mean objectives as calculated for these seasons/sub-seasons.

Use of seasonal geometric means would not change any target, allowed exceedance rate or allocation and would not represent a need for significantly greater or smaller reductions in bacterial densities and would not require greater or lesser implementation actions on the part of responsible parties.

Recommendation

Include consideration of seasonal and monthly geometric means in the Basin Plan, Chapter 3 "Water Quality Objectives."

To calculate discrete geometric means, calculate a seasonal geometric mean such that a separate geometric mean is calculated for all summer months and for three winter sub-seasons where April is included as a winter month consistent with Alternative Three.

Staff continues to recommend allowing no exceedances of the geometric mean objectives as calculated for these seasons/sub-seasons.

Application of Rolling Geometric Mean Calculation or Discrete Geometric Mean Calculation

Two principal types of error are possible when determining whether a waterbody is meeting the geometric mean standard: 1) determining the waterbody *does not* meet water quality standards when it *does* and 2) determining the waterbody *does* meet water quality standards when it *does not*.

A rolling geometric mean may in some cases determine a waterbody does not meet standards when it does. For example, a single very high sample can influence the geometric mean calculation week after week into a period where the water quality is, in fact, meeting standards.

Alternatively, a discrete geometric mean can in some cases, arbitrarily split a period of low water quality such that the geometric mean calculation determines the waterbody does meet water quality standards when there was a period when it did not. While a discrete geometric mean calculation may adjust the periods of calculation according to seasons and weather or rainfall patterns in an appropriate manner, the exact boundaries between seasons may be arbitrary. Using seasonal Alternative Three, above, as an example, low water quality results from the last week in October, would be separated from low water quality results in the beginning of November and since the late October-early November time period is never assessed on its own, the period of low water quality is not identified.

In the superior interest of not failing to identify water quality impairment, the rolling geometric mean calculation is preferred. This is consistent with the discussion of listing and delisting decisions in the Functional Equivalent Document for the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) list (SWRCB, 2004).

Recommendation

For the Malibu Bacteria TMDL, calculate *rolling* geometric means; calculate a geometric mean weekly using 5 or more samples (calculation Method 3a, above) for rolling six week periods. For consistency, start all calculation weeks on Sunday.

The revised method for assessing compliance with the geometric means should be reflected in updated monitoring plans, which should be submitted for Executive Officer consideration.

Geometric Means Calculated with the *Enterococcus* Detection Limits

There are several USEPA-approved methods to measure the number of *enterococcus* bacteria in a water sample including membrane filtration and the chromogenic method, Enterolert by IDEXX. Enterolert is usually preferred because it is faster and less expensive. However, the Enterolert method has a higher method detection limit than the membrane filtration method.

The calculation method for the geometric mean requires the use of the detection limit as a substitute for the sample result when the sample result shows that the sample is at, or below, the detection limit (a non-detect result). The resulting geometric mean is higher than it might be if the actual sample result was known. This is the conservative calculation method. However, because the *enterococcus* geometric mean objective of 35 mpn/100ml is close to the Enterolert detection limit of 10 mpn/100ml and because the results of many water samples are at, or below, the detection limit, the difference between calculating the geometric mean using the detection limit for non-detect samples and using another substitute, such as zero or half the detection limit, may be meaningful.

The City of Los Angeles Environmental Monitoring Division evaluated data from seven beach monitoring sites of Jurisdictional Groups 5 and 6 (the northern border of Manhattan Beach to southern border of Torrance). The data, collected between January 1, 1996 and October 31, 2004, was analyzed by membrane filtration (detection limit: 1 mpn/100ml), and included 3179 samples of which 2135 had a concentration between 1 and 9 mpn/100ml. Assuming a normal distribution of the log results, 90% of results reported as less than 10 would be less than 3.7. Therefore, the Jurisdictional Groups for the Santa Monica Bay Beaches Bacteria TMDLs have suggested using 3.7 mpn/100ml as the result in geometric mean calculations when the Enterolert result is less than the detection limit of 10mpn/100ml (Jurisdictional Groups, 2009).

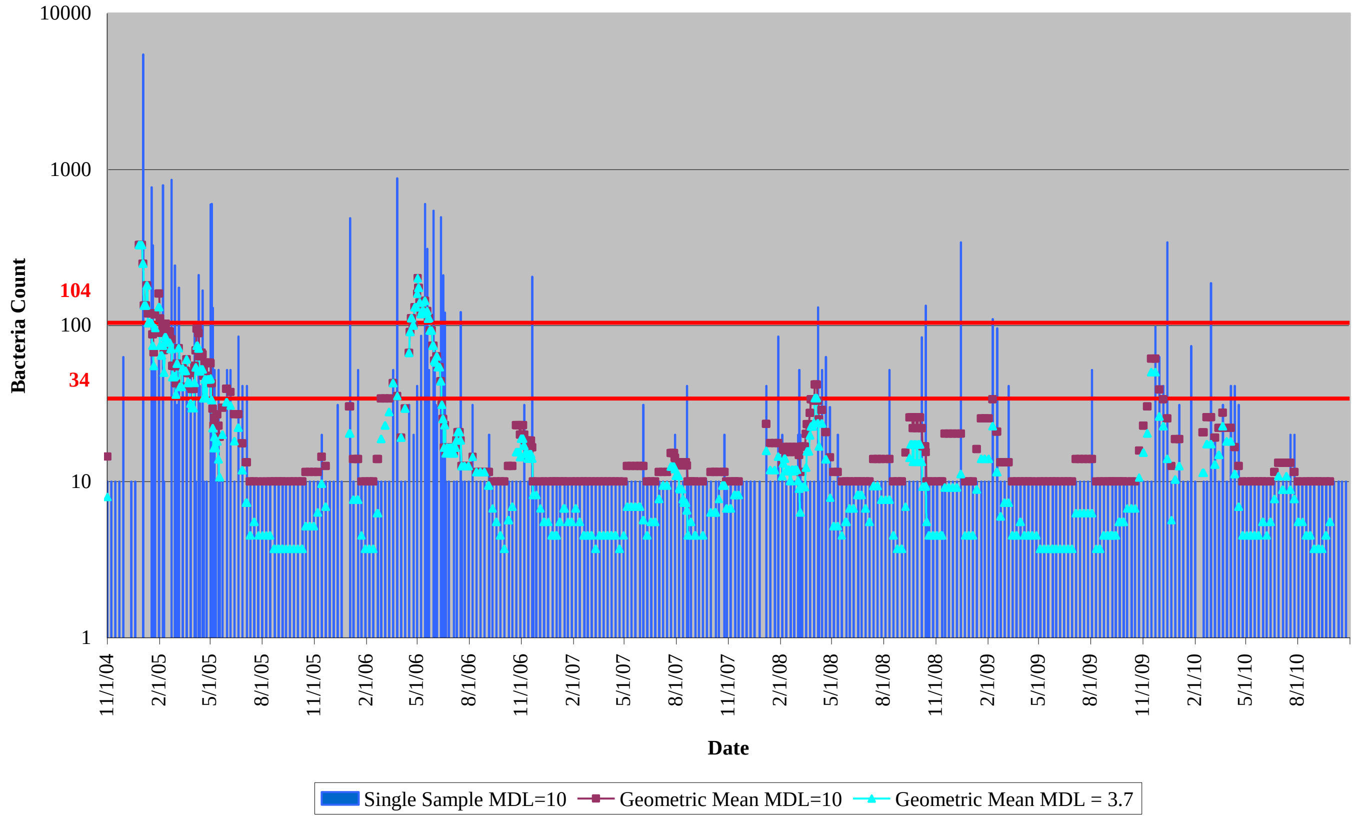
Table 9 and Figure 1 show the difference between calculating the rolling geometric mean using the method detection limit of 10 mpn/100 ml in calculations when the actual result is below the detection limit and using 3.7 mpn/100 ml as a substitute for 10 in the calculation. The percent of exceedances of the rolling geometric mean at Leo Carrillo Beach decreased from 23.47% to 20.64%. Because no exceedance of the geometric mean is allowed, the recalculation of the geometric mean does not affect any allowable exceedance rate.

Table 9. Geometric Means Calculated with New Point Zero Data at Leo Carrillo Beach

Leo Carrillo Beach November 2004 - October 2010 Exceed % (Exceed Count/Sample Count)			
Total Coliform	**Fecal Coliform**	***enterococcus* MDL10[1]**	***enterococcus* MDL3.7[2]**
21.93% (186/848)	1.18% (10/848)	23.47% (199/848)	20.64% (175/848)

*Geometric Means were calculated based on a rolling 30-day with 5 or more samples
[1]MDL 10 refers *enterococcus* calculated with a method detection limit of 10
[2]MDL 3.7 refers *enterococcus* calculated assuming a method detection limit of 3.7

Figure 1. Leo Carrillo Beach, *enterococcus*, single sample and geometric means calculated with different substitutes for detection limit data (November 2004 - October 2010)



The City of Los Angeles also examined the consequences of using 3.7 mpn/day as a substitute for 10 mpn/day with data from a number of beaches. Similar to staff's finding with the data from Leo Carrillo Beach, very few beaches showed a meaningful difference.

Although this change in how the *enterococcus* geometric mean is calculated could allow for a small reduction in the number of exceedances of the geometric mean, it does not change any target, allowed exceedance rate or allocation. Therefore, it does not represent a need for significantly greater or smaller reductions in bacterial densities and will not require greater or lesser implementation actions on the part of responsible parties.

Recommendation

No additions or modifications to the TMDL. Responsible jurisdictions and agencies subject to the TMDL may conduct special studies for the Malibu Lagoon to determine the appropriate value for usage when samples results are below the detection limit. These studies should then be included in an updated monitoring plan for Executive Officer consideration. Detection limit substitutes will be subject to change if a different testing method with a different method detection limit is used.

4. Other Considerations not Specified for Reconsideration in the Malibu Bacteria TMDL

In addition to the technical considerations specified in the Malibu Bacteria TMDL, this reconsideration examines other issues that have been brought to the Regional Board's attention since the Malibu Bacteria TMDL was adopted and approved. This section discusses these additional issues.

4.1 Numeric Targets

The Malibu Bacteria TMDL has a multi-part numeric target based on the bacteriological water quality objectives for marine and fresh waters to protect the REC-1 beneficial use.

The Regional Board has updated the bacteria objectives for freshwaters designated as REC-1 to remove redundancy and maintain consistency with USEPA's recommended criteria. The Regional Board adopted the revised objectives on July 8, 2010 in Resolution R10-005, the State Water Board approved the revised objectives on July 19, 2011 in Resolution 2011-0031 and OAL approved them on November 1, 2011. The revised objectives became final after USEPA approval on December 5, 2011.

The update of bacteria objectives removes the fecal coliform objectives and uses *E. coli* objectives as the sole objectives for freshwaters designated with the REC-1 beneficial use. To be consistent with the update of the bacteria objectives, staff proposes that numeric targets in the revised Malibu Bacteria TMDL only include the Basin Plan objectives for *E. coli* for REC-1 in freshwaters.

The revised numeric targets for single sample limits are:

In Fresh Waters Designated for Water Contact Recreation (REC-1):
1. Geometric Mean Limits
    a. *E. coli* density shall not exceed 126/100 ml.

2. Single Sample Limits
    a. *E. coli* density shall not exceed 235/100 ml.

4.2 Time Periods for Allowable Exccedance Days

In the studies of reference systems for freshwaters, allowable exceedance days are set on an annual basis based on rainfall conditions, namely dry-weather days and wet-weather days. Wet weather is defined as days of 0.1 inch of rain or more plus three days following the rain event. Therefore, this TMDL has been modified from three time periods (i.e., summer dry weather, winter dry weather, wet weather) to two time periods (i.e., dry weather and wet weather irrespective of season) for the allocations to be consistent with the data from the freshwater reference system.

4.3 Implementation

Additional language is proposed for the TMDL implementation that clarifies the requirements for Phase II Municipal Separate Storm Sewer System (MS4) permits. The existing TMDL assigns waste load allocations (WLAs) to MS4 permits. Staff proposes to clarify these WLAs apply to Phase II MS4 permits as well as Phase I MS4 permits.

4.4 Monitoring

The existing TMDL requires responsible agencies to conduct a follow up investigation if sampling demonstrates that a site is non-attaining. The TMDL states on page 8 of the Basin Plan amendment that, "Furthermore, if a creek location is out of compliance as determined in the previous paragraph, the Regional Board shall require responsible agencies to initiate an investigation, which at a minimum shall include daily sampling in the target receiving waterbody reach or at the existing monitoring location until all single sample events meet bacteria water quality objectives." To clarify the Regional Board's intent that responsible agencies take the initiative to conduct follow-up sampling, staff recommends that the TMDL language be revised to state that, "Furthermore, if a creek location is out of compliance as determined in the previous paragraph, the responsible agencies shall initiate an investigation within 24 hours of receiving analytical results, which at a minimum shall include daily sampling in the target receiving waterbody reach or at the existing monitoring location until all single sample events meet bacteria water quality objectives." This 24-hour timeframe for follow up sampling is consistent with the California Ocean Plan.

During implementation of the Ballona Creek Bacteria TMDL as well as the Santa Monica Bay Beaches Bacteria TMDLs, responsible agencies requested permission to use *E. coli* sampling in lieu of fecal coliform sampling and to apply a ratio to convert the *E. coli* data to fecal coliform equivalents in order to compare with the fecal coliform objective for marine waters. Staff proposes to allow this approach and recommends that if responsible agencies wish to follow this approach that they resubmit their monitoring plan for Executive Officer approval and include a proposed ratio to convert *E. coli* data to fecal coliform equivalents.

Finally, staff proposes to require responsible jurisdictions and agencies for the waste load allocations to conduct outfall monitoring for the purpose of demonstrating compliance. Responsible jurisdictions and agencies would be required to submit a revision to the comprehensive bacteria water quality monitoring plan to include an outfall monitoring plan with an adequate number of proposed outfalls and a frequency of sampling. This outfall monitoring is consistent with the recently adopted Santa Clara River and Los Angeles River Bacteria TMDLs.

5. CEQA Analysis

Pursuant to Public Resources Code section 21080.5, the Resources Agency has approved the Regional Water Boards' basin planning process as a "certified regulatory program" that adequately satisfies the California Environmental Quality Act (CEQA) (Public Resources Code section 21000 et seq.) requirements for preparing environmental documents. (14 Cal. Code Regs. § 15251(g); 23 Cal. Code Regs. § 3782.) The Regional Board previously prepared "substitute environmental documents" for the establishment of the Malibu Bacteria TMDL adopted by Resolution No. R04-019R, which was filed with the Resources Agency on January 24, 2006. Those documents contained the required environmental documentation under the State Water Board's CEQA regulations (23 Cal. Code Regs § 3777.) The project itself was the establishment of the Malibu Bacteria TMDL. In preparing the previous substitute environmental documents, the Regional Board considered the requirements of Public Resources Code section 21159 and California Code of Regulations, Title 14, section 15187, and intended those documents to serve as a tier 1 environmental review. The previous substitute environmental documents contained environmental analysis and findings related to the reasonably foreseeable methods of compliance, the impacts of the methods of compliance, feasible mitigation measures, and alternative means of compliance.

Staff has determined that this TMDL revision does not alter the environmental analysis that was previously prepared for the establishment of the Malibu Bacteria TMDL because the TMDL revisions will not result in different implementation actions than those previously analyzed for the Malibu Bacteria TMDL, or different effects upon the environment. Moreover, no additional reasonably foreseeable methods of compliance warrant environmental analysis pursuant to Public Resources Code section 21159 and California Code of Regulations, Title 14, section 15187. As such, this amendment is consistent with the prior CEQA documentation.

Further, consistent with California Code of Regulations, title 14, section 15162, the Regional Board has determined that no subsequent environmental documents shall be prepared because this TMDL revision does not involve new significant environmental effects, a substantial increase in the severity of previously identified significant effects, or mitigation measures or alternatives that are considerably different from those analyzed in the previous substitute environmental documentation.

6. References

Griffith, J. F., K. C. Schiff, and G. S. Lyon. 2006. Microbiological Water Quality at Non-human Impacted Reference Beaches in Southern California During Wet Weather. Southern California Coastal Water Research Project. Technical Report 495.

Jurisdictional Groups, 2009. Reconsideration Elements for Bacteria TMDLs, July 2009. 25pp.

Los Angeles County Department of Public Works. 2007. Integrated Total Maximum Daily Load Implementation Plan for the Malibu Creek Watershed. Prepared by CDM.

Los Angeles County Department of Public Works. 2008. Malibu Creek and Lagoon Bacteria TMDL Compliance Monitoring Plan. February 25, 2008.

Los Angeles Regional Water Quality Control Board. 2002. Amendment to the Water Quality Control Plan - Los Angeles Region to incorporate the Santa Monica Bay Beaches Bacteria TMDL. Regional Board Resolution No. R02-004.

Los Angeles Regional Water Quality Control Board. 2002. Amendment to the Water Quality Control Plan - Los Angeles Region to incorporate Implementation Provisions for the Region's Bacteria Objectives and to incorporate the Santa Monica Bay Beaches Wet-Weather Bacteria TMDL. Regional Board Resolution No. R02-022.

Los Angeles Regional Water Quality Control Board. 2004. Amendment to the Water Quality Control Plan - Los Angeles Region to incorporate the Malibu Creek and Lagoon Bacteria TMDL. Regional Board Resolution No. R04-019R.

Los Angeles Regional Water Quality Control Board. 2004. Total Maximum Daily Loads for Bacteria Malibu Creek Watershed. Staff Report.

Saiz, S.G. 2005. Assessing Compliance with Average Monthly Effluent Limitations using Calendar Monthly and 30-day Moving Averages. State Water Resources Control Board, Ocean Standards Unit, Standards Development Section, Sacramento, CA:. February 14, 2005. 16pp.

Schiff, K. C., J. S. Brown, S. B. Weisberg. 2002. Model monitoring program for large ocean discharges in southern California. Technical Report 357. Southern California Coastal Water Research Project.

State Water Resources Control Board (SWRCB) 2004. Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) list. Sept. 30, 2004.

Stein, E. D. and V. K., Yoon. 2007. Assessment of Water Quality Concentrations and Loads from Natural Landscapes. Southern California Coastal Water Research Project. Technical Report 500.

Tiefenthaler, L. L., E. D., Stein , and G. S., Lyon, 2008. Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams. Southern California Coastal Water Research Project. Technical Report 542.

U.S. Environmental Protection Agency, 1986. Ambient Water Quality Criteria for Bacteria – 1986. Office of Water Regulations and Standards, January 1986. 24pp.

U.S. Environmental Protection Agency, 2011. Draft Recreational Water Criteria and Request for Scientific Views. December 21, 2011. 73pp.