CHAPTER 2
PROBLEM IDENTIFICATION: STANDARDS AND INDICATORS

This chapter describes the water quality standards that are applicable to this TMDL project, the types of human pathogens most commonly associated with waterborne diseases, the types of bacteria used to indicate the presence of pathogens, and the nature of the impairment.

2.1 WATER QUALITY STANDARDS

In accordance with the Clean Water Act, a TMDL is set at a level necessary to achieve applicable water quality standards. Water quality standards consist of three basic elements:

1. Designated uses of the waterbody, which in California are known as beneficial uses;
2. Water quality criteria to protect designated uses, which in California are known as water quality objectives;
3. An antidegradation policy to maintain and protect existing uses and high quality waters.

This section summarizes the beneficial uses and water quality objectives applicable to the Russian River.

2.1.1 BENEFICIAL USES

The Basin Plan documents the beneficial uses of the waters within the boundaries of the region. Tables 2.1 and 2.2 identify and define beneficial uses for each hydrologic subarea in the Russian River Watershed. The beneficial uses of any specifically identified waterbody generally apply to all its tributaries. Beneficial uses defined by waterbody type (e.g., groundwater or wetlands) may also be applicable.

Beneficial uses relevant to the numeric water quality objectives are defined below. The Basin Plan does not include explicit numeric pathogen indicator bacteria objectives for other beneficial uses.

- Water Contact Recreation (REC-1): Uses 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.

- Non-Contact Water Recreation (REC-2): Uses 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.

- Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Table 2.1
Beneficial Uses Designated for Protection in Surface Waters of the Russian River Watershed

HYDROLOGIC AREAS (HA)		**Upper Russian River**			**Middle Russian River**						**Lower Russian River**	
HYDROLOGIC SUB AREAS (HSA)		**Coyote Valley**	**Forsythe Creek**	**Ukiah**	**Sulphur Creek**	**Warm Springs**	**Geyserville**	**Laguna**	**Santa Rosa**	**Mark West**	**Guerneville**	**Austin Creek**
MUN	Municipal and Domestic Supply	X	X	X	X	X	X	X	X	X	X	X
AGR	Agricultural Supply	X	X	X	X	X	X	X	X	X	X	X
IND	Industrial Service Supply	X	X	X	X	X	X	X	X	X	X	X
PRO	Industrial Process Supply	X	X	X	X	X	X	X	X	X	X	X
GWR	Groundwater Recharge	X	X	X	X	X	X	X	X	X	X	X
FRSH	Freshwater Replenishment	X		X		X	X	X		X	X	
NAV	Navigation	X	X	X	X	X	X	X	X	X	X	X
POW	Hydropower Generation		X		X		X		X	X	X	X
REC-1	Water Contact Recreation	X	X	X	X	X	X	X	X	X	X	X
REC-2	Non-Contact Water Recreation	X	X	X	X	X	X	X	X	X	X	X
COMM	Commercial and Sport Fishing	X	X	X	X	X	X	X	X	X	X	X
WARM	Warm Freshwater Habitat	X	X	X	X	X	X	X	X	X	X	X
COLD	Cold Freshwater Habitat	X	X	X	X	X	X	X	X	X	X	X
WILD	Wildlife Habitat	X	X	X	X	X	X	X	X	X	X	X
RARE	Rare, Threatened, or Endangered Species	X	X	X	X	X	X	X	X	X	X	X
MIGR	Migration of Aquatic Organisms	X	X	X	X	X	X	X	X	X	X	X
SPWN	Spawning, Reproduction, and/or Early Development	X	X	X	X	X	X	X	X	X	X	X
SHELL	Shellfish Harvesting			X			X	X	X	X	X	
EST	Estuarine Habitat										X	
AQUA	Aquaculture	X	X	X	X	X	X	X	X	X	X	X

2.1.2 WATER QUALITY OBJECTIVES

The Basin Plan includes a water quality objective for bacteria, as follows.

> **Bacteria Water Quality Objective**
>
> The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels.
>
> In no case shall coliform concentrations in waters of the North Coast Region exceed the following: In waters designated for contact recreation (REC-1), the median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50/100 mL, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 mL (State Department of Health Services).
>
> At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, Manual of Operation).

The objective has three parts requiring:

1. Consistency with natural background conditions;
2. Protection of contact recreation; and
3. Protection of human consumption of shellfish.

The objective was adopted by the Regional Water Board in 1975 when fecal coliform was a common measure of bacterial contamination. In 1984, the U.S. EPA promulgated national criteria for the protection of recreation, which are based on *E. coli* and enterococci bacteria (see Section 2.2.1.2). In 2012, U.S. EPA released revised national criteria for the protection of recreation, also based on *E. coli* and enterococci bacteria. The State Water Resources Control Board (State Water Board) is currently in the process of developing indicator bacteria objectives based on U.S. EPA's 2012 national criteria, which will be proposed for statewide applicability. The State Water Board's schedule indicates a hearing on this item in Spring 2016.

2.2 WATER QUALITY IMPAIRMENTS

Pathogens most commonly identified and associated with waterborne diseases can be grouped into three general categories: bacteria, protozoans, and viruses (Table 2.3). Bacteria are microscopic unicellular organisms that are ubiquitous in nature, including the intestinal tract of warm-blooded animals. Many types of harmless bacteria colonize the human intestinal tract and are routinely shed in feces. However, pathogenic (disease-causing) bacteria are present in the feces of infected humans and animals and can contaminate surface water and groundwater as a result of inadequate waste treatment or disposal methods. Protozoans are unicellular organisms that are present primarily in the aquatic environment. Of the 35,000 known species of protozoans, almost 30 percent are pathogenic. Pathogenic protozoans can occur in humans and animals where they multiply in the intestinal tract of the infected individual or animal and are later excreted in feces as cysts. Viruses are obligate intracellular parasites, incapable of replication outside of a specific host organism. Viruses that are of a public health concern are viruses that replicate in the intestinal tract of humans, and are referred to as human enteric viruses (U.S. EPA 2001).

Table 2.2
Pathogenic Bacteria, Protozoan, and Virus of Concern to Water Quality

Pathogen Type	Disease	Effects
Bacteria		
Escherichia coli	Gastroenteritis	Vomiting, diarrhea
Salmonella typhi	Typhoid fever	High fever, diarrhea, ulceration of the small intestine
Salmonella	Salmonellosis	Diarrhea, dehydration
Shigella	Shigellosis	Bacillary dysentery
Vibrio cholera	Cholera	Extremely heavy diarrhea, dehydration
Yersinia enterolitica	Yersinosis	Diarrhea
Protozoan		
Balantidium coli	Balantidiasis	Diarrhea, dysentery
Cryptosporidium	Cryptosporidiosis	Diarrhea, death in susceptible populations
Entamoeba histolytica	Amebiasis (ameobic dysentery)	Prolonged diarrhea with bleeding, abscesses of the liver and small intestine
Giardia lamblia	Giardiasis	Mild to severe diarrhea, nausea, indigestion
Virus		
Adenovirus	Respiratory disease, gastroenteritis	Various effects
Enterovirus	Gastroenteritis, heart anomalies, meningitis	Various effects
Hepatitus A	Infectious hepatitis	Jaundice, fever
Reovirus	Gastroenteritis	Vomiting, diarrhea
Rotavirus	Gastroenteritis	Vomiting, diarrhea
Calicivirus	Gastroenteritis	Vomiting, diarrhea
Astrovirus	Gastroenteritis	Vomiting, diarrhea

Adapted from Metcalf & Eddy 1991 and Fout 2000; as cited in U.S. EPA 2001

2.2.1 BACTERIA INDICATORS

Several groups of intestinal bacteria are used as indicators that a waterbody has been contaminated with human sewage and that pathogens are present. Most strains of pathogen indicator bacteria do not directly pose a health risk to swimmers and those recreating in the water, but indicator bacteria often co-occur with human pathogens and are easier to measure than the actual pathogens that may pose the risk of illness. It is impractical to directly measure the wide range of types of fecal-borne pathogens (bacteria, viruses, and protozoans) and the methods to detect human pathogens are characteristically expensive and inefficient, or may be not available.

2.2.1.1 FECAL COLIFORM

Fecal coliform bacteria are a subgroup of total coliform bacteria found mainly in the intestinal tracts of warm-blooded animals, and thus, are considered a more specific indicator of fecal contamination of water than the total coliform group. Fecal coliform bacteria concentration criteria were initially recommended by U.S. EPA (1976) for assessing support of recreational use. However, since 1976, several key epidemiological studies were conducted to evaluate the criteria for effectiveness at protecting public health from water contact recreation (Cabelli et al. 1982; Cabelli et al. 1983; Dufour 1983; Favero 1985; Seyfried et al. 1985a, Seyfreid et al. 1985b). These studies concluded that the 1976 U.S. EPA recommended fecal coliform bacteria criteria were not protective of public health from swimming recreation. As a result, the U.S. EPA changed the criteria recommendation in 1986 to use the pathogen bacteria indicators of *E. coli* and enterococci bacteria. Detection of fecal coliform bacteria in recreational waters may overestimate the level of fecal contamination because this bacteria group contains a genus, *Klebsiella*, with species that are not necessarily fecal in origin. *Klebsiella* bacteria are commonly associated with soils and the surfaces of plants, so that areas with organic debris may show high levels of fecal coliform bacteria that do not have a fecal-specific bacteria source.

2.2.1.2 E. COLI BACTERIA AND ENTEROCOCCI BACTERIA

E. coli is a species of fecal coliform bacteria that is found in the fecal material of humans and other animals. U.S. EPA (2012) compiled numerous epidemiological studies and concluded that *E. coli* bacteria are a good indicator of human health risk from water contact in recreational freshwaters. The criteria are established for both the geometric mean and the statistical threshold value (STV) (Table 2.4). To assess impairment of REC-1, the geometric mean criterion is compared to the logarithmic average of the bacteria concentration distribution. In addition, the STV criterion is compared to the 90th percentile of the bacteria concentration distribution.

Table 2.3
U.S. EPA's *E. coli* Recreational Water Quality Criteria & Beach Action Values

Estimated Illness Rate	Water Quality Criteria		Beach Action Value
	Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)	Single Sample Maximum (cfu/100mL)
36 Illnesses per 1,000 Recreators	126	410	235
32 Illnesses per 1,000 Recreators	100	320	70

Note: The highlighted values are the TMDL Numeric Targets
* cfu = colony forming units

Enterococci is a genera of fecal indicator bacteria that is found in the fecal material of humans and other animals. U.S. EPA (2012) compiled numerous epidemiological studies and concluded that enterococci bacteria are a good indicator of human health risk from water contact in recreational marine and freshwaters. The criteria are established for both the geometric mean and the statistical threshold value (STV) (Table 2.5). To assess impairment of REC-1, the geometric mean criterion is compared to the logarithmic average of the bacteria concentration distribution. In addition, the STV criterion is compared to the 90th percentile of the bacteria concentration distribution.

Table 2.4
U.S. EPA's Enterococci Recreational Water Quality Criteria & Beach Action Values

Estimated Illness Rate	Water Quality Criteria		Beach Action Value
	Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)	Single Sample Maximum (cfu/100mL)
36 Illnesses per 1,000 Recreators	35	130	70
32 Illnesses per 1,000 Recreators	30	110	60

Note: The highlighted values are the TMDL Numeric Targets
* cfu = colony forming units

U.S. EPA published *E. coli* and enterococci bacteria criteria for two different levels of illness risk. The first level of risk (36 estimated illnesses per 1,000 recreators) is the same risk level applied with the previous recreational criteria (i.e., U.S. EPA 1986). The 1986 U.S. EPA criteria correspond to the level of risk associated with an estimated illness rate of the number of highly credible gastrointestinal illnesses (HCGI) per 1,000 primary contact recreators. The information developed for the 2012 U.S. EPA criteria use a more comprehensive definition of GI illness, referred to as NEEAR-GI (NGI), which includes diarrhea without the requirement of a fever. Because NGI is broader than HCGI, more illness cases were reported and associated with recreation using the NGI definition of illness, at the same level of water quality observed using the previous illness definition (i.e., HCGI). The U.S. EPA (2012) also recommends criteria that correspond to an illness rate of 32 NGI per 1,000 primary contact recreators to "encourage an incremental improvement in water quality."

The 2012 U.S. EPA criteria are expressed as colony-forming units per sample volume (cfu/100mL) based on membrane filtration methods (U.S. EPA 2002a; U.S. EPA 2002b). Many laboratories, including the Regional Water Board Microbiology Laboratory, use a different analysis method to measure *E. coli* (and enterococci) bacteria concentrations (IDEXX 2001). These methods, (Colilert® and Enterolert® Quanti-Tray/2000) have been shown to produce equivalent results as the membrane filtration methods (Budnick et al. 1996; Yakub et al. 2002) and have been approved by the U.S. EPA in the Code of Federal

Regulations (40 C.F.R. 136.3). Both methods are based on culturing the bacteria in the sample on nutrient media.

In addition to the 2012 U.S. EPA criteria, U.S. EPA suggests the use of the Beach Action Value (BAV) as a conservative, precautionary tool for making beach notification decisions. The BAV is not a component of U.S. EPA's recommended criteria, but a tool that states may choose to use, without adopting it into their water quality standards as a "do not exceed value" for beach notification purposes. The BAV is applied to single sample measurements: any single sample above the BAV could trigger a beach notification until another sample below the BAV is collected. States also may choose a quantitative polymerase chain reaction-based (qPCR) BAV for beach notification purposes.

2.2.1.2 BACTEROIDES BACTERIA

Bacteroides bacteria are another group of pathogen indicator organisms that are used to measure fecal waste in water. *Bacteroides* is the genus name of the bacteria from the phylum Bacteroidetes and order Bacteroidales. *Bacteroides* bacteria are anaerobic (i.e., they do not live or grow in the presence of oxygen) and make up a substantial portion of the gastrointestinal flora of mammals (Wexler 2007). However, some species of *Bacteroides* bacteria can come from non-enteric sources (Niemi et al. 2012).

Due to their anaerobic-nature, *Bacteroides* bacteria have a low potential for survival and regrowth in the environment. In addition, water temperature has been shown to affect the persistence of *Bacteroides* in surface water. For water temperatures typically observed in the Russian River during the summer period (20-25°C or 68-77°F), *Bacteroides* bacteria survive one to two days. In cooler temperatures, *Bacteroides* bacteria likely survive for a week or more. Because of this short life span, *Bacteroides* bacteria concentrations are often used to indicate recent fecal waste of surface waters.

Bacteroides bacteria are especially useful as a tool to identify fecal waste from specific animal sources. The percentage of the *Bacteroides* bacteria population that originates from specific animal hosts can be determined using real-time quantitative polymerase chain reaction (qPCR) methods, which amplify specific DNA sequences of the 16S rRNA gene marker (Molina 2007). Some animal host assays are non-quantitative and produce only presence/absence results. Water samples analyzed for this TMDL project were analyzed for both human-specific and bovine- specific *Bacteroides* bacteria. *Bacteroides* bacteria assay primers have been developed for most domestic animal hosts including cattle, swine, chicken, dog, and horse (Griffith et al. 2013). Commercial laboratories are available that conduct these animal host analyses.

Water samples for *Bacteroides* bacteria should not be collected form disinfected waters, such as wastewater treated with chlorine, ozone, or UV light. While disinfection processes kill bacteria cells and eliminate the risk of illness to humans, pieces of the nucleic acids that comprise the bacterial DNA may persist in the water post-death in a non-viable state.

These DNA pieces may be counted in molecular amplification methods like qPCR that rely on the detection of DNA or RNA gene sequences to quantify bacteria.

According to the few epidemiological studies currently available for human *Bacteroides*, there is link between the bacteria and illness rates. Wade et al. (2010) estimated the probability of gastrointestinal illness due to increasing concentrations of *Bacteroides* bacteria, and found that a geometric mean of 60 gene copies/100mL corresponded to about 30 gastrointestinal illnesses per 1,000 swimmers. Ashbolt et al. (2010) compared human-specific *Bacteroides* bacteria concentration to *Norovirus* concentrations. From these estimates, a concentration of 860 gene copies/100mL corresponded to about 30 gastrointestinal illnesses per 1,000 swimmers. Soller et al. (2010a) identified *Norovirus* as the pathogen most responsible for a majority of gastrointestinal illness.

2.2.1.3 DNA MARKER SENSITIVITY AND SPECIFICITY

Bernhard and Field (2000a) first identified species composition differences in *Bacteroides* bacteria populations by screening 16S rDNA from human and cow feces. Conventional host-specific PCR assays were then developed to detect these genetic markers in environmental samples (Bernhard and Field 2000b). Further technical advancements have allowed for the relative quantification of animal host-specific genetic markers. There have been more than a dozen human-specific genetic markers developed over the last decade (Griffith et al. 2013). Studies have evaluated these genetic markers for sensitivity (does the marker detect human material when it is present in the sample) and specificity (does the marker cross-react with other animal sources).

Shilling et al. (2009) recommended use of the HuBac genetic marker of human-specific *Bacteroides* bacteria and the BoBac marker for bovine-specific *Bacteroides* bacteria for concentration measurements to support the Russian River Pathogen Indicator TMDL. Layton et al. (2006) found the HuBac genetic marker assay had 100% sensitivity, but it also had a 32% false-positive rate with potential for cross-sensitivity with swine feces. Shanks et al. (2010a) found the HuBac marker showed cross-sensitivity with feces from other animal hosts, most prominently with cats, dogs, and chickens. This leads staff to conclude that the HuBac marker was highly likely to correctly detect human waste material in samples from the watershed, but could have also counted other animal waste in the total concentration value.

In regards to bovine host markers, Layton et al. (2006) found the BoBac genetic marker assay was specific for bovine fecal samples with 100% sensitivity and 0% cross-sensitivity with the other animal hosts evaluated. Shanks et al. (2010b) found that the BoBac genetic marker showed cross-sensitivity with feces from many other animal hosts, most prominently with sheep and pig feces. The bovine-specific genetic markers, CowM2 and CowM3, both showed 100% specificity with no detection of other animal host fecal wastes.

The use of the HF183 and HumM2 markers is recommended for future human-specific *Bacteroides* analyses and CowM2 and Rum2Bac markers for bovine-specific analyses, until such time that better technology becomes available. These recommendations are based on the research and review by Griffith et al. (2013) of studies on human-specific and bovine-specific genetic markers. Griffith et al. concluded that the HF183 and HumM2 markers should be used for measuring human fecal waste in environmental samples because they provide the best combination of sensitivity and specificity. Griffith et al. also suggests that bovine-specific assays use both the CowM2 and the Rum2Bac genetic markers if non-cow ruminants are present in the watershed. Additionally, the U.S. EPA is in the process of approving the CowM2 method.

2.2.1.4 BACTERIA COMMUNITY

Analytical measurement technology has advanced to a point where entire bacterial communities are quantified instead of just specific pathogen indicator bacteria groups or species. High-throughput DNA sequence analysis can potentially identify all sources of microbial contaminants in a single test by measuring the total diversity of microbial communities. The PhyloChip™ (Second Genome, San Bruno CA) is a phylogenetic DNA microarray that has 16S rRNA gene probes that can quantify 59,316 different bacterial taxa in a single water sample. Analyzing the comprehensive suite of bacteria in a sample can help identify the major sources of fecal contamination in surface waters (Hazen et al. 2010).

Analysis of the bacteria with the PhyloChip™ reveals strong differences in community composition among fecal wastes from human, birds, pinnipeds, and livestock. Differences in the diversity among fecal wastes reveal hundreds of unique taxa that are specific to human, bird, and livestock feces (Dubinsky et al. 2012). Actinobacteria, Bacilli, and many Gammaproteobacteria taxa discriminated birds from mammalian sources. Families within the Clostridia and Bacteroidetes taxa discriminated between humans, livestock, and pinniped animal sources. Comprehensive interrogation of microbial communities for these diverse identifier taxa can assist in fecal waste source identification. Phylogenetic microarrays are an effective tool for rapidly measuring the full assortment of microbial taxa that discriminate sources of fecal contamination in surface waters.

Numeric targets for the bacteria community are not proposed as epidemiological studies have not yet been conducted to link concentrations to illness rates. However, analysis of the bacteria community is used in the TMDL to understand sources of fecal waste in the surface waters of the Russian River Watershed as described in Chapter 4.

2.2.2 DETERMINATION OF IMPAIRMENT

The 2012 Section 303(d) List of Impaired Waters was approved by U.S. EPA on July 30, 2015.[1] The List identifies six waterbody-pollutant pairs in the Russian River Watershed as not attaining the bacteria water quality objective and therefore, not supporting the REC-1 beneficial use. These waterbodies are the Russian River at Veterans Memorial Beach,

[1] The list was partially approved by U.S. EPA on June 26, 2015.

Russian River between the confluences of Fife Creek in Guerneville and Dutch Bill Creek in Monte Rio, an unnamed stream near Healdsburg at Fitch Mountain, Laguna de Santa Rosa, Santa Rosa Creek, Green Valley Creek, and Dutch Bill Creek. The data assessment that supports the official 2012 Section 303(d) listings was valid, and the listings provide a line of evidence of pathogen impairment in the Russian River Watershed.

Since that assessment was completed, additional data have been collected, criteria have been updated, and assessment methods have improved. Data were reassessed in accordance with improved criteria and methods. The determination of impairment was based on several lines of evidence. For a complete analysis of the evidence of impairment see Chapter 3. As a result of this evidence, the Russian River Watershed was deemed impaired due to exceedances of the Basin Plan water quality objective for bacteria and impairment of the Rec-1 beneficial use.

2.2.3 ADDRESSING IMPAIRMENT OF REC-1 AND REC-2 ONLY

This TMDL is developed to address the exceedance of the Rec-1 numeric water quality objective and associated impairment of recreational uses (Rec-1 and Rec-2).[2] It is not intended to address potential impairments based on indicator bacteria concentrations greater than natural background. This is because the Regional Water Board must complete a study of reference streams to determine the expected bacterial concentrations from relatively undisturbed waterbodies, prior to drawing a conclusion regarding natural background exceedances. When the Regional Water Board's reference study is complete, a revision to the TMDL may be necessary to update load allocations based on protection of background conditions.

Furthermore, this TMDL is not intended to address potential impairments based on indications of pathogenic contamination of shellfish. This is because based on updated science, fecal coliform is no longer recognized as an appropriate metric for measuring anthropogenic contributions of pathogenic waste. Yet, alternative objectives or criteria that establish a risk of pathogenic contamination have not yet been developed. Regional Water Board staff assessed the extent of the SHELL use in the watershed and documented evidence of shellfish in several areas (Butkus 2015). Freshwater mussels (*Anodonata* spp., *Margaritifera falcate*, and other unidentified species) were observed in the mainstem Russian River, East Fork, Mark West Creek, and Green Valley Creek. A limited staff survey of resource agency professionals, non-governmental organizations, and recreation sport fishing suppliers found no evidence of existing or historical harvesting of freshwater shellfish from the Russian River Watershed. A U.C. Davis survey of Native American tribal use found anecdotal evidence to historic traditional use of mussels from the river (Butkus 2015). Although staff will continue to research and document tribal uses of freshwater shellfish, there remains the potential for any individual to use shellfish from the Russian River and its tributaries for human consumption. The Russian River Pathogen Indicator

[2] Support of the REC-1 beneficial use is also protective of the REC-2 non-contact water recreation beneficial use.

TMDL does not immediately establish wasteload and load allocations for fecal coliform bacteria concentration to protect potential SHELL beneficial use. The Section 303(d) listing evaluated only impairments to REC-1. A future TMDL effort may be necessary to address impairments to SHELL beneficial use, including the evaluation of more protective water quality objectives. That effort may result in establishing additional bacteria concentration targets in the Russian River.

The State Water Resources Control Board (State Water Board) is proposing a statewide control program to protect recreational users from the effects of pathogens in California water bodies. The program would be adopted as amendments to both the Inland Surface Water, Enclosed Bays and Estuaries Plan and the California Ocean Plan. Significant proposed program elements may include: new water quality objectives for both fresh and marine waters based on newly released United States Environmental Protection Agency U.S. EPA (2012) criteria; a reference beach/natural source exclusion process and high flow exemptions; and revised beach notification requirements. The proposed bacteria water quality objective amendment is expected to be before the State Water Board for adoption in Spring 2016.

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 of the TMDL may be necessary should they be inconsistent with the new statewide objectives.