California Regional Water Quality Control Board
Los Angeles Region

STAFF REPORT – DRAFT

PROPOSED AMENDMENT OF THE *WATER QUALITY CONTROL PLAN – LOS ANGELES REGION* TO REVISE BACTERIA OBJECTIVES FOR WATERS DESIGNATED FOR CONTACT RECREATION

July 31, 2001

I. SUMMARY

Staff proposes an amendment to the *Water Quality Control Plan for the Los Angeles Region* (hereafter Basin Plan) to update the water quality objectives for bacteria that are applied to waters designated for contact recreation (REC-1). The proposed amendment would update the current objectives outlined in the Basin Plan. Our goal in updating the region's bacteria objectives is to better protect human health by reducing the risk of illnesses associated with exposure to water containing fecal bacteria. The proposed revisions are based on more recent epidemiological studies and research on the most appropriate bacterial indicators conducted locally and nationally.

Specifically, staff proposes that combinations of four bacterial indicators be used to assess the quality of waters used for contact recreation (REC-1).[1] Staff recommends that the fecal coliform objectives for non-contact recreation (REC-2) remain unchanged at the current time, since no epidemiological studies or research have been conducted focusing on accidental/incidental contact.[2]

Water quality objectives are based on the beneficial use of a water body, and may also differ depending on whether a water body is fresh or saline. These differences are due to differences in the risk of human exposure (e.g., immersion vs. incidental contact), epidemiological research, and indicator characteristics (e.g., enterococci bacteria survive longer than *E. coli* in marine water). Bacteria objectives therefore differ for water bodies designated for contact recreation, non-contact recreation and shellfish harvesting. If a water body is designated for all three uses, the most stringent water quality objectives apply. Staff is not proposing to update the water quality objectives for shellfish harvesting at this time.

Staff recommends that the bacteria objectives for waters used for contact recreation (REC-1) be updated to reflect those specified by California Code of Regulations, title 17, section 7958 "Bacteriological Standards" (Assembly Bill 411, Statutes of 1997) and "Ambient Water Quality

[1] REC-1 (water contact recreation) is a beneficial use, defined in the Basin Plan, and designated as either "Existing," "Potential," or "Intermittent" for all water bodies in the Region. REC-1 is defined in the Basin Plan as "[U]ses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs" (p. 2-2).

[2] REC-2 (non-contact water recreation) is defined in the Basin Plan as "[U]ses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities" (p. 2-2).

Criteria for Bacteria – 1986" (U.S. EPA, 1986). The updated objectives for marine waters would be based on four bacterial indicators: total coliform, fecal coliform, the fecal coliform-to-total coliform ratio, and enterococcus; for fresh water, the objectives would be based on two indicators, fecal coliform and *E. coli*.

The proposed water quality objectives for bacteria for water bodies designated as REC-1 are shown in Table 1.

In the sections below, we first present the existing objectives, the historical basis for these objectives, and criticisms leveled against these objectives. Second, we describe the proposed objectives and how they differ from existing objectives. We also discuss the technical basis for the proposed objectives as well as the policy justifications for revising the objectives. After our discussion of the proposed objectives, we present several alternatives for the Regional Board to consider from taking no action to adopting the proposed objectives.

II. RATIONALE FOR BASIN PLAN AMENDMENT

There are several reasons to update our bacteria objectives. First and foremost, the water quality standards outlined in the Basin Plan are the cornerstone of all of the other activities of the Regional Board and should be based on the best science available to protect beneficial uses.[3] The bacteria objectives that staff is proposing are based on substantial research conducted locally and nationally, which has provided new information on the best "indicators" of the presence of disease-causing organisms and the relationship between these indicators and illness rates.[4]

Second, we use water quality standards to determine which water bodies are impaired and, thus, to identify water bodies for which we must develop total maximum daily loads (TMDLs). These standards translate into the numeric targets in a TMDL. The numeric targets then form the basis for determining the allowable pollutant load to a water body and allocating this load among the various point and nonpoint source dischargers. These allocations are then incorporated, as appropriate, into discharge permits issued by the Regional Board. We have many bacteria TMDLs planned or underway. If we use outdated bacteria objectives as the basis of these TMDLs, we are likely to have to spend significant resources to redo these TMDLs once the new objectives are adopted.[5]

[3] Water quality standards are defined as the beneficial uses of a water body, the water quality objectives associated with that beneficial use, and the State's antidegradation policy. This Basin Plan amendment only proposes changes to the water quality **objectives** for bacterial indicators, not to the beneficial uses of water bodies.

[4] Indicator organisms often do not cause illness directly. However, they are associated with fecal contamination and have characteristics that make them good predictors of pathogens in water bodies. Pathogens are disease-causing microorganisms that include viruses, protozoa and bacteria. Many of these pathogens can not be measured directly. In addition, water bodies may contain many different pathogens, making measurement impractical even if techniques were available to detect all pathogens of concern. Therefore, indicator organisms are used to predict the health risks from pathogens residing in water bodies.

[5] We know, for example, that many of the beaches in Santa Monica Bay exceed the proposed single sample objective for enterococcus. It will be most efficient for us to address this impairment as part of a comprehensive pathogen TMDL for Santa Monica Bay beaches, since many of the sources are likely to be the same.

Third, if the Regional Board does not take action soon to update the bacteria objectives for the region, it is likely that the State Water Resources Control Board (State Board) and U.S. EPA will act on behalf of the region. Specifically, the State Board has plans to revise the bacteria objectives for contact recreation in the California Ocean Plan in 2002. In addition, in March 1999, U.S. EPA made a commitment in the *Action Plan for Beaches and Recreational Waters* that "where a State does not amend its water quality standards to include the 1986 criteria, U.S. EPA will act under Section 303(c) of the Clean Water Act to promulgate the criteria with the goal of assuring that the 1986 criteria apply in all states not later than 2003."[6]

III. PROPOSED CHANGES FOR WATERS DESIGNATED FOR CONTACT RECREATION (REC-1)

A. Current Objectives

The current objectives are based on total coliform and fecal coliform.

For **fresh water**, the current objectives are:

In waters designated for water contact recreation (REC-1), the fecal coliform concentration shall not exceed a log mean of 200/100 ml (based on a minimum of not less than four samples for any 30-day period), nor shall more than 10 percent of total samples during any 30-day period exceed 400/100 ml.

(RWQCB-LA Basin Plan, 1994, p 3-3)

For **marine water**, the current objectives are:

Samples of water from each sampling station shall have a density of total coliform organisms less than 1,000 per 100 ml; provided that not more than 20 percent of the samples at any sampling station, in any 30-day period, may exceed 1,000 per 100 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.

The 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 percent of the total samples during any 60-day period exceed 400 per 100 ml.

(California Ocean Plan, 1997, p. 2)

History of Current Objectives. In brief, the current fecal coliform objectives for waters designated REC-1 are based on the results of a series of epidemiological studies conducted in the late 1940s and early 1950s, which are summarized by Stevenson (1953). These studies showed that there was a significantly greater illness rate in individuals who swam in water with an average total coliform density of 2,300 organisms per 100 ml compared to those who swam in water with an average total coliform density of 43 organisms per 100 ml. This total coliform index was translated into a fecal coliform index by using the ratio of fecal coliforms to total

[6] The 1986 guidance issued by U.S. EPA only addresses bacteria objectives for waters designated for contact recreation, and only recommends use of enterococcus (marine water) and *E. coli* (freshwater). However, based on local research, the California Code of Regulations, title 17, section 7958 requires the use of total coliforms, fecal coliforms, the fecal coliform-to-total coliform ratio and enterococcus for marine water.

coliforms at one of the original study sites. This change from total coliform to fecal coliform was made because fecal coliform is more fecal specific. Based on this ratio, it was assumed that for fecal coliform, one would observe statistically significant swimming-associated gastrointestinal illness at 400 organisms/100 ml. The National Technical Advisory Committee (NTAC) of the Department of the Interior, which oversaw these initial epidemiological studies, suggested that a detectable risk was unacceptable, and so proposed a density of 200 fecal coliform per 100 ml as the criterion. The NTAC further proposed that not more than 10 percent of samples should exceed 400 fecal coliform per 100 ml. This criterion was recommended again by U.S. EPA in 1976.

B. Proposed Objectives

The revised objectives would still include objectives for total coliform (for marine water) and fecal coliform (for both marine and fresh water), but would add objectives for the fecal-to-total coliform ratio and enterococcus (for marine water), and *E. coli* (for fresh water).

Specifically, staff recommends the following:

In Marine Waters Designated for Water Contact Recreation

1. Geometric Mean Limits

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.

2. Single Sample Limits

a. Total coliform density shall not exceed 10,000/100 ml.
b. Fecal coliform density shall not exceed 400/100 ml.
c. Enterococcus density shall not exceed 104/100 ml.
d. Total coliform density shall not exceed 1,000/100 ml, if the ratio of fecal-to-total coliform exceeds 0.1.

In Fresh Waters Designated for Water Contact Recreation

1. Geometric Mean Limits

a. E. coli density shall not exceed 126/100 ml.
b. Fecal coliform density shall not exceed 200/100 ml.

2. Single Sample Limits

a. E. coli density shall not exceed 235/100 ml.
b. Fecal coliform density shall not exceed 400/100 ml.

Implementation Provisions for Water Contact Recreation Bacteria 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).

If any of the single sample limits are exceeded, the Regional Board may require repeat sampling on a daily basis until the sample falls below the single sample limit or for 5 days, whichever is less, in order to determine the persistence of the exceedance.

When repeat sampling is required because of an exceedance of any one single sample limit, values from all samples collected during that 30-day period will be used to calculate the geometric mean.

Justification for Revised Objectives. The revised objectives are based on new, better information on the relationship between illness rates and bacterial indicator densities. The new information was collected through more recent epidemiological studies conducted nationwide, including one study sponsored by the Santa Monica Bay Restoration Project of swimmers at Santa Monica Bay beaches (Cabelli, 1983; Dufour, 1984; Haile *et al*., 1999). There is also better information on the bacterial indicators themselves, allowing us to select the best indicators given local conditions (e.g., enterococcus survives longer than *E. coli* in marine water, better mimicking viruses (Fattal, *et al*., 1983)). This new information is briefly summarized below.

In response to criticisms leveled at the fecal coliform objective, in 1972, U.S. EPA initiated another series of epidemiological studies in both fresh water and marine water. The purpose of these studies was to: (1) confirm that swimming in sewage-contaminated water carries a health risk for bathers and (2) determine which indicator(s) is best correlated with swimming-associated health effects. These studies found that swimming in sewage-contaminated water does carry a health risk. Enterococcus and *E. coli* were the indicators most strongly correlated with gastroenteritis. These studies found that total coliform and fecal coliform densities were only weakly correlated with gastroenteritis. The enterococcus and *E. coli* criteria now recommended by U.S. EPA were calculated based on historical “acceptable” illness rates of 8 illness per 1,000 swimmers at fresh water beaches, and 19 illness per 1,000 swimmers at marine beaches, which are the illness rates associated with the fecal coliform criterion.

In a study conducted at Santa Monica Bay beaches, researchers also found an increased risk of illness associated with swimming in areas with high densities of bacterial indicators (Haile *et al.,* 1999). (In this study, researchers examined the correlation between indicator densities and gastrointestinal illness *as well as* respiratory illness, skin irritation, and earaches.) Researchers used “cutoff points” to determine whether there were differences in the incidence of illness for those who swam in waters with bacterial densities “greater than” versus “less than” certain cutoff points. Symptoms were found to be associated with swimming in areas where bacterial indicator counts were greater than the cutoff points that are used in state standards and federal guidelines. And while total coliform and fecal coliform were not found to be strongly associated with increased risk for gastrointestinal illness (as in the national studies), these indicators were associated with increased risk of skin rashes. In addition, the fecal coliform-to-total coliform ratio was found to be one of the better indicators for predicting health risks. Specifically, significant associations were observed with the incidence of illness generally increasing as the ratio of densities of total coliforms to fecal coliforms decreased towards a 1:1 ratio. The strongest effects were observed when analyses were restricted to times when total coliforms exceeded 1,000 cfu/100 ml. Table 2 shows the various outcomes that were found to be associated with these high densities of indicator bacteria.

As a result of the national epidemiological studies, the U.S. EPA published revised criteria guidelines for bacteria, recommending that states use enterococcus in marine water and *E. coli* or enterococcus in fresh water (U.S. EPA, 1986). As a result of the epidemiological study

conducted at Santa Monica Bay beaches, the California State Legislature passed Assembly Bill 411 (1997) requiring weekly monitoring of enterococcus, fecal coliform, total coliform and other microbiological indicators that the California Department of Health Services (Department) determines are appropriate during the period from April 1 to October 31. Assembly Bill 411 also required the Department to established bacteriological standards to be used for public notification. The Department adopted regulations in 1999 that add fecal-to-total coliform ratio as an additional microbiological indicator. Further, the Department's regulations establish standards that include both single sample standards and geometric mean standards, and are the same as those proposed in this Basin Plan amendment.

IV. ALTERNATIVES

1. ***No action.***

If the Regional Board does not adopt revised standards consistent with U.S. EPA's recommendations and California law, U.S. EPA and the State Board will act in place of the Regional Board to promulgate revised bacteria objectives for waters designated for water contact recreation (REC-1). Specifically, the State Board plans to adopt revised bacteria objectives for ocean waters in 2002; these objectives will likely be the same as those in the California Code of Regulations, title 17, section 7958 "Bacteriological Standards," which includes objectives for total coliform, fecal coliform, the fecal-to-total coliform ratio, and enterococcus. In addition, U.S. EPA will act by 2003 to change bacteria objectives for waters designated as REC-1 by adding an objective for enterococcus in marine waters and *E. coli* in freshwaters as necessary.

In the meantime, due to deadlines for certain TMDLs established in a consent decree between Heal the Bay, Inc. et al. and the U.S. EPA, the Regional Board may adopt TMDLs based on the old objectives, but have to redo these TMDLs when the new objectives are adopted by the State Board and U.S. EPA. Finally, the Regional Board may overlook beneficial use impairments, as indicated by exceedances of enterococcus or the total-to-fecal coliform ratio, which have been shown to be strongly correlated with an increased risk of illness, when conducting its biennial water quality assessment.

2. Adopt proposed revisions for freshwater only

Because the State Board plans to revise the bacteria objectives for contact recreation in marine water in the near future, the Regional Board could choose to only adopt the proposed *E. coli* objective for freshwater. However, pathogen TMDLs for coastal beaches will need to be brought to the Regional Board before the State Board is likely to adopt the revised objectives. It should be emphasized that staff has been working closely with State Board while preparing this Basin Plan amendment, and staff's proposal is consistent with the State Board's draft proposal.

3. Adopt proposed revisions to bacteria objectives

By adopting the proposed revisions to bacteria objectives for waters designated for water contact recreation, the Regional Board will make the region's bacteria objectives consistent with State law and U.S. EPA guidance, which are based on the latest research on the best indicators of bacterial contamination and public health risks. Finally, by acting proactively, we will be able to more efficiently carry out our other activities such as developing the region's 303(d) List, developing TMDLs, and specifying effluent limits in discharge permits.

V. RECOMMENDED ALTERNATIVE (#3)

Revise Chapter 3, "Water Quality Objectives" by replacing the second paragraph under ***Bacteria, Coliform*** with the following:

In Marine Waters Designated for Water Contact Recreation

1. Geometric Mean Limits
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.

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

In Fresh Waters Designated for Water Contact Recreation

1. Geometric Mean Limits
a. E. coli density shall not exceed 126/100 ml.
b. Fecal coliform density shall not exceed 200/100 ml.

2. Single Sample Limits
a. E. coli density shall not exceed 235/100 ml.
b. Fecal coliform density shall not exceed 400/100 ml.

Implementation Provisions for Water Contact Recreation Bacteria 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).

If any of the single sample limits are exceeded, the Regional Board may require repeat sampling on a daily basis until the sample falls below the single sample limit or for 5 days, whichever is less, in order to determine the persistence of the exceedance.

When repeat sampling is required because of an exceedance of any one single sample limit, values from all samples collected during that 30-day period will be used to calculate the geometric mean.

VI. OTHER CONSIDERATIONS

1. CEQA and Economic Considerations

The Basin Planning process has been certified by the Secretary of Resources as functionally equivalent to the preparation of an initial study, a negative declaration, or environmental impact report (EIR) pursuant to CEQA. In lieu of these documents, however, the Regional Board is required to prepare the following: the Basin Plan amendment; an Environmental Checklist that

identifies potentially significant adverse environmental impacts of the Basin Plan amendment; and a staff report that describes the proposed amendment, reasonable alternatives, and mitigation measures to minimize any significant adverse environmental impacts identified in the Checklist. The Basin Plan amendment, Environmental Checklist, and staff report together are functionally equivalent to an initial study, negative declaration, or EIR.

Based on the Environmental Checklist (attached to this report), staff concludes that there would be no potentially significant adverse impacts on the environment caused by adoption of this Basin Plan amendment.

As for economic considerations, the bacteria objectives proposed in this Basin Plan amendment are considered “indicators” of the presence of disease-causing pathogens. The Basin Plan amendment retains total and fecal coliform objectives, but adds to these objectives for enterococcus, *E. coli* and the ratio of fecal-to-total coliforms. Epidemiological studies have shown these to be even better indicators of the presence of disease-causing pathogens. Therefore, while the proposed objectives are not currently being attained, the methods and associated costs to achieve compliance with the objectives are not expected to be different from those necessary to achieve the existing objectives for total and fecal coliform.

The addition of these objectives may increase the costs of monitoring slightly. The increased analytical cost per sample is approximately $25.00 for either enterococcus or *E. coli*. However, the benefits of improved public health warnings and reduced illness are expected to far outweigh the additional analytical costs. Furthermore, many dischargers are already monitoring for the proposed bacterial indicators during much of the time as a result of state law (California Code of Regulations, title 17, section 7958), which went into effect in 1999.

VII. RECOMMENDATION

Staff recommends that the Regional Board approve the proposed Basin Plan amendment.

REFERENCES

Cabelli, V. J. 1983. “Health Effects Criteria for Marine Recreational Waters.” EPA-600/1-80-031.

California Code of Regulations. title 17, section 7958 “Bacteriological Standards.”

Committee of Water Quality Criteria. 1972. National Academy of Sciences – National Academy of Engineering. “Water Quality Criteria.” EPA-R3-73-003.

Dufour, Alfred P. 1984. “Health Effects Criteria for Fresh Recreational Waters.” EPA-600/1-84-004.

Fattal, B., R. J. Vasl, E. Katzenelson, and H. I. Shuval. 1983. “Survival of Bacterial Indicator Organisms and Enteric Viruses in the Mediterranean Coastal Waters off Tel-Aviv.” *Water Res.* 17:397.

Haile, Robert W., John S. Witte, Mark Gold, Ron Cressey, Charles McGee, Robert C. Millikan, Alice Glasser, Nina Harawa, Carolyn Ervin, Patricia Harmon, Janice Harper, John Dermand, James Alamillo, Kevin Barrett, Mitchell Nides, and Guang-yu Wang. 1999. “The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff.” *Epidemiology* 10(4):355-63.

Haile, Robert W. and John Witte. no date. “Addendum to ‘An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay – Description of Additional Analyses’.”

National Technical Advisory Committee, Federal Water Pollution Control Administration. 1968. “Water Quality Criteria.”

Stevenson, Albert H. 1953. “Studies of Bathing Water Quality and Health.” *American Journal of Public Health* 43(5):529-38.

United States District Court for the Northern District of California. 1999. Heal the Bay, Inc. Santa Monica BayKeeper, Inc. and Terry Tamminen, Plaintiffs, v. Carol Browner, Administrator of the U.S. EPA, Felicia Marcus, Regional Administrator of the U.S. EPA Region IX, and the U.S. EPA, Defendants. Case No. 98-4825 SBA. March 22, 1999.

United States Environmental Protection Agency. 2000. “Draft Implementation Guidance for ‘Ambient Water Quality Criteria for Bacteria – 1986’.” EPA-823-D-00-001.

United States Environmental Protection Agency. 1999. “Action Plan for Beaches and Recreational Waters.” (March).

United States Environmental Protection Agency. 1986. “Ambient Water Quality Criteria for Bacteria – 1986.” EPA440/5-84-002.

United States Environmental Protection Agency. 1976. “Quality Criteria for Water.”

TABLE 1.
Summary of Proposed Bacteriological Standards for Marine and Fresh Waters Designated for Water Contact Recreation in the Los Angeles Region

Beneficial Use	**Total Coliform Objective**	**Fecal Coliform Objective**	**Fecal-to-Total Ratio Objective**	**Enterococcus Objective**	***E. coli* Objective**
Marine Water[7]					
REC-1 (single sample)	≤10,000/100 ml	≤400/100 ml	Total coliform ≤ 1,000/100 ml, if Fecal-to-Total ratio > 0.1	≤104/100 ml	N/A
REC-1 (geometric mean)	≤1,000/100 ml	≤200/100 ml	N/A	≤35/100 ml	N/A
Fresh Water[8]					
REC-1 (single sample)	N/A	≤400/100 ml	N/A	N/A	≤235/100 ml
REC-1 (geometric mean)	N/A	≤200/100 ml	N/A	N/A	≤126/100 ml

[7] REC-1 bacteria objectives for marine waters are based on California Code of Regulations, title 17, section 7958 and U.S. EPA (1986).
[8] REC-1 bacteria objectives for freshwater are based on U.S. EPA (1986).

Table 2. Health outcomes associated with swimming in areas with high bacterial indicator counts from Santa Monica Bay Restoration Project study (Haile *et al*., 1999; Haile and Witte, no date)

Indicator (cutoff)	*Health outcomes*	*Increased risk*	*Excess cases per 10,000 persons*
Total coliform (>10,000 cfu*/100 ml)	Skin rash	200%	165
Fecal coliform (>400 cfu/100 ml)	Skin rash	88%	74
Enterococcus (>104 cfu/100 ml)	Diarrhea with blood HCGI-1**	323% 44%	27 130
E. coli (>320 cfu/100 ml)	Earache Nasal congestion	46% 24%	149 211
Total-to-fecal coliform ratio (≤10 when total coliform >1,000 cfu/100 ml)	Chills Nausea Diarrhea HCGI-2***	Not available Not available Not available Not available	117 230 281 98

*Colony forming units

**Highly credible gastrointestinal illness with vomiting, diarrhea and fever or stomach pain and fever

***Highly credible gastrointestinal illness with vomiting and fever only