

**CHAPTER 7
LINKAGE ANALYSIS**

This chapter describes the link between the *E. coli* and enterococci bacteria numeric targets, loading capacities, and load allocations used in this TMDL project and attainment of REC-1 beneficial uses. *E. coli* and enterococci bacteria numeric targets, loading capacities, and load allocations are used in this TMDL project as support of the Water Contact Recreation Beneficial Use. If *E. coli* and enterococci bacteria targets are met, REC-1 and REC-2 beneficial uses will be supported and applicable water quality standards will be attained. This section includes information previously discussed in Section 2.1 on water quality standards.

The current Basin Plan WQOs for protection of REC-1 beneficial use are based on outdated science¹. The U.S. EPA has found no linkage between fecal coliform bacteria concentrations and increased risk of gastrointestinal illness. The U.S. EPA (1986) water contact recreation criteria recommendation replaced EPA's previously recommended fecal coliform criteria for water contact recreation (U.S. EPA, 1976). U.S. EPA conducted a review of published studies and evaluated the evidence linking specific microbial indicators of recreational water quality to specific health outcomes. These studies concluded that both *E. coli* and enterococci, but not fecal coliform bacteria, are good indicators of fecal contamination. Russian River Watershed Pathogen Indicator Bacteria TMDLs were not established for fecal coliform bacteria concentrations since no linkage between REC-1 beneficial use could be established.

E. coli and enterococci bacteria are found in the fecal material of humans and other animals. The U.S. EPA recommends *E. coli* and enterococci bacteria criteria as good indicators of health risk from water contact in freshwater. The U.S. EPA published criteria under Section 104(v) of the federal Clean Water Act for the purpose of protecting human health in waters designated by states for use for swimming, bathing, surfing, or similar water contact activities (U.S. EPA 2012). Development of the criteria included epidemiological studies, quantitative microbial risk assessment, site characterization studies, methods development and validation studies, modeling, assessment of levels of public health protection, and literature reviews. The U.S. EPA also considered relevant studies conducted by independent researchers. Although the U.S. EPA did not include *E. coli* bacteria in their epidemiological study, U.S. EPA did review and cite other scientific literature that found linkages between *E. coli* and illness, from which they derived the recommended *E. coli* criteria. For example, the U.S. EPA (2012) reviewed published studies and concluded that

¹ The State Water Board will consider revision of the Inland Surface Waters Plan to include revised bacteria objectives, comparable to the national criteria recently established by U.S. EPA. When adopted, these objectives will be applicable statewide, replacing existing bacteria objectives in individual basin plans. The State Board is tentatively scheduled to consider adoption of revised bacteria objectives in the Spring of 2016. The Regional Water Board has decided to postpone any effort to separately update its own objective, relying instead on the State Board's efforts.

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both *E. coli* and enterococci are good indicators of predictors of gastrointestinal illness in fresh waters.

An increase in *E. coli* or enterococci bacteria concentrations correlated well with an increase in illness rate, verifying the linkage between the *E. coli* and enterococci bacteria concentration-based numeric targets, loading capacities, and load allocations in this TMDL project and risk of illness during water contact recreation and non-contact water recreation (i.e., REC-1 and REC-2 beneficial uses).

Because of the availability of updated national criteria for bacteria to protect recreation and the need to initiate action towards addressing pathogenic contamination as soon as possible, this TMDL project includes TMDLs/loading capacities for *E. coli* and enterococci bacteria to ensure protection of water contact recreational uses. Furthermore, as the State Water Board is currently developing a statewide amendment to the Inland Surface Waters, Enclosed Bays, and Estuaries Plan to protect recreational users from the effects of pathogens in California waterbodies, this TMDL is established at levels expected to implement the applicable water quality standard. To ensure that this TMDL is protective, staff recommends that this TMDL not go before the State Board for adoption until after the State Bacteria objective is adopted. An update may be necessary to conform with the new statewide objectives, should they be more restrictive than the national criteria.