Draft Staff Report

for the

Action Plan
for the
Russian River Watershed
Pathogen Indicator Bacteria
Total Maximum Daily Load

August 21, 2015
California Regional Water Quality Control Board
North Coast Region

California Water Boards
State Water Resources Control Board
Regional Water Quality Control Boards

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California Regional Water Quality Control Board
North Coast Region
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LIST OF ACRONYMS & SHORT HAND NAMES

APMP	Advanced Protection Management Plan
Basin Plan	Water Quality Control Plan for the North Coast Region
BLRP	Bacteria Load Reduction Plan
BMP	Best Management Practice
BAV	Beach Action Value
CAFO	Confined Animal Feeding Operation
Caltrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
CDHCD	California Department of Housing and Community Development
CDPH	California Department of Public Health
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
CIWQS	California Integrated Water Quality System
cfu	colony forming units
CSD	Community Service District
CWA	Clean Water Act
CWC	California Water Code
DNA	Deoxyribonucleic acid
EIR	Environmental Impact Report
EL	Effluent Limitation
I/I	inflow and infiltration
Impaired Waters Policy	California Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options
gpd	gallons per day
LA	Load Allocation
mgd	million gallons per day
MPN	Most Probably Number
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer Systems
NGI	Near Gastrointestinal Illness (includes diarrhea without the requirement of a fever)
NOAA Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPS	Non-point Source
NRCS	Natural Resources Conservation Service
OWTS	Onsite Wastewater Treatment Systems
qPCR	Quantitative Polymerase Chain Reaction
QA/QC	Quality Assurance / Quality Control
REC-1	Water Contact Recreation Beneficial Use
REC-2	Non-Contact Water Recreation Beneficial Use
Regional Water Board	North Coast Regional Water Quality Control Board

RCD .... Resource Conservation District
rRNA... Ribosomal Ribonucleic Acid
ROWD .... Report of Waste Discharge
SSO .... Sanitary Sewer Overflow
State Water Board.................. State Water Resources Control Board
STV .... Statistical Threshold Value or 90th percentile
TMDL.. Total Maximum Daily Load
U.S. EPA .... United States Environmental Protection Agency
USFS... United States Forest Service
USFWS .... United States Fish and Wildlife Service
Waiver .... Waiver of Waste Discharge Requirements
WDRs .... Waste Discharge Requirements
WLA .... Wasteload Allocation
WWTP... Wastewater Treatment Plant

CHAPTER 1
INTRODUCTION

1.1 PURPOSE

The purpose of this Staff Report is to present the information and analyses developed to support the *Action Plan for the Russian River Watershed Pathogen Indicator Bacteria Total Maximum Daily Load* (TMDL Action Plan). The information and analyses presented are further supported by individual study and monitoring reports and technical memoranda. The TMDL Action Plan will be presented to the North Coast Regional Water Quality Control Board (Regional Water Board) in a public hearing as a proposed amendment to the *Water Quality Control Plan for the North Coast Region*, which is also known as the Basin Plan. The Basin Plan, Staff Report, TMDL Action Plan, supporting technical reports and memoranda, and Regional Water Board meeting schedule and agendas can be found on the Regional Water Board website (http://www.waterboards.ca.gov/northcoast/).

The purposes of the TMDL Action Plan for the Russian River Watershed Pathogen Indicator Bacteria Total Maximum Daily Load (Russian River Pathogen TMDL) are four-fold:

1. To improve the bacteriological quality of the surface waters in the Russian River Watershed so that public health is protected and water quality standards[1] are attained. The public health risk of most concern results from water contact recreation (REC-1) and incidental ingestion of contaminated river water, when and where such conditions exist or threaten to exist.

2. To set limits on the amount of bacterial discharges from non-natural controllable sources[2] into the surface waters of the Russian River Watershed that are necessary to protect water contact beneficial uses (REC-1).

3. To describe the implementation actions that are necessary to identify and control discharges of pathogenic waste and reduce bacteria concentrations in the Russian River Watershed to levels that protect public health and meet water quality standards.

4. To describe the monitoring actions that are necessary to ensure that implementation actions result in attainment of water quality standards or modify implementation actions, as necessary.

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[1] Water quality standards are made up of three parts: the beneficial uses of the waterbody of interest (e.g., water contract recreation in the Russian River Watershed), water quality objectives that will ensure the reasonable protection of beneficial uses, and an antidegradation policy, which maintains and protects existing uses and high quality waters.

[2] As examples, the non-natural controllable sources of concern to the Russian River Watershed include but are not limited to leaking septic systems, leaking sewer lines, leaking or undersized manure holding ponds, and direct disposal (or indirect disposal via storm water runoff) of human or domestic animal waste into the Russian River and its tributaries.

This chapter presents an overview of the regulatory and environmental settings within which this TMDL project is developed.

1.2 REGULATORY FRAMEWORK

Several laws and regulations govern the development and implementation of TMDLs, most notably the federal Clean Water Act (CWA) and the state Porter-Cologne Water Quality Control Act. This section describes the framework and context of these laws and regulations for the Russian River Pathogen TMDL.

1.2.1 IMPAIRED WATERBODIES

Section 303(d) of the CWA requires states to develop a list of waterbodies where required pollution control mechanisms are not sufficient or stringent enough to meet water quality standards applicable to such waters (known as the Section 303(d) List). The Section 303(d) List applicable to a given region of the State is updated once every 6 years.

Pathogen indicator bacteria data collected as part of the Russian River Pathogen TMDL project indicate that all surface stream and river reaches in the Russian River Watershed are impacted during some time of the year by pathogens[3]. Table 1.1 shows those waterbodies identified on the Section 303(d) List in 2012[4] as impaired by pathogens, as well as those impaired waterbodies that are not yet listed. Figure 1.1 shows those waterbodies identified on Section 303(d) List in 2012. All the waterbodies listed as impaired in the table are included in this TMDL project. Waterbody-pollutant pairs that are not on the Section 303(d) List adopted in 2012 will be proposed for addition to the Section 303(d) List in 2018, unless new information indicates attainment of standards.

[3] No conclusions are made with respect to the lakes and reservoirs within the Russian River Watershed, which were not sampled nor assessed as part of this TMDL project.
[4] The 2012 Section 303(d) has been adopted by the Regional Water Board and State Water Resources Control Board, and on July 30, 2015 it was approved by U.S. EPA (it was partially approved on Jun 26, 2015).

Table 1.1
Waterbodies within the Russian River Watershed and their Pathogen Impairment Status

Waterbody Name			2012 303(d) Listed	Impairment Identified/ Confirmed by the TMDL
Hydrologic Area	**Hydrologic Sub Area**	**Listing Extent**		
Upper Russian River	Coyote Valley	Entire Waterbody	N	Y
	Forsythe Creek	Entire Waterbody	N	Y
	Ukiah	Entire Waterbody	N	Y
Middle Russian River	Sulphur Creek	Entire Waterbody	N	Y
	Warm Springs	Entire Waterbody	N	Y
	Geyserville	Stream 1 (unnamed tributary) on Fitch Mountain	Y	Y
		Entire Waterbody	N	Y
	Laguna	Mainstem Laguna de Santa Rosa	Y	Y
		Tributaries to the Laguna de Santa Rosa Except Santa Rosa Creek	Y	Y
	Santa Rosa	Mainstem Santa Rosa Creek	Y	Y
		Tributaries to Santa Rosa Creek	Y	Y
	Mark West	Mainstem Mark West Creek Downstream of the Confluence with the Laguna de Santa Rosa	N	Y
		Mainstem Mark West Creek Upstream of the Confluence with the Laguna de Santa Rosa	N	Y
		Tributaries to Mark West Creek Except Windsor Creek	N	Y
		Windsor Creek and its Tributaries	N	Y
Lower Russian River	Guerneville	Mainstem Russian River at Veterans Memorial Beach from the Railroad Bridge to Hwy 101	Y	Y
		Mainstem Russian River from Fife Creek to Dutch Bill Creek	Y	Y
		Mainstem Dutch Bill Creek	Y	Y
		Green Valley Creek Watershed	Y	Y
		Entire Waterbody	N	Y
	Austin Creek	Entire Waterbody	N	Y

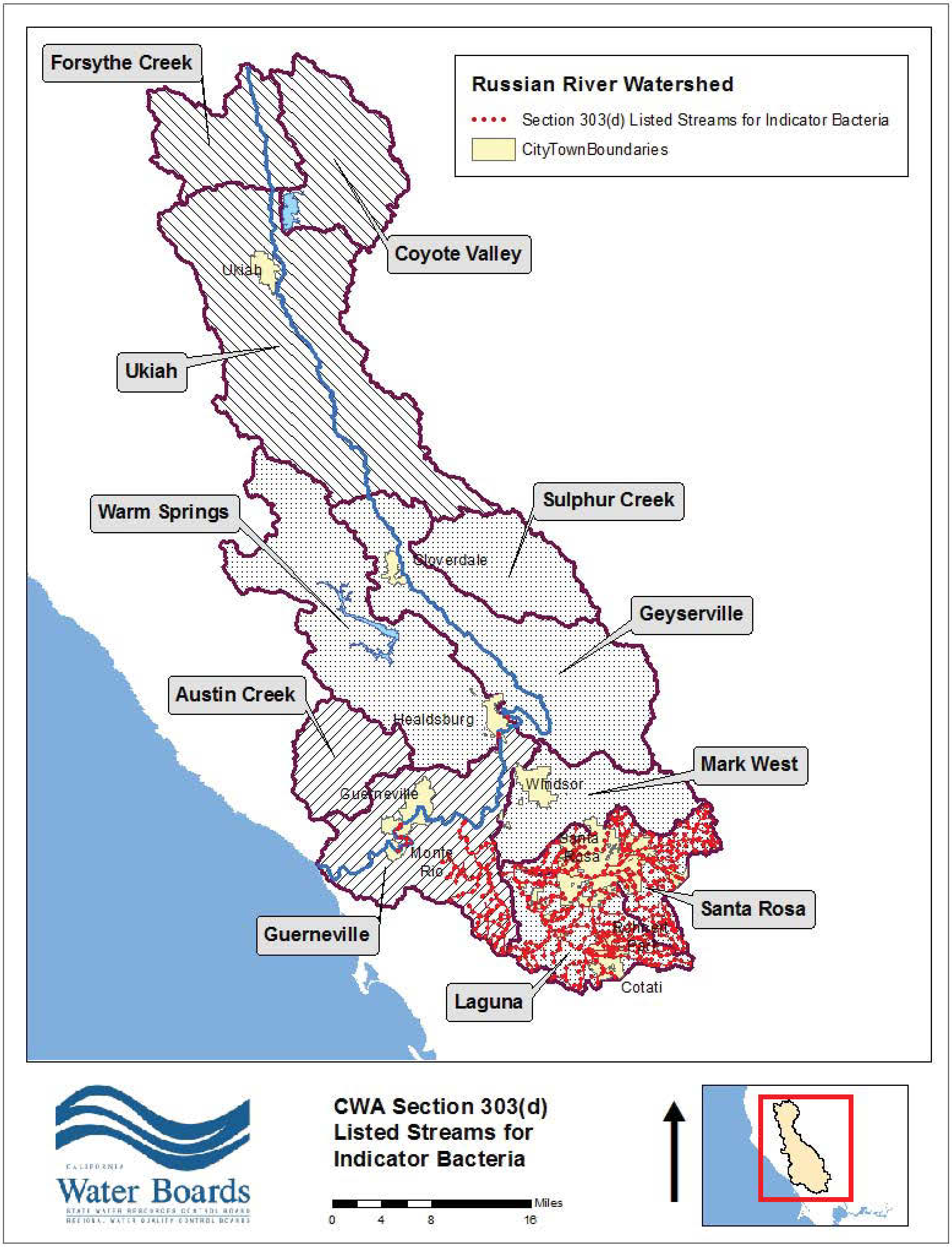

Figure 1.1: Streams that are included on the2012 Section 303(d) Listed as Impaired for REC-1 on the Russian River Watershed.

Source: North Coast Regional Water Quality Control Board

Once a waterbody is identified on the Section 303(d) List as impaired, a more detailed assessment of existing data is conducted, including assessment of data gaps. Studies are developed to fill critical data gaps so that the full spatial and temporal extent of the impairment can be defined. Chapter 3 summarizes the results of the assessment conducted for the Russian River Watershed, which constitute evidence of watershed-wide pathogen impacts and impairment of water contact recreational uses.

1.2.2 TMDL DEVELOPMENT

For waters listed as impaired, the state must develop a total maximum daily load (TMDL). A TMDL is a numerical calculation of the amount of a pollutant that a waterbody can assimilate and still meet water quality standards. This calculation includes waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and an attribution to natural background. An allocation can be expressed as a concentration rather than a load. For pathogens, TMDLs are generally expressed as the concentration of an fecal indicator bacteria, which indicate the potential presence of pathogens.

TMDLs established for impaired waters must be submitted to U.S. EPA for approval. Impaired waterbodies will then be restored to attain water quality standards using existing regulatory tools such as individual or general waste discharge requirements, enforcement actions, basin plan amendments, or other policies for water quality control.

1.2.3 BASIN PLAN AMENDMENT DEVELOPMENT

The federal Clean Water Act requires states to address impaired waters by developing a TMDL, fully implementing existing programs, or implementing additional water quality programs that will result in the attainment of water quality standards. Development of TMDLs and an implementation plan are required to address the pathogen impairment of the Russian River Watershed. The TMDLs and implementation plan are contained in the *Action Plan for the Russian River Watershed Pathogen Indicator Bacteria Total Maximum Daily Load,* which is proposed as an amendment to the Basin Plan. The Basin Plan establishes the regulations by which the Regional Water Board protects and restores water quality within the North Coast Region.

The Basin Plan identifies the beneficial uses of water within the North Coast Region, the water quality objectives necessary to protect those uses, implementation programs that ensure objectives are attained, and monitoring programs. The Basin Plan also incorporates state policies, including the Antidegradation Policy (Resolution 68-16), which requires the maintenance of high quality waters, unless degrading those high quality waters is otherwise in the maximum benefit of the people of the state.[5] The specific requirements

[5] High quality waters are those waters whose ambient water quality exceeds or is better than the water quality objective established for the pollutant in question.

for basin plans are described in the California Water Code (also known as the Porter-Cologne Water Quality Control Act), Division 7, Article 3, sections 13240 to 13247.

A Basin Plan amendment is appropriate for the Russian River Pathogen TMDL because control of existing direct and indirect discharges of pathogenic waste, protection of public health via application of REC-1 indicator bacteria criteria, and attainment of water quality standards will require multiple implementation actions. The California Administrative Procedures Act and the State's *Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options* (Impaired Waters Policy) require the use of a Basin Plan amendment to tie together numerous actions by the Regional Water Board to ensure that persons subject to regulations have the opportunity to participate in the process of developing the implementation plan.

Through the Basin Plan amendment process, the Regional Water Board meets the requirements of the California Environmental Quality Act (CEQA) to analyze and disclose environmental effects. Because the basin planning process is certified as an exempt regulatory program meeting the requirements of Public Resources Code section 21080.5 (Cal. Code Regs., tit.14, § 15251), the Regional Water Board is not required to prepare an initial study, a Negative Declaration, or an Environmental Impact Report. Instead, the basin planning process uses substitute environmental documentation. This Staff Report is a critical part of that documentation as it includes the required environmental analysis. (See Chapter 11 for the CEQA checklist and a programmatic analysis of the potential environmental effects resulting from implementation of the draft TMDL Action Plan).

The Staff Report, TMDL Action Plan, and substitute environmental documentation will be presented before the Regional Water Board at a public hearing for the purpose of adopting the TMDL Action Plan as an amendment to the Basin Plan. Should the Regional Water Board adopt the TMDL Action Plan, the State Water Resources Control Board (State Water Board) will hold a hearing to consider approving the decision of the Regional Water Board. California's Office of Administrative Law provides a final legal review before the TMDL Staff Report and TMDL Action Plan are forwarded to the U.S. EPA. The U.S. EPA approves only the technical elements of TMDL, not the implementation plan components. The TMDL and implementation plan components take effect upon approval of the TMDL Action Plan by the Office of Administrative Law

1.3 WATERSHED DESCRIPTION & ENVIRONMENTAL SETTING

The Russian River Watershed encompasses 1,484 square miles (949,982 acres) in Sonoma and Mendocino counties, California (Figure 1.2). Major municipalities within the watershed include Santa Rosa, Rohnert Park, Windsor, Healdsburg, Sebastopol, Cloverdale, and Ukiah. The watershed also includes numerous unincorporated communities such as, Forestville, Guerneville, Monte Rio, Hopland, and Calpella.

The Russian River Watershed has been divided into eleven (11) Hydrologic Subareas which are listed Table 1.2 and shown in Figure 1.3.

Figure 1.2: Russian River Watershed Overview Map
Source: North Coast Regional Water Quality Control Board

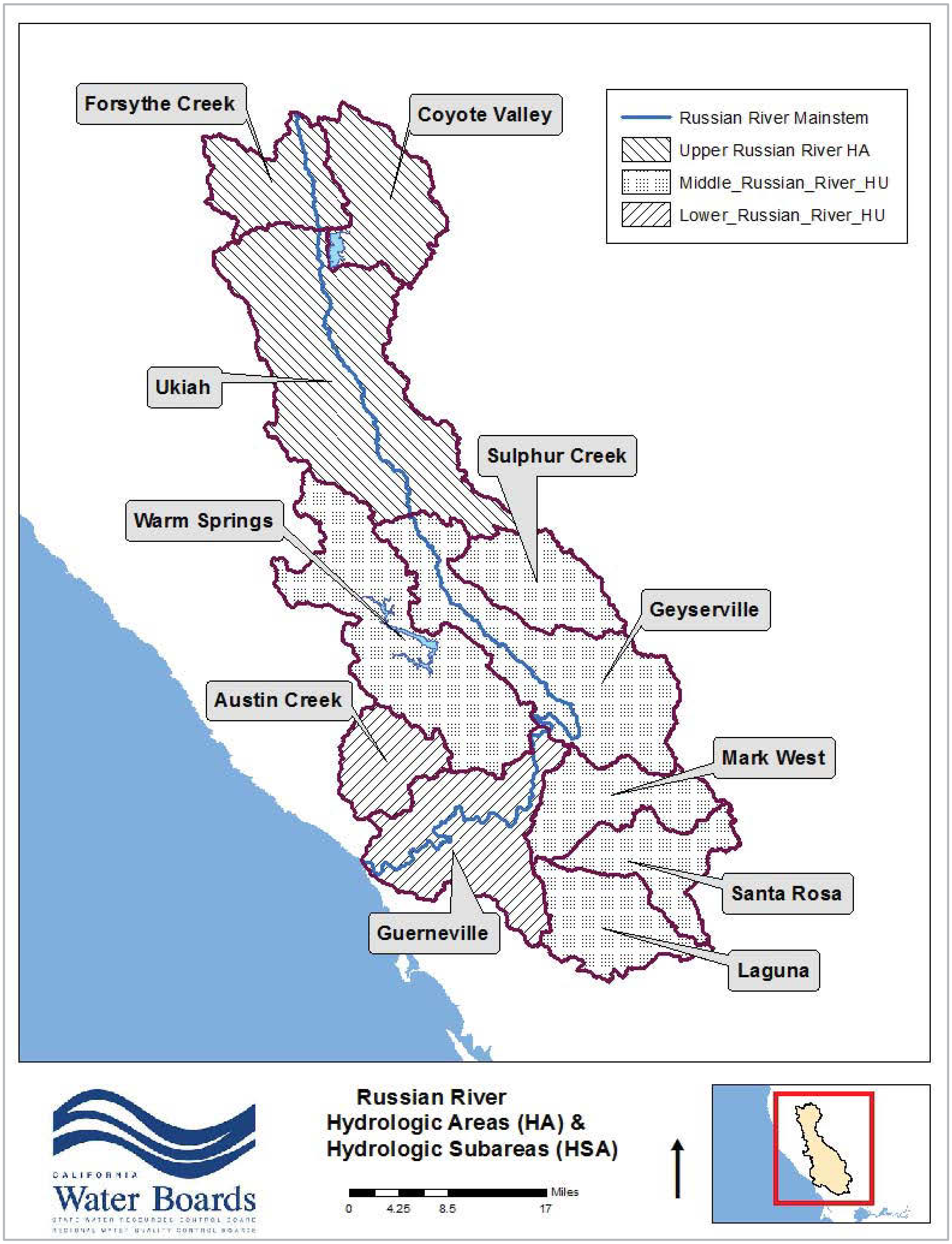

Figure 1.3: Hydrologic Subareas of the Russian River Watershed

Source: North Coast Regional Water Quality Control Board

Table 1.2
Hydrologic Areas and Subareas of the Russian River

Hydrologic Area Name	Hydrologic Subarea Name	Acres	Relative Area (%)
Upper Russian River	Coyote Valley	67,011	7%
	Forsythe Creek	53,965	6%
	Ukiah	200,235	21%
Middle Russian River	Sulphur Creek	52,655	6%
	Warm Springs	139,536	15%
	Geyserville	133,007	14%
	Laguna	56,644	6%
	Santa Rosa	49,511	5%
	Mark West	55,248	6%
Lower Russian River	Guerneville	102,303	11%
	Austin Creek	39,867	4%
Russian River Watershed		**949,982**	**100%**

1.3.1 HYDROLOGY

The Russian River Watershed is hydrologically and geomorphologically diverse, containing 238 streams, 23 named springs, 14 natural lakes, 15 named reservoirs, all or portions of 10 groundwater basins, steep ridges, ephemeral streams, rolling hills, and wide alluvial valleys. The Russian River, in conjunction with Lake Mendocino and Lake Sonoma, serves as the primary water source for more than 500,000 residents in Mendocino, Sonoma and Marin counties, and for agricultural production in Mendocino and Sonoma counties. Lake Mendocino, located on the East Fork of the Russian River, has a capacity of 118,900 acre-feet and captures a drainage area of about 105 square miles. Lake Sonoma, located at the confluence of Warm Springs Creek and Dry Creek, about 14 miles northwest of the city of Healdsburg, has a capacity of 381,000 acre-feet and captures a drainage area of about 130 square miles.

The Russian River drainage basin includes all of the tributaries to the river and is affected by the interactions between the hillslopes, the channel, and its floodplain. Sediment produced in the headwaters of the Russian River basin is stored in the channel or in reservoirs, extracted as aggregate, or transported toward the Pacific Ocean. The main channel of the Russian River flows through a series of wide alluvial valleys separated by relatively narrow bedrock constrictions. These bedrock constrictions act as geologic controls such that each alluvial valley is relatively independent with respect to adjustments in slope, width and depth (Florsheim and Goodwin 1995).

The 110-mile mainstem channel of the Russian River originates in the Redwood Valley of central Mendocino County about 15 miles north of Ukiah. From its origin, the Russian River flows in a south to southeast direction to the Wohler Bridge area, where it changes to a southwest direction, crosses the Coast Range, and empties into the Pacific Ocean near the town of Jenner 20 miles west of Santa Rosa. Elevations range from zero at the Pacific Ocean to 4,343 feet at Mount St. Helena in the Mayacamas Mountains. Nine sub-basins containing fifty-seven valleys comprise the watershed.

The Russian River originates upstream of the Ukiah Valley and passes through the alluvial valley until the valley constricts at the Hopland Gage. The river again passes through another alluvial valley that contains the Town of Hopland before again being constricted in the Frog Woman Rock region.

Downstream of Ukiah and Hopland, in the Alexander Valley reach, the river enters a mountainous area east of Healdsburg known as the Fitch Mountain Constriction where it is confined by steep bedrock banks. The section of the river in the Healdsburg Valley downstream to Wohler Bridge, where another bedrock constriction occurs, is known as the middle reach. The middle reach contains several permanent in-stream structures including the Healdsburg Dam, two bridges in Healdsburg, Wohler Bridge, and Highway 101. The lower reach is a narrow alluvial valley that terminates at the Pacific Ocean, near the town of Jenner.

Three major reservoir projects provide water supply for the Russian River Watershed: Lake Pillsbury on the Eel River, Lake Mendocino on the East Fork of the Russian River, and Lake Sonoma on Dry Creek. The Potter Valley Project is an interbasin water transfer project, delivering water from the Eel River basin to the headwaters of the Russian River. The main facilities are two dams on the Eel River, a diversion tunnel and hydroelectric plant. The project derives water from above Scott Dam and approximately 50 square miles between Scott Dam and Cape Horn Dam, where water is diverted to the Russian River. In the Russian River Valley and under agreements with the US Army Corps of Engineers, the Sonoma County Water Agency manages the stored water supply in Lake Mendocino and Lake Sonoma to provide water for agriculture, municipal, and industrial uses in accordance with its water-right permit. In addition, the Sonoma County Water Agency also releases water from these reservoirs to contribute the minimum stream flow requirements in the Russian River and Dry Creek established in 1986 by the State Water Board's Decision 1610. These minimum stream flows provide water for recreation and fish passage for salmon and steelhead in the mainstem Russian River and Dry Creek.

The Sonoma County Water Agency operates an inflatable dam on the Russian River in the Wohler Bridge area to increase water production capacity during peak demand months. The dam is inflated in the early spring to create pool conditions in the river. In the fall, the dam is deflated to provide passage for fish migration. Operation of the inflatable dam increases water production capacity in two important ways. First, surface water immediately behind the dam can be diverted to a series of infiltration ponds that are constructed adjacent to the three Mirabel collector wells. Second, infiltration to the underlying aquifer behind the dam is significantly improved by increasing the recharge area from the river.

1.3.2 LAND USES

Primary land uses in the Russian River Watershed include urban, rural, agricultural, and undeveloped lands as shown in Table 1.3 and Figure 1.4, which are based on Landsat satellite imagery (Fry et al. 2006). Most of the land in the watershed is privately owned (89.78%), with federal (5.41%), state (2.59%), local (2.15%), and tribal lands (0.08%) making up the remaining ownership. Land cover is primarily open space with fifty-one percent of the watershed having less than one housing unit per 160 acres (WCW 2007). Almost 300,000 people live in municipalities of the Russian River watershed (Table 1.4).

Table 1.3
Land Cover in the Russian River Watershed

Land Cover Category	Acres	Percent of Watershed Area
Shrub/Scrub	260,269	27.4%
Evergreen Forest	231,347	24.4%
Grassland/Herbaceous	163,358	17.2%
Mixed Forest	104,836	11.0%
Developed, Open Space	57,173	6.0%
Cultivated Crops	55,813	5.9%
Deciduous Forest	23,096	2.4%
Developed, Low Intensity	22,233	2.3%
Developed, Medium Intensity	16,312	1.7%
Open Water	7,130	0.8%
Woody Wetlands	2,564	0.3%
Developed, High Intensity	1,948	0.2%
Pasture/Hay	1,719	0.2%
Barren Land	1,469	0.2%
Herbaceous Wetlands	343	<0.1%
Total	949,611	100%

Table 1.4 Population of Municipalities in the Russian River Watershed		
Municipality	**Population[1]**	**Percent of Municipal Population**
Santa Rosa	171,990	60.1%
Rohnert Park	41,398	14.5%
Windsor	27,243	9.5%
Ukiah	15,871	5.5%
Healdsburg	11,517	4.0%
Sebastopol	7,596	2.7%
Cloverdale	8.738	0.0%
Guerneville	4,534	1.6%
Forestville	3,293	1.2%
Monte Rio	1,152	0.4%
Hopland	756	0.3%
Calpella	679	0.2%
Total Municipal Population	286,038	100%

[1] Per U.S. Census Bureau 2010 and U.S. Census Bureau 2013

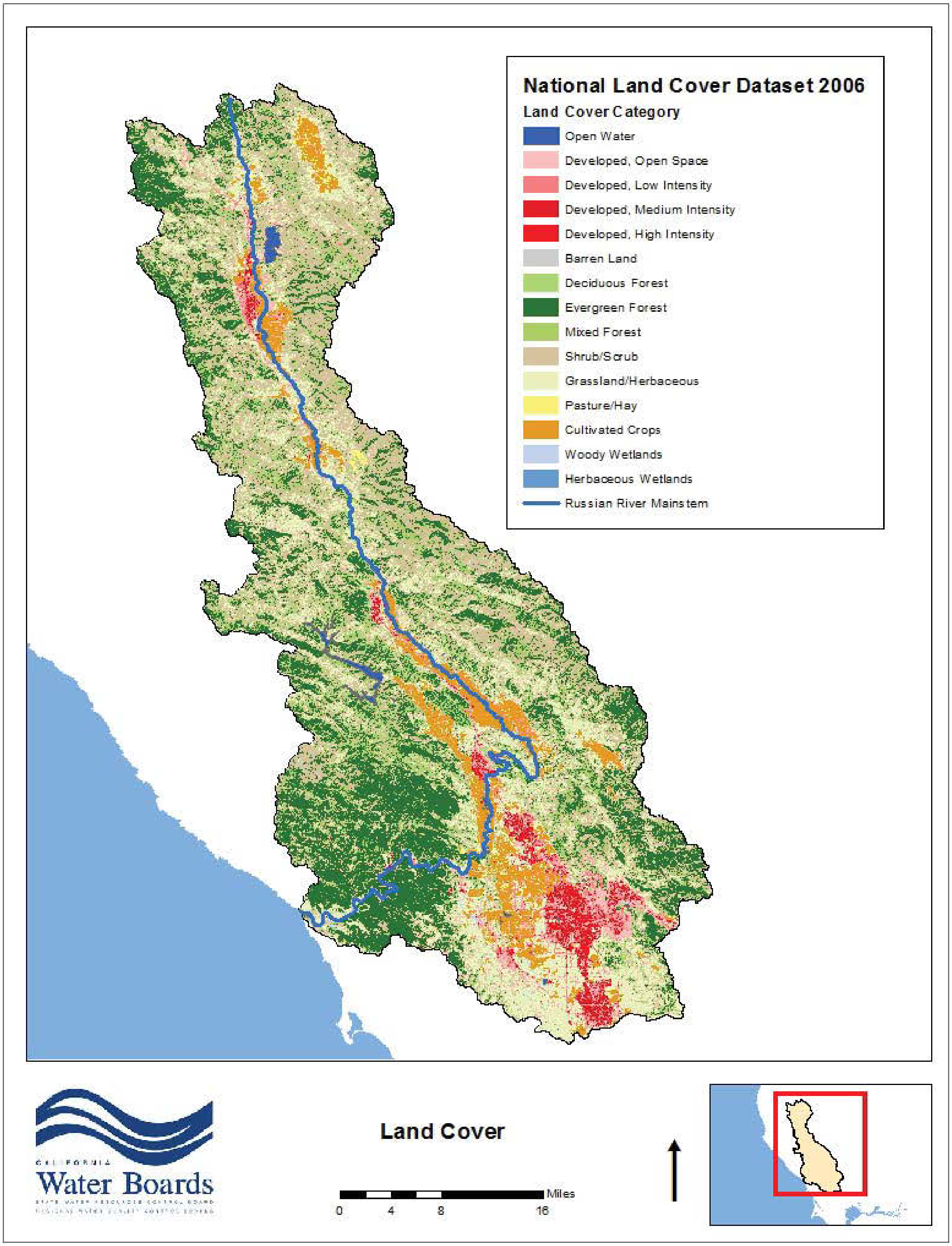

Figure 1.4: Land Cover in the Russian River Watershed
Source: North Coast Regional Water Quality Control Board

1.3.2.1 RECREATIONAL USES

The Russian River and tributary creeks are enjoyed by many swimmers, waders, canoers, kayakers, fishermen, and enthusiasts that partake in water contact and non-contact water recreation. The Russian River is one of the most intensively used rivers for recreation in the North Coast Region. On holiday weekends in the summer, beach visitors along the river number in the thousands. Several of the most popular beaches are listed in Table 1.5 and shown in Figure 1.5. The greatest number of popular swimming beaches are located in the Guerneville HSA, in the lower part of the Russian River Watershed.

Table 1.5
Popular Swimming Beaches along the Russian River

Hydrologic Area Name	Hydrologic Subarea Name	Recreational Beach Name	Location
Upper Russian River	Coyote Valley	Mill Creek Park	Potter Valley
	Forsythe Creek	Mariposa Swimming Hole	Redwood Valley
	Ukiah	Vichy Springs Park	Ukiah
		Mill Creek Park	Ukiah
Middle Russian River	**Geyserville**	**Cloverdale River Park**	**Cloverdale**
		Alexander Valley Campground	Healdsburg
Lower Russian River	Guerneville	Veteran Memorial Beach	Healdsburg
		Riverfront Park	Windsor
		Mirabel Park Campground	Forestville
		Steelhead Beach	Forestville
		River Access Beach	Forestville
		Sunset Beach	Forestville
		Johnson's Beach	Guerneville
		Monte Rio Beach	Monte Rio
		Casini Ranch Campground	Duncans Mills

Figure 1.5: Popular Swimming Beaches on the Russian River
Source: North Coast Regional Water Quality Control Board

1.3.3 CLIMATE

The Russian River Watershed has a Mediterranean climate with hot, dry summers and wet winters. Average precipitation varies across the watershed with generally wetter conditions in the north and west. Summer temperatures can reach over 100° F in inland valleys for weeks at a time, with coastal conditions cool and moist. Drought and severe storms occur periodically but mostly unpredictably; El Niño/ La Niña Southern Oscillation climatic conditions can exacerbate climatic extremes.

Precipitation in the Russian River Watershed is distinctly seasonal; about 80 percent of the total occurs during five months, November through March. The bulk of the precipitation occurs during moderately intense general storms of several days' duration. Snow falls in modest amounts at altitudes above 2,000 feet, but it seldom remains on the ground for more than a few days. Mean annual precipitation varies from about 30 inches in the flat valley lands north of Santa Rosa to more than 80 inches in parts of the mountains. Summers are dry, with total rainfall from June through August averaging less than 0.5 inch (Zhang and Johnson 2010).

The spatial distribution of mean annual rainfall in the Russian River Watershed is shown in Figure 1.6. These precipitation zones were derived statewide by the California Department of Forestry and Fire Protection for the period 1900-1960. Table 1.6 presents the area weighted precipitation for each Hydrologic Subarea in the Russian River.

Table 1.6
Average Annual Precipitation

Hydrologic Area Name	**Hydrologic Subarea Name**	**Mean Precipitation (inches/year)**
Upper Russian River	Coyote Valley	41.1
	Forsythe Creek	46.0
	Ukiah	43.1
Middle Russian River	Sulphur Creek	51.4
	Warm Springs	48.6
	Geyserville	41.6
	Laguna	31.3
	Santa Rosa	38.5
	Mark West	39.0
Lower Russian River	Guerneville	45.1
	Austin Creek	65.5
Russian River Watershed Mean		44.2

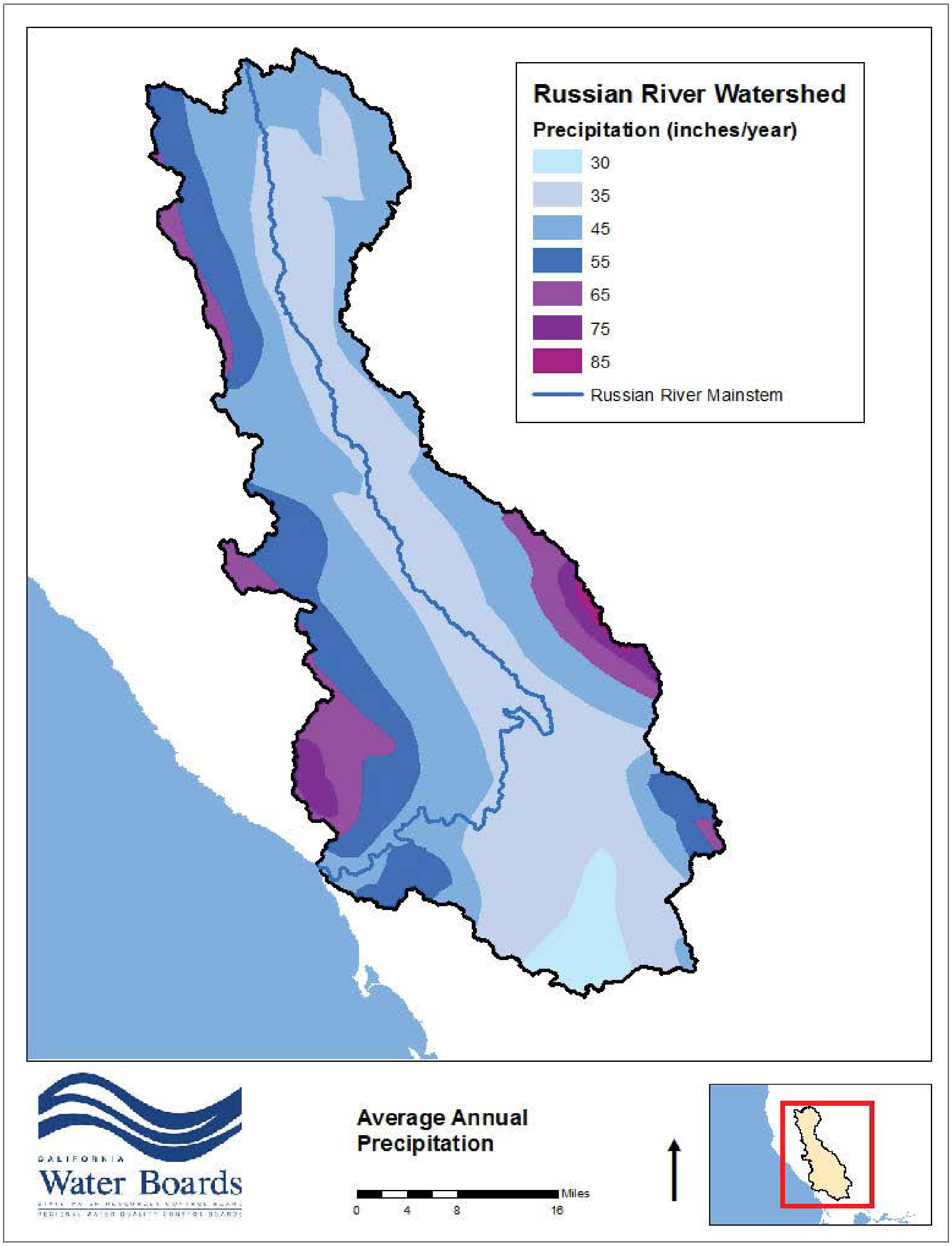

Figure 1.6: Average Annual Precipitation Patterns in the Russian River Watershed
Source: North Coast Regional Water Quality Control Board

1.3.4 GEOLOGY AND SOILS

The Russian River Watershed is underlain predominantly by the Franciscan Assemblage, which is a highly erodible mélange that formed during the Jurassic-Cretaceous age. The Franciscan Assemblage forms the bulk of the coast range; the sediment consists of muddy sandstones and cherts jumbled together and layered with basalt lava flow. This lithology is very unstable with landslides common throughout the mountainous regions of the basin. Many of the streams within the basin, including the upper mainstem Russian River, follow the northwest to southeast orientation of geologic faults. The Rodgers Creek Fault enters Sonoma County at San Pablo Bay and extends northward through the City of Santa Rosa, where it meets up with the Healdsburg Fault, which continues northward passing east of the Town of Windsor. The Mayacama Fault lies to the east of the Healdsburg Fault and continues northward, passing east of the City of Cloverdale.

The Russian River flows through a series of broad alluvial valleys and narrow bedrock constrictions. Historic photographs show that the historic river channel once meandered across a broad natural floodplain and that the elevation of the active channel was once close to the elevation of the floodplain. Traces of the channel remained on the irregular floodplain as a series of "sloughs" or side channels. Subsequent land use changes in the Russian River Basin have leveled the floodplain, filled the side channels, and constrained the river channel into a narrow and straighter course (Florsheim and Goodwin 1995).

The Russian River Watershed contains a large number of different soils types (NRCS 2013). Hydrologic soil characteristics influence the delivery of bacteria to surface waters. Soils with a greater potential to runoff also have a greater potential to deliver bacteria with the soil particles. Impervious lands, such as urban paved areas, deliver storm water and associated bacteria directly to the river and its tributaries. Identification of hydrologic soil groups is based on comparison of the characteristics of soil profiles, which include hydraulic conductivity, texture, bulk density, structure, strength, clay mineralogy, and organic matter content. Four hydrologic soil groups are categorized (NRCS 2007: Table 1.7 and Figure 1.7):

Table 1.7
Hydrologic Soil Characteristics of the Russian River Watershed

Hydrologic Soil Group	Runoff Potential	Acres	Relative Watershed Area (%)
A	Low when thoroughly wet. Water is transmitted freely through the soil.	1,756	0.2%
B	Moderately low when thoroughly wet. Water transmission through the soil is unimpeded.	477,416	50%
C	Moderately high when thoroughly wet. Water transmission through the soil is somewhat restricted.	218,774	23%
D	High when thoroughly wet. Water movement through the soil is restricted or very restricted.	251,664	27%
	Total	949,611	100%

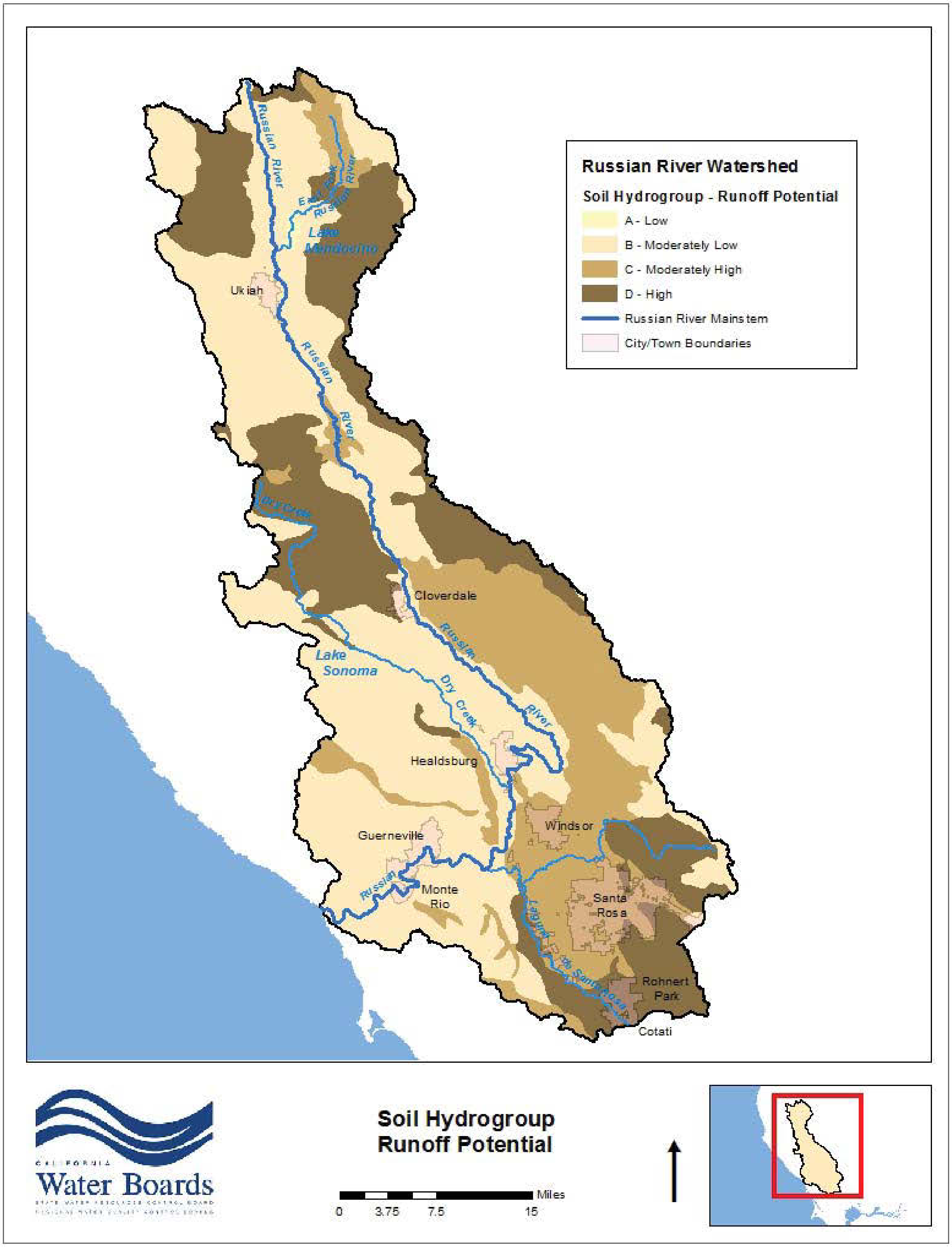

Figure 1.7: Hydrologic Soil Characteristics of the Russian River Watershed
Source: North Coast Regional Water Quality Control Board

In summary, the Russian River Watershed is a very important watershed in the North Coast Region. It contains one of the largest population centers in the region, dependent on the water supplies provided by the Russian River. Similarly, the river provides broad recreational value, attracting a large tourist population. The Russian River Watershed supports multiple thriving landuses, which produce a variety of anthropogenic influences, stemming both from urban and rural living. The Mediterranean climate ensures that most of the precipitation in the Russian River Watershed falls during the winter season. This, coupled with the steep slopes of the watershed, ensure significant storm water runoff during the wet season. Similarly, the broad valleys ensure significant agricultural production within the river corridor. The Russian River TMDL as described in the following chapters defines the extent and seasonality of the pathogen problem and the sources of pathogenic waste discharges. It establishes appropriate numeric targets by which to monitor attainment of water quality objectives and defines the waste load and load allocations necessary to meet those targets. Finally, the Russian River TMDL describes the implementation measures necessary to control the discharge of pathogenic waste in the Russian River Watershed and the monitoring appropriate to measure program success.

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.[6] 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,

[6] 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).[7] 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

[7] 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.

CHAPTER 3
EVIDENCE OF IMPAIRMENT

This chapter describes the evidence of beneficial use impairment in the Russian River and its tributaries by pathogen indicator bacteria, summarizes the basis for the current Section 303(d) impairment listings, and describes more recent data.

In summary, all surface streams and river reaches in the Russian River Watershed are impaired by pathogen indicator bacteria, which are found in concentrations that exceed the bacteria water quality objective and U.S. EPA's national bacteria criteria for protection of recreation. Water contact recreation is a beneficial use of the Russian River Watershed throughout the year. Though, it is recognized that the greatest public use of the Russian River occurs during the summer months. The beneficial use impairment is based on data collected in both the wet and dry season, with the following findings:

1. Concentrations of fecal coliform bacteria measured in several streams in the watershed that indicate a potential risk of illness during water contact recreation.
2. Concentrations of *E. coli* bacteria measured in several streams in the watershed that indicate a potential risk of illness during water contact recreation.
3. Concentrations of enterococci bacteria measured in several streams in the watershed that indicate a potential risk of illness during water contact recreation.
4. Human-specific and bovine-specific *Bacteroides* bacteria are found in almost all sampling locations in the watershed.
5. Bacteria species that are potential human pathogens are found at numerous locations in the watershed.
6. The 2012 Section 303(d) List of Impaired Waters identifies several reaches of the mainstem Russian River and several tributaries as impaired. The listings are based on data collected prior to August 2010.
7. Public health advisories warning of potential risk of illness from recreational water contact have been posted at mainstem Russian River beaches and along Santa Rosa Creek.

3.1 ASSESSMENT OF FECAL COLIFORM BACTERIA DATA

Measured fecal coliform bacteria concentrations were used to assess whether the waterbody is supporting recreational (i.e., REC-1) beneficial use. North Coast Regional Water Board staff has collected water samples to measure fecal coliform bacteria concentrations at several beaches and streams in the Russian River Watershed since 1980. Measured fecal coliform bacteria concentrations were compiled from four (4) recreation beaches on the Russian River (i.e., Camp Rose Beach, Healdsburg Veteran's Memorial

Beach, Johnsons Beach, and Monte Rio Beach) and one tributary stream along a public park (i.e., Santa Rosa Creek at Railroad Street along the Prince Memorial Greenway).

Measured fecal coliform bacteria concentrations were compiled and compared to the numeric Basin Plan water quality objectives (WQOs) (Butkus 2013c). Only 15 percent of the 30-day periods within the data record have adequate fecal coliform concentrations measurements for application of the two-part Basin Plan water quality objective (i.e., median and 90th percentile from a 30-day period), since the objective requires 5 samples collected within a 30-day period. Water samples were simply not collected frequently enough to provide a complete assessment of impairment to REC-1 using the Basin Plan WQO. For example, adequate water samples were not collected in Santa Rosa Creek to assess exceedance of the Basin Plan WQO. Based on those available data, all four beaches assessed showed at least one 30-day period that exceeded the water quality objective, with 37% of the measurements overall exceeding the water quality objective (Butkus 2013c).

Fecal coliform bacteria storm water samples are also collected as a requirement of the Municipal Separate Storm Sewer Systems (MS4) permit for the City of Santa Rosa, County of Sonoma, and Sonoma County Water Agency. Single storm water samples were collected from Santa Rosa Creek upstream and downstream of the urban area. These single samples cannot be directly assessed with the Basin Plan Water Quality Objective for fecal coliform bacteria, which requires 5 samples collected in a 30-day period. However, the fecal coliform concentrations measured in Santa Rosa Creek during storm events range from 170 – 5,000,000 MPN/100mL. These very high concentrations supplement other evidence that Santa Rosa Creek is impaired due to high bacterial loads, especially during wet weather.

3.2 ASSESSMENT OF E. COLI BACTERIA DATA

E. coli bacteria data from the Russian River Watershed were compiled from three agencies: the Regional Water Board, the Sonoma County Water Agency, and the University of California (UC) Davis Aquatic Ecosystems Analysis Laboratory. Sample locations are representative of the range of streams and rivers in the watershed. Water samples were collected at 29 locations from 2001 to 2013 for analysis of *E. coli* bacteria concentrations (NCRWQCB 2012, 2013a, 2013b).

Water samples were analyzed by IDEXX Colilert and were either undiluted or serially diluted 1:10, resulting in a minimum reporting limit of 1 or 10 MPN/100mL and a maximum reporting limit of 2,419 or 24,196 MPN/100mL. Sample measurements below and above analytical reporting limits are called censored data. When bacteria concentration results were beyond any of these limits, the reporting limit was substituted for censored data. Data were assessed using discrete 30-day periods were defined based on the Julian calendar date of each year (i.e., 30-day period 1 for Julian days 1-30; 30-day period 2 for Julian days 31-60, etc.).

Impairment was determined using *E. coli* bacteria concentrations measured at each specific sampling location using U.S. EPA's *E. coli* Recreational Water Quality Criteria of the geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL) for 32 illnesses per 1000 recreators The results of the assessment for *E. coli* bacteria concentrations are presented in Figure 3.1 and Table 3.1 for discrete 30-day averaging periods.

The results of the studies as referenced above verify there is evidence of impairment of REC-1 from *E. coli* in the Russian River Watershed at Foss Creek, Green Valley Creek, the Laguna de Santa Rosa, Matanzas Creek, and Santa Rosa Creek.

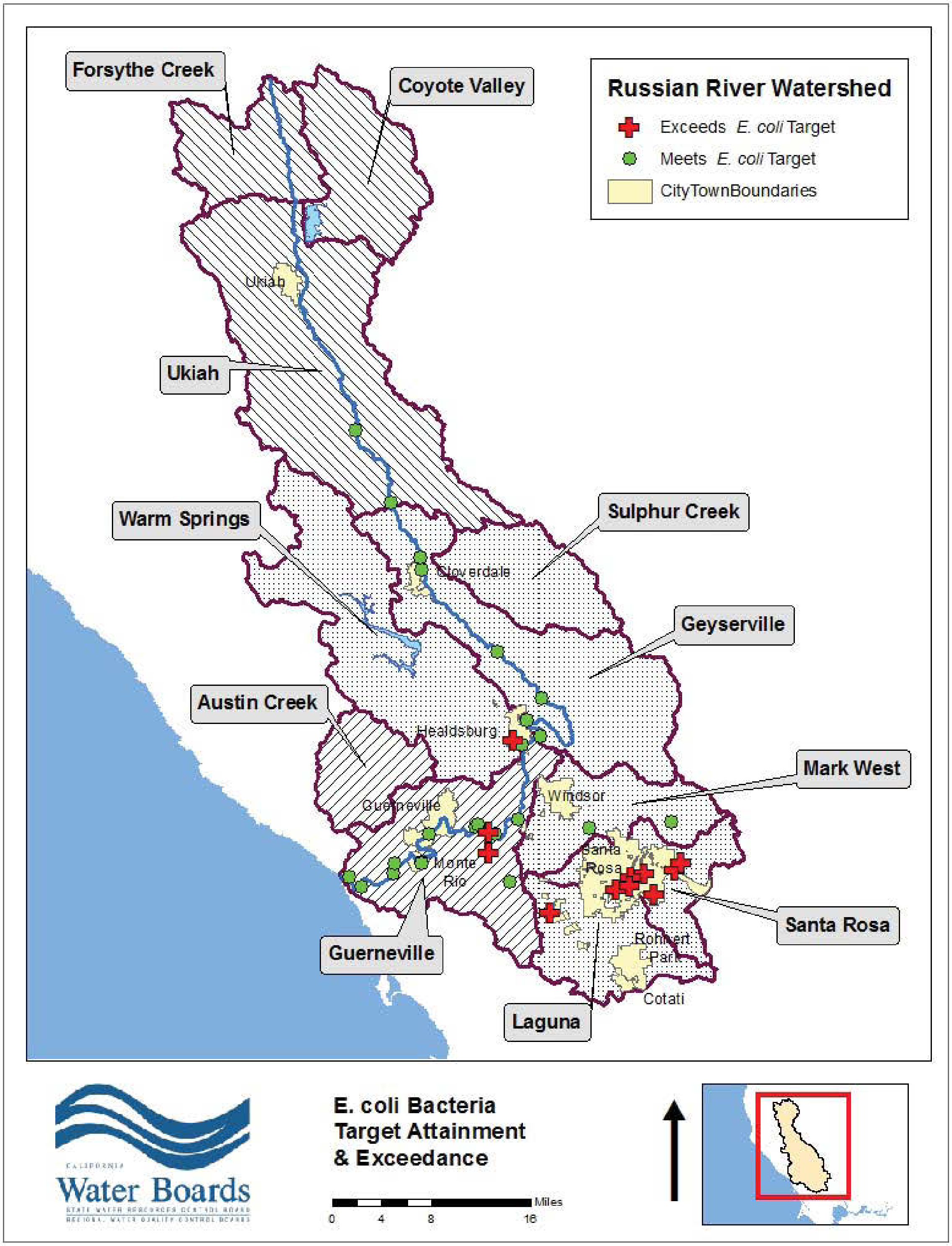

Figure 3.1: *E. coli* Bacteria Target Attainment & Exceedance

Table 3.1
***E. coli* Bacteria Target Attainment & Exceedance**

Hydrologic Area Name	Hydrologic Subarea Name	Location	Number of 30-day Periods Sampled	Number of Periods that Exceed Geomean or STV Targets[1]
Upper Russian River	Coyote Valley	East Fork Russian R.	1	0
	Forsythe Creek	Russian R. at East School Way	1	0
	Ukiah	Russian R. at Lake Mendocino Drive	1	0
		Russian R. at Vichy Springs Road	1	0
		Russian R. at Talmadge Road	1	0
		Russian R. at River Road (Hopland)	6	0
Middle Russian River	Geyserville	**Russian R. at Commisky Station Rd**	**18**	**1**
		Russian R. at Cloverdale River Park	9	0
		Russian R. at Crocker Rd	4	0
		Russian R. at Hwy 128 Bridge	**12**	**1**
		Russian R. at Jimtown Bridge	23	0
		Russian R. at Diggers Bend	12	0
		Russian R. at Camp Rose Beach	49	0
		Foss Creek at Matheson Street	**7**	**7**
	Laguna	**Laguna de Santa Rosa at Sebastopol Community Park**	**11**	**6**
	Santa Rosa	**Matanzas Creek at Doyle Park and Bethards Drive**	**8**	**7**
		Santa Rosa Creek at Wildwood Drive, Highway 12, upstream of Rincon Creek, at Alderbrook Drive, and at Railroad Street	**61**	**59**
	Mark West	**Mark West Ck at Old Redwood Hwy & Trenton Healdsburg Rd**	**11**	**3**
Lower Russian River	Guerneville	**Russian R. at Veterans Memorial Beach**	**55**	**2**
		Russian R. at Riverfront Park	18	0
		Russian R. at Steelhead Beach	**52**	**1**
		Russian R. at River Access Beach	**28**	**1**
		Russian R. at Hacienda Bridge	6	0
		Russian R. at Johnson's Beach	49	0
		Russian R. at Monte Rio Beach	**61**	**5**
		Russian R. at Casini Ranch Campground	12	0
		Russian R. at Bridgehaven Station	**12**	**2**
		Russian R. at Duncans Mills	**12**	**1**
		Russian R. at Jenner Boat Ramp	**17**	**2**
		Atascadero Creek at Green Valley Road	**6**	**4**
		Dutch Bill Creek	6	0
		Green Valley Creek at Martinelli Road and River Road	**5**	**4**

[1] Number of periods that exceed either the geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL)

* Locations that exceed the U.S. EPA criteria are shown in **BOLD** font

3.3 ASSESSMENT OF ENTEROCOCCI BACTERIA DATA

Enterococci bacteria data from the Russian River Watershed were compiled from three agencies: the Regional Water Board, the Sonoma County Water Agency, and the University of California (UC) Davis Aquatic Ecosystems Analysis Laboratory. Sample locations are representative of the range of streams and rivers in the watershed. Water samples were collected at 29 locations from 2001 to 2013 for analysis of Enterococci bacteria concentrations (NCRWQCB 2012, 2013a, 2013b).

Water samples were analyzed by IDEXX Enterolert and were either undiluted or serially diluted 1:10, resulting in a minimum reporting limit of 1 or 10 MPN/100mL and a maximum reporting limit of 2,419 or 24,196 MPN/100mL. Sample measurements below and above analytical reporting limits are called censored data. When bacteria concentration results were beyond any of these limits, the reporting limit was substituted for censored data. Data were assessed using a static/discrete 30-day averaging approach (Butkus 2013b). Discrete 30-day periods were defined based on the Julian calendar date of each year (i.e., 30-day period 1 for Julian days 1-30; 30-day period 2 for Julian days 31-60, etc.).

Impairment was determined using enterococci bacteria concentrations measured at each specific sampling location using the enterococci criteria of the geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL) for 32 illnesses per 1000 recreators. The results of the assessment for enterococci bacteria concentrations are presented in Figure 3.2 and Table 3.2 for discrete 30-day averaging periods.

The results verify there is evidence of impairment of REC-1 from enterococci bacteria in the Russian River Watershed at Foss Creek, Green Valley Creek, the Laguna de Santa Rosa, and Santa Rosa Creek, and at the flowing location in the mainstem: Commisky Station Road, Cloverdale River Park, Jimtown bridge, Camp Rose Beach, Steelhead Beach, Monte Rio Beach, and Jenner Boat Ramp.

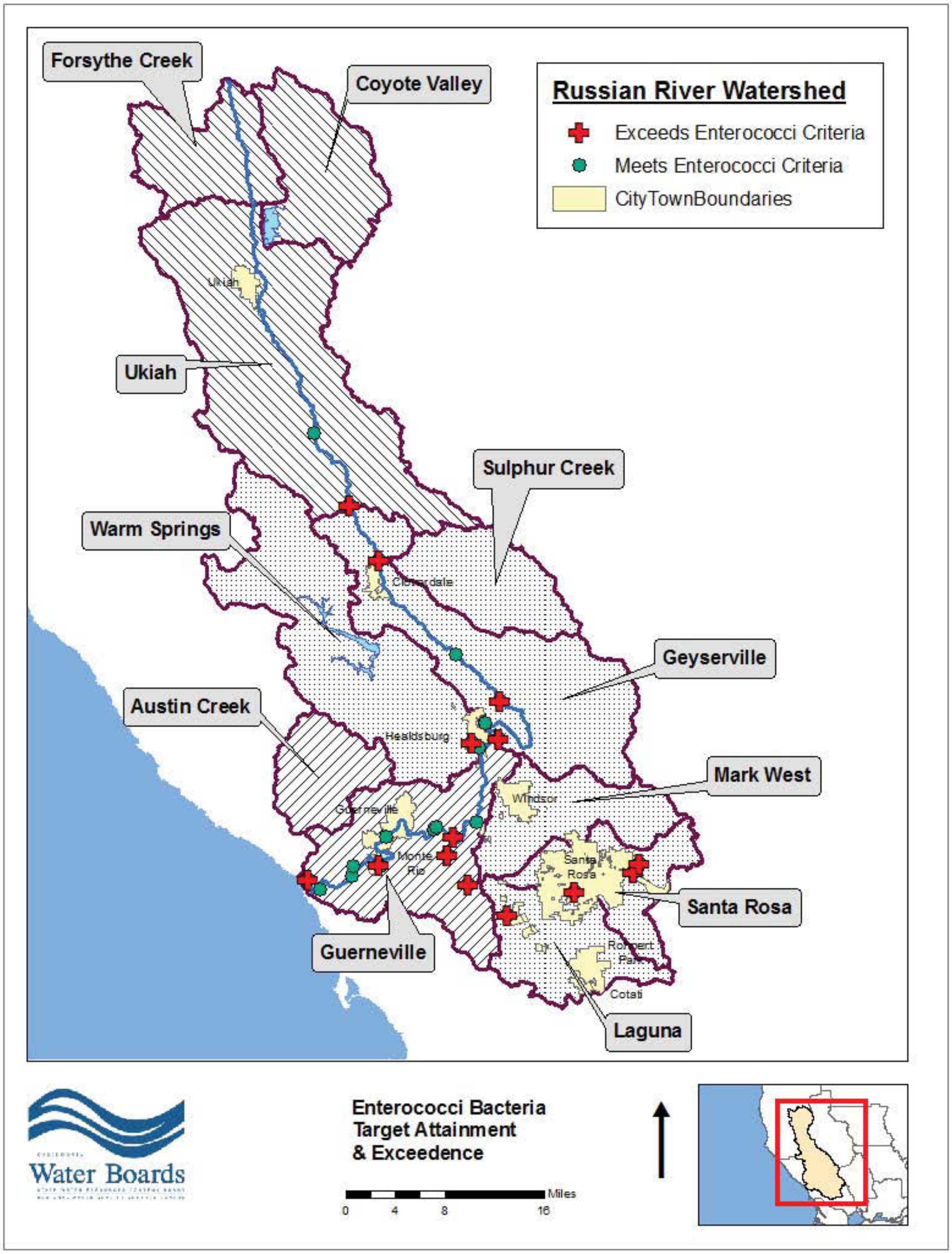

Figure 3.2: Enterococci Bacteria Criteria Attainment & Exceedance

Table 3.2
Enterococci Bacteria Target Attainment & Exceedance

Hydrologic Area Name	Hydrologic Subarea Name	Location	Number of 30-day Periods Sampled	Number of Periods that Exceed Geomean or STV Targets[1]
Upper Russian River	Coyote Creek	**East Fork Russian R.**	**1**	**1**
	Forsythe Creek	**Russian R. at East School Way**	**1**	**1**
	Ukiah	**Russian R. at Lake Mendocino Drive**	**1**	**1**
		Russian R. at Vichy Springs Road	1	0
		Russian R. at Talmadge Road	1	0
		Russian R. at River Road (Hopland)	**6**	**1**
Middle Russian River	Warm Springs	**Foss Creek at Matheson Street**	**5**	**5**
	Geyserville	**Russian R. at Commisky Station Rd**	**18**	**7**
		Russian R. at Cloverdale River Park	**27**	**9**
		Russian R. at Crocker Rd	**4**	**3**
		Russian R. at Hwy 128 Bridge	**12**	**2**
		Russian R. at Jimtown Bridge	**23**	**8**
		Russian R. at Diggers Bend	**11**	**3**
		Russian R. at Camp Rose Beach	**35**	**6**
	Laguna	**Laguna de Santa Rosa at Sebastopol Community Park**	**11**	**9**
	Santa Rosa	**Santa Rosa Creek at Wildwood Drive, Highway 12, and at Railroad Street**	**41**	**37**
	Mark West	**Mark West Creek at Trenton Healdsburg Rd**	**3**	**3**
Lower Russian River	Guerneville	**Russian R. at Veterans Memorial Beach**	**41**	**5**
		Russian R. at Steelhead Beach	**41**	**8**
		Russian R. at River Access Beach	28	0
		Russian R. at Hacienda Bridge	6	0
		Russian R. at Johnson's Beach	**25**	**1**
		Russian R. at Monte Rio Beach	**46**	**9**
		Russian R. at Casini Ranch Campground	**11**	**2**
		Russian R. at Bridgehaven Station	**11**	**2**
		Russian R. at Duncans Mills	**11**	**4**
		Russian R. at Jenner Boat Ramp	**17**	**6**
		Atascadero Creek at Green Valley Road	**5**	**3**
		Dutch Bill Creek	**6**	**2**
		East Fork Russian River	**1**	**1**
		Green Valley Creek at Martinelli Road and River Road	**11**	**10**

[1] Number of periods that exceed either the numeric target geometric mean (100 cfu/100mL) or the statistical threshold value (320 cfu/100mL)
* Locations that exceed the U.S. EPA criteria are shown in **BOLD** font

3.4. ASSESSMENT OF BACTEROIDES BACTERIA DATA

Regional Water Board staff collected water samples for measurement of human-specific and bovine-specific *Bacteroides* bacteria at numerous locations in the Russian River Watershed from 2011 to 2013 (NCRWQCB 2012; NCRWQCB 2013a; NCRWQCB 2013b). Sample locations are representative of the range of streams and rivers in the watershed. Samples were collected from waterbodies during both wet and dry periods and from a range of flows. Sample sites were located in waterbodies that drain the wide range of land uses (from urban to undeveloped) and geomorphic features (from bedrock to alluvial landscapes) in the watershed.

Bacteroides bacteria are a suitable indicator of a waterbody's bacteriological quality since the bacteria come from the gastrointestinal systems of mammals, they degrade rapidly outside of the body, and technology is available to trace the bacteria back to specific types of animals, including humans and domestic animals. For the purpose of this assessment, waters are determined not to be in a minimally disturbed condition if *Bacteroides* bacteria 16S rRNA gene copies are significant enough to be present in a water sample at levels above the laboratory reporting limit. The laboratory reporting limit is the level at which the laboratory is 95% confident that the *Bacteroides* bacteria 16S rRNA gene copies are present in the sample and are accurately counted. If the bacteria 16S rRNA gene copies are present and can be quantified with certainty, it is highly likely that fecal waste material is present and the bacteriological quality of the water has been degraded beyond a minimally disturbed condition.

Human-specific and bovine-specific *Bacteroides* bacteria data were compared to the current laboratory reporting limit of 60 gene copies/100mL for human-specific *Bacteroides* and 30 gene copies/100mL for bovine-specific *Bacteroides*. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker and the Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B. The median concentrations measured at each location in the Russian River Watershed are shown in Tables 3.3 through 3.6 and Figures 3.3 through 3.4.

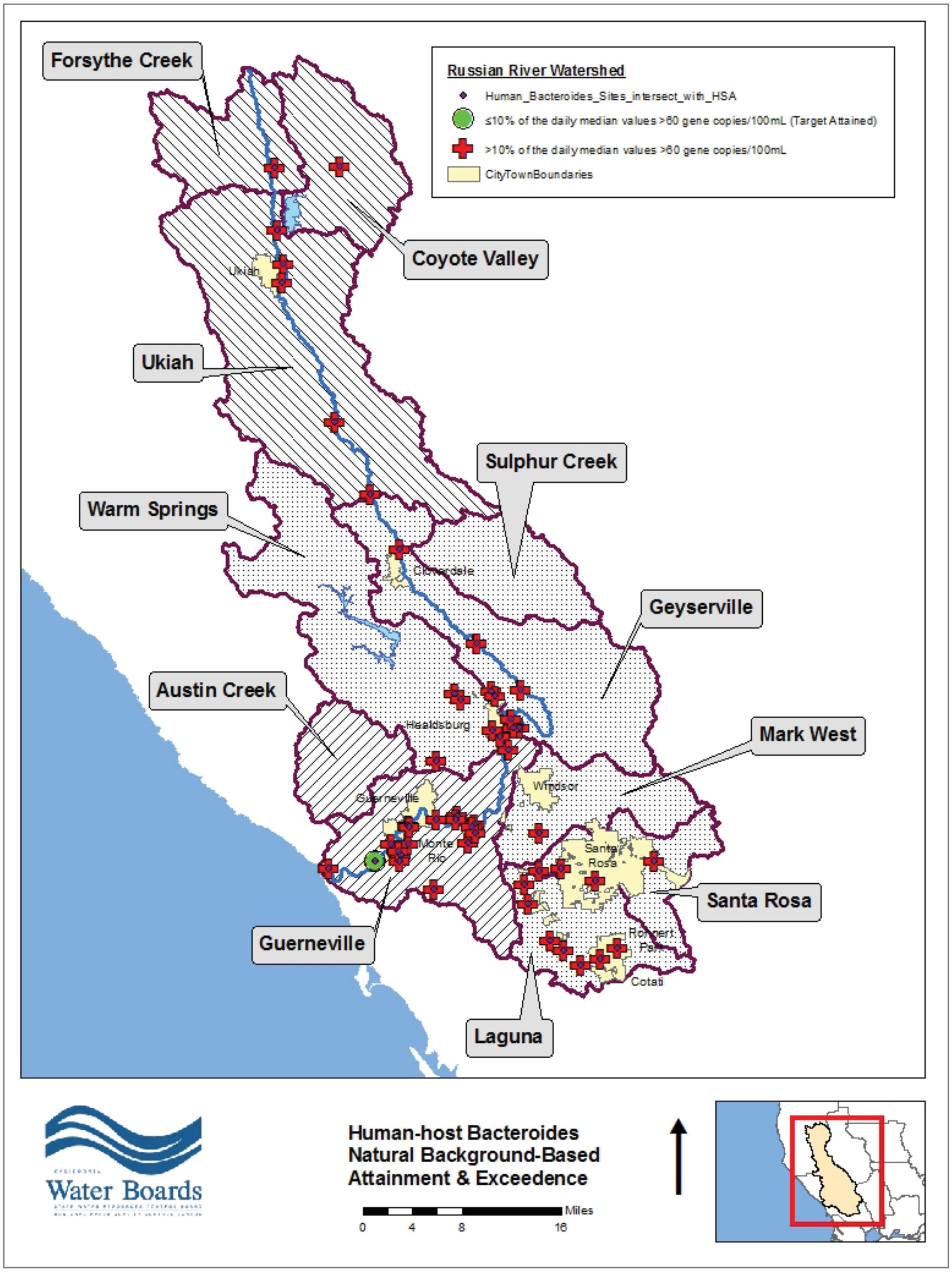

Figure 3.3: Human-specific *Bacteroides* Natural Background-based Target Attainment & Exceedance. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

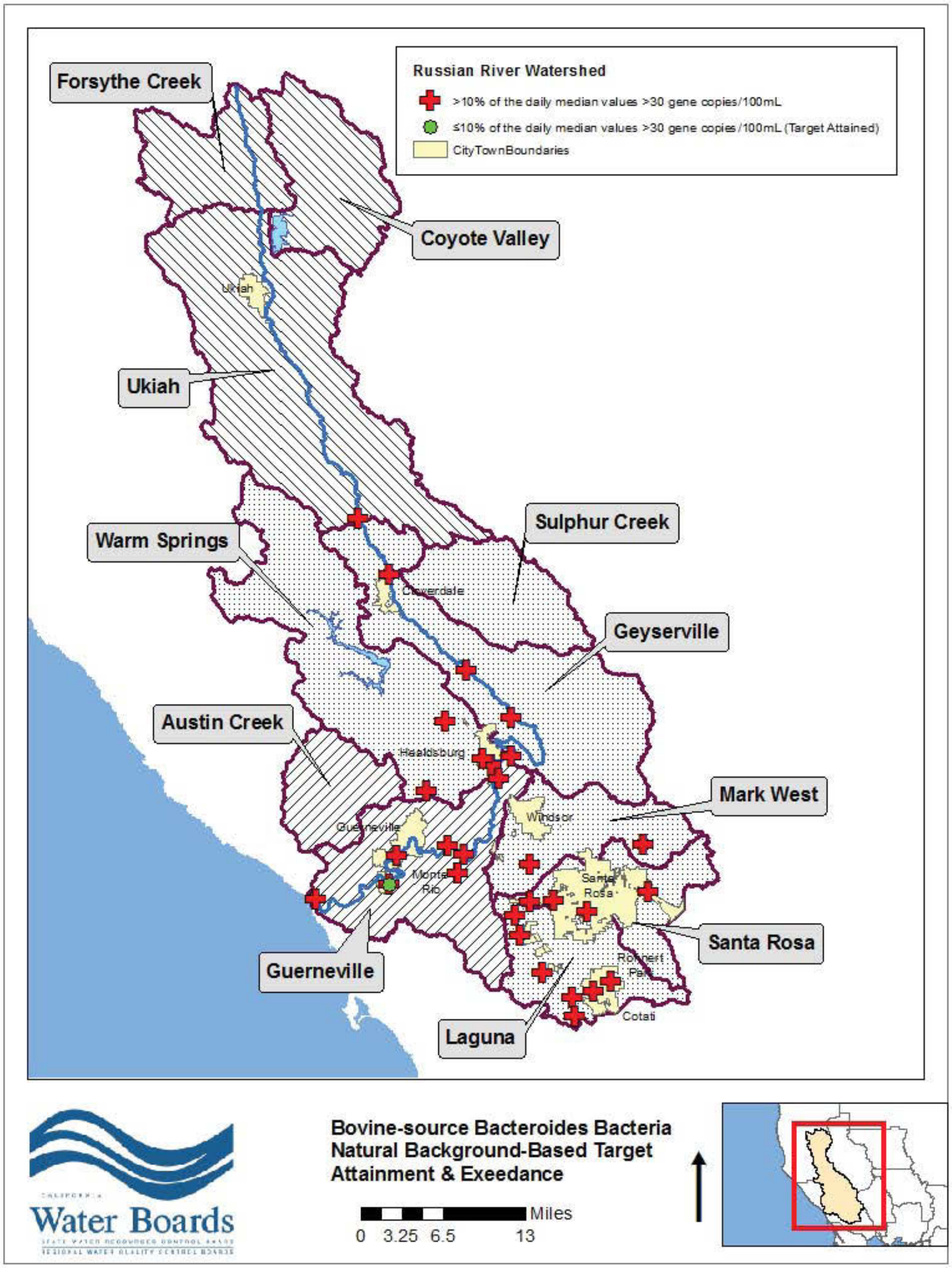

Figure 3.4: Bovine-specific Bacteroides Bacteria Natural Background-based Target Attainment & Exceedance. Bovine-specific Bacteroides were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

Table 3.3
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River
Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Russian River Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Upper Russian River	Forsythe Creek	East School Way, Redwood Valley	979	3	3
	Coyote Valley	East Fork at East Road, Potter Valley	5,949	3	3
	Ukiah	Lake Mendocino Drive, Ukiah	3,275	3	3
		Vichy Springs Road, Ukiah	11,803	3	3
		Talmadge Road, Ukiah	9,293	3	3
		River Road, Hopland	1,898	3	3
Middle Russian River	Geyserville	Commisky Station Road, Cloverdale	2,731	2	2
		River Park, Cloverdale	1,087	2	2
		Hwy 128 Bridge, Geyserville	13,501	2	2
		Jimtown Bridge, Healdsburg	37,052	2	2
		Camp Rose Beach, Healdsburg	31,055	2	2
Lower Russian River	Guerneville	Veteran Memorial Beach, Healdsburg	14,921	10	10
		Steelhead Beach, Forestville	48,485	2	2
		River Access Beach, Forestville	57,554	2	2
		Johnson's Beach, Guerneville	1,677	10	10
		Monte Rio Beach, Monte Rio	8,898	18	18
		Public Boat Ramp, Jenner	4,837	2	2

Table 3.4
Bovine-specific *Bacteroides* Attainment & Exceedance in the Russian River
Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Russian River Location	Median Bovine-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 30 gene copies/100mL
Middle Russian River	Geyserville	Commisky Station Road, Cloverdale	5,413	2	2
		River Park, Cloverdale	710	2	2
		Hwy 128 Bridge, Geyserville	236	2	2
		Jimtown Bridge, Healdsburg	116	2	2
Lower Russian River	Guerneville	Camp Rose Beach, Healdsburg	286	2	2
		Veteran Memorial Beach, Healdsburg	381	2	2
		Steelhead Beach, Forestville	23,684	2	2
		River Access Beach, Forestville	14,710	2	2
		Johnson's Beach, Guerneville	85	7	7
		Monte Rio Beach, Monte Rio	762	10	10
		Public Boat Ramp, Jenner	2,682	2	2

Table 3.5
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River Tributaries
Human-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Name	Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Middle Russian River	Geyserville	Foss Creek	Matheson Street, Healdsburg	37,346	2	2
		Unnamed Creek	Lambert Bridge Road, Healdsburg	5,257	2	2
		Unnamed Creek	Fitch Mountain Road, Healdsburg	238	6	5
		Unnamed Creek	Fredson Road, Healdsburg	8,580	5	5
		Unnamed Creek	West Dry Creek Road, Healdsburg	4,040	5	5
		Unnamed Creek	Alexander Valley Road, Healdsburg	2,031	5	4
		Unnamed Creek	Redwood Drive, Healdsburg	2,310	5	5
		Unnamed Creek	Limerick Road, Healdsburg	20,000	4	4
	Warm Springs	Palmer Creek	Palmer Creek Road, Healdsburg	2,781	2	1
	Laguna	Blucher Creek	Lone Pine Road, Cotati	18,022	2	2
		Copeland Creek	Commerce Blvd, Rohnert Park	19,928	2	2
		Crane Creek	Snyder Ln., Rohnert Park	26,703	2	2
		Gossage Creek	Stony Glen Lane, Cotati	29,902	2	2

Table 3.5
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River Tributaries
Human-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Name	Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Middle Russian River	Laguna	Laguna de Santa Rosa	Community Center, Sebastopol	7,469	2	2
		Unnamed Creek Unnamed Creek	Sanford Road, Sebastopol	1,576	4	4
		Unnamed Creek	Daywalt Road, Cotati	37,632	2	2
	Santa Rosa	Abramson Creek	Willowside Rd Path, Santa Rosa	273,401	4	4
		Piner Creek	Fulton Road, Santa Rosa	12,394	2	2
		Santa Rosa Creek	Hwy 12, Santa Rosa	2,727	2	2
		Santa Rosa Creek	Railroad Street, Santa Rosa	32,909	2	2
		Unnamed Creek	River Road, Fulton	2,759	4	4
	Mark West	Van Buren Creek	Erland Road, Santa Rosa	2,089	2	1
Lower Russian River	Guerneville	Dutch Bill Creek	Main Street, Monte Rio	416	2	1
		Green Valley Creek	Martinelli Road, Forestville	17,016	2	2
		Mays Creek	Neeley Road, Guerneville	1,325	2	2
		Unnamed Creek	Summerhome Park Rd, Forestville	7,975	4	4
		Unnamed Creek	Trenton Road, Forestville	48,200	5	5
		Unnamed Creek	Del Rio Court, Forestville	3,460	3	3
		Unnamed Creek	River Road, Rio Nido	3,600	3	2

Table 3.5
Human-specific *Bacteroides* Attainment & Exceedance in the Russian River Tributaries
Human-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Name	Location	Median Human-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 60 gene copies/100mL
Lower Russian River	Guerneville	Unnamed Creek	Foothill Drive, Monte Rio	371,000	1	1
		Unnamed Creek	Duncan Road, Monte Rio	353	3	2
		Unnamed Creek	Old Monte Rio Road, Monte Rio	25,100	4	4
		Unnamed Creek	Main Street, Monte Rio	1,392	5	4
		Unnamed Creek	Moscow Road, Duncans Mills	<60	1	0
		Unnamed Creek	Lakeside Ave, Camp Meeker	9,090	4	4

Table 3.6
Bovine-specific *Bacteroides* Bacteria Attainment & Exceedance in Russian River Tributaries. Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B

Hydrologic Area Name	Hydrologic Subarea Name	Tributary	Location	Median Bovine-specific Bacteroides (gene copies /100mL)	Number of Measurements	Number of Measurements > 30 gene copies/100mL
Middle Russian River	Geyserville	Foss Creek	Matheson St., Healdsburg	8,668	2	1
		Unnamed Creek	Lambert Bridge Road, Healdsburg	453	2	1
		Unnamed Creek	Limerick Rd., Healdsburg	1,966	4	4
	Warm Springs	Palmer Creek	Palmer Creek Road, Healdsburg	106	2	1
	Laguna	Blucher Creek	Lone Pine Road, Cotati	177,248	2	2
		Copeland Creek	Commerce Blvd, Rohnert Park	51,685	2	2
		Crane Creek	Snyder Ln., Rohnert Park	23,602	2	2
		Gossage Creek	Stony Glen Lane, Cotati	76,895	2	2
		Laguna de Santa Rosa	Community Center, Sebastopol	514	2	1
		Unnamed Creek	Sanford Road, Sebastopol	482	4	4
		Unnamed Creek	Daywalt Road, Cotati	867,503	2	1
	Santa Rosa	Abramson Creek	Willowside Road Path, Santa Rosa	425,164	4	4
		Piner Creek	Fulton Road, Santa Rosa	3,274	2	2
		Santa Rosa Creek	Hwy 12, Santa Rosa	181	2	2
		Santa Rosa Creek	Railroad St., Santa Rosa	7,765	2	2
		Unnamed Creek	River Road, Fulton	768	4	4
	Mark West	Van Buren Creek	Erland Road, Santa Rosa	2,265	2	1
Lower Russian River	Guerneville	Dutch Bill Creek	Main Street, Monte Rio	15	2	0
		Green Valley Creek	Martinelli Rd., Forestville	72	2	2
		Mays Creek	Neeley Road, Guerneville	608	2	2

Assessment of the human-specific *Bacteroides* bacteria data shows that bacteria from human waste are widespread throughout the Russian River Watershed. Human-specific *Bacteroides* bacteria are present at levels that exceed the current laboratory reporting limit (60 gene copies/100mL for human-specific *Bacteroides*) in all 17 mainstem locations, and in all but one of the 35 tributary locations sampled by Regional Water Board staff. Of the 179 samples collected in these 52 sites, 95% of the samples exceed the analytical reporting limit, meaning that 95% of the samples contain detectable levels of human waste.

For bovine-specific *Bacteroides* bacteria, quantifiable levels were found in all 11 mainstem locations, and in all but one of the 19 tributary locations. Of the 83 samples collected, 95% of the samples also exceed the analytical reporting limit (30 gene copies/100mL for bovine-specific *Bacteroides*), meaning that 95% of the samples contain detectable levels of bovine waste.

These results demonstrate that human and domestic animal fecal wastes are present in amounts that indicate the bacteriological quality of the Russian River and its tributaries is degraded beyond minimally disturbed conditions exceeding the natural background narrative bacteria water quality objective.

3.5 ASSESSMENT OF PATHIGENIC SPECIES

Pathogenic bacteria and protozoans are occasionally measured directly without relying on indicator bacteria species, and the ability to do so is increasing with continuing advances in DNA technology. This section describes detections of pathogenic organisms and provides additional evidence of impairment.

3.5.1 PATHOGENIC BACTERIA DETECTIONS

Regional Water Board staff collected water samples for development of this TMDL project from 2011 to 2013 (NCRWQCB 2012, 2013a, 2013b). The monitoring focused on microbiological source identification in the middle and lower Russian River Watershed. Over one hundred samples were analyzed by the Lawrence Berkeley National Laboratory using the PhyloChip™ phylogenetic DNA microarray, which evaluates 16S rRNA gene sequences to identify different bacteria taxa. Taxa were identified, but not quantified. The analysis results (Dubinsky and Anderson 2014) are summarized in this section and in a memo to the file record (Butkus 2014a).

Over 10,000 different bacteria taxa were identified in the samples from the Russian River Watershed. Most of the taxa detected are in the Actinobacteria phylum, Flavobacteria order, and Proteobacteria phylum of bacteria, which are naturally abundant in freshwater and soil, and do not likely originate from animal fecal waste sources. However, a substantial number of taxa in the Bacteroidia class, Clostridia class, Bacilli class, and Verrucomicrobia phylum of bacteria were also found in the samples. These taxa likely originate from fecal waste sources and individual pathogenic species are found within these taxa groups.

The human health risk associated with the presence of pathogenic bacteria is unknown since detection of a pathogenic species does not necessarily indicate that illness will occur. Some pathogenic bacteria are only pathogenic under certain circumstances, such as contact with an open wound. Additionally, there can be more than one strain of a particular bacterium species, and not all strains are pathogenic. The results of the PhyloChip™ analysis, as presented in Table 3.7, show a list of bacteria species found in the Russian River Watershed that have the potential to be human pathogens and cause illness.

Table 3.7
Potential Human Pathogens Detected in the Russian River Watershed

Pathogenic Bacteria Species	Health Impact	Number of Locations with Detected Species		Percent of Samples with Detected Bacteria
		Mainstem	Tributaries	
Proteus mirabili	Urinary Tract Infections	1	10	11%
Salmonella enterica	Gastroenteritis	1	9	10%
Serratia marcescens	Infections, Pneumonia, Meningitis	3	27	41%
Shigella flexneri	Gastroenteritis	0	15	16%
Staphylococcus epidermidis	Infections	3	13	22%
Staphylococcus haemolyticus	Infections	2	0	2%
Yersinia sp.	Plague	4	7	15%

3.5.2 CRYPTOSPORIDIUM AND GIARDIA DETECTIONS

The Sonoma County Water Agency conducted monitoring for *Cryptosporidium* and *Giardia* oocysts in the Russian River near Wohler Bridge from 2004 through 2006 as part of their Sanitary Survey (Table 3.8)(Palencia & Archibald 2013). The SCWA found three *Giardia* cysts and five *Cryptosporidium* oocysts out of 660 L of water from 48 samples. *Giardia lamblia* and *Cryptosporidium parvum* are pathogens that can cause gastrointestinal illness. The low number of *Cryptosporidum* oocysts detected meant no additional treatment is needed for the drinking water collected from the Russian River near Wohler Road (71 FR 775).

Table 3.8 *Cryptosporidium* and *Giardia* Detections in the Russian river near Wohler Bridge (data from Palencia and Archibald, 2013)		
Collection Date	*Cryptosporidium* (oocysts/L)	*Giardia* (cysts/L)
3/9/2004	0.1	-
5/18/2004	-	0.1
12/26/2004	0.2	-
3/2/2005	0.1	0.1
3/23/2005	0.1	-
8/8/2005	0.1	0.1
1/10/2006	-	0.1

3.6 SECTION 303(D) IMPAIRED WATER LISTINGS

The 2012 Section 303(d) List of Impaired Waters was approved by the Regional Water Board on August 14, 2014 and State Water Board on April 8, 2015. The list was approved by U.S. EPA on July 30, 2015.[8] 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. In order to determine whether a waterbody should be listed as impaired on the 2012 Section 303(d) List, instream measurements of *E. coli* and fecal coliform bacteria concentrations collected and submitted prior to August 2010 were assessed. The data used in the listing decisions available online at http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/table_of_contents.shtml. 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. The listed waterbodies are the Russian River at Veterans Memorial Beach, 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.

For the Section 303(d) List assessment, *E. coli* data were compared against the draft California Department of Health Services (CDHS 2006) guidance for posting advisories at fresh water beaches. The draft guidance identifies a single sample concentration level of 235 MPN/100 mL as a threshold for posting a beach advisory to inform swimmers of

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

potential risk. The draft guidance also recommends a 30-day average value of 126 MPN/100 mL applied on a rolling basis.

State Water Board staff determined that the 2012 U.S. EPA Recreational Water Quality Criteria (U.S. EPA 2012) would not be applied to data submitted for the 2012 Integrated Report cycle, as the data had already been assessed and lines of evidence developed by the time the criteria were finalized. In the interest of expedience, State Water Board staff directed the Regional Water Boards to move forward with the existing lines of evidence and to utilize the 2012 U.S. EPA criteria for the next Integrated Report cycle. Thus, the evaluation guideline for *E. coli* utilized to interpret the Basin Plan objective is cited from the "California Department of Health Services Draft Guidance for Fresh Water Beaches" (CADHS 2011), which is the same as that recommended in the U.S. EPA document "Ambient Water Quality Criteria for Bacteria-1986" (U.S. EPA 1986).

Since that assessment was completed, additional data have been collected, criteria have been updated, and assessment methods have improved. *E. coli* data used in the listing process were also used for this TMDL project. Data were reassessed in accordance with improved criteria and methods, and the results are described in Section 3.2. Data collected both before and after 2010 are assessed in this TMDL project.

Detailed information on listing decisions and respective lines of evidence can be found at: http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/303d/.

3.7 PUBLIC HEALTH ADVISORIES

Local agencies use information on pathogen indicator concentrations to post streams with public health advisories that warn against swimming and water recreation. The City of Santa Rosa posts a permanent advisory for swimming in Santa Rosa Creek at Prince Memorial Greenway. This advisory is based on pathogen indicator concentrations measured in the stream near the Railroad Street Bridge. The Sonoma County Department of Health Services uses indicator bacteria data to temporarily post Russian River beaches when concentrations exceed thresholds during the summer recreation season. Table 3.9 lists the number of days with posted advisories each year since 2001 (Tyler 2013; SCDHS 2014). Since 2001, Russian River beaches have been posted with advisories 157 days.

E. coli bacteria concentration data used by the City of Santa Rosa and the County of Sonoma for posting advisories are assessed by the TMDL, and the results are described in Section 3.2.

Table 3.9 Russian River Beach Advisories Issued by the Sonoma Co. Department of Health Services		
Year	Number of Beaches Sampled	Number of Posted Advisories (Days)
2001	6	0
2002	6	1
2003	6	1
2004	6	0
2005	6	0
2006	6	1
2007	6	3
2008	6	11
2009	10	80
2010	6	5
2011	7	7
2012	9	36
2013	8	9
2014	9	3
Total Days Posted Since 2001		157

In summary, the potential risk of illness to recreational users of the Russian River and its tributaries has been assessed using a variety of fecal indicator bacteria, including genetic markers that indicate whether fecal contributions to the water column are from human or animal sources. Each fecal indicator has its strengths and its weaknesses. As such, this assessment uses multiple lines of evidence to determine the spatial and temporal extent of beneficial use impairment. In conclusion, there is evidence of fecal waste entering the waters of the Russian River Watershed at locations throughout the whole watershed. The recreational beneficial use exists in the Russian River Watershed throughout the year, not only during summer months. The discussion presented in Chapter 5 (Source Analysis) further elaborates on the spatial and temporal extent of the impairment, as derived from an assessment of source categories, their presence throughout the watershed, and the discharge mechanism (e.g., storm water discharge).

CHAPTER 4
NUMERIC TARGETS

Numeric targets are values used in a TMDL to measure attainment of applicable water quality standards. Numeric targets may be defined in terms other than the method through which the standard is expressed when the targets achieve the water quality standard. In addition, multiple indicators and associated numeric target values may be used to interpret an individual water quality standard.

The fecal coliform value described in the Basin Plan for the protection of water contact recreation conformed to the U.S. EPA criteria of the 1970s. Since the 1970s when the objective was established, several key epidemiological studies have evaluated the U.S. EPA criteria for protection of 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.

E. coli and enterococci bacteria are found in the fecal material of humans and other animals. Epidemiological studies have demonstrated a link between *E. coli* and enterococci bacteria concentrations and gastrointestinal illness. The U.S. EPA have recommended *E. coli* and enterococci bacteria concentration criteria as an indicator of health risk from water contact recreation.

As discussed in more detail in Chapter 2, this TMDL only addresses impairment of recreational uses. These targets are set at levels designed to protect recreators from illness, using EPA's 2012 recommended criteria (U.S. EPA 2012).

4.1 NUMERIC TARGETS

4.1.1 *E. COLI* 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). 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.

4.1.1.1 E. COLI NUMERIC TARGETS TO PROTECT RECREATIONAL USES

The *E. coli* bacteria numeric targets are expressed as a geometric mean and statistical threshold value in Table 4.1. The numeric targets are used to determine if water quality conditions attain the recreation-specific portion of the bacteria water quality objective and the extent of impairment by pathogen indicator bacteria in the Russian River Watershed. The *E. coli* numeric targets are equivalent to the *E. coli* TMDLs/loading capacities, as described in Chapter 8.

Table 4.1
***E. coli* Bacteria Numeric Targets**

Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)
≤ 100	≤ 320

cfu: colony forming units
ml: milliliters

The *E. coli* bacteria TMDL numeric targets are based on the U.S. EPA (2012) criteria that correspond to an illness rate of 32 gastrointestinal illnesses per 1,000 water contact recreators in order to provide additional protection. The sampling frequency and period of sampling is important to proper interpretation of monitoring results. Any ambient water quality monitoring of fecal indicator bacteria must be in accordance with an approved monitoring plan, which specifies the appropriate sampling frequency and period of sampling, as defined by the monitoring purpose, season of interest, and other relevant factors. The STV approximates the 90th percentile of the water quality distribution and is intended to be a value that should not be exceeded by more than 10% of the samples used to calculate the GM.

4.1.2 ENTEROCOCCI BACTERIA

Enterococci is a genus 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). 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.

4.1.2.1 ENTEROCOCCI NUMERIC TARGETS TO PROTECT RECREATIONAL USES

The enterococci bacteria numeric targets are expressed as a geometric mean and statistical threshold value in Table 4.2. The numeric targets are used to determine if water quality conditions attain the recreation-specific portion of the bacteria water quality objective and the extent of impairment by pathogen indicator bacteria in the Russian River Watershed. The enterococci numeric targets are equivalent to the enterococci TMDLs/loading capacities, as described in Chapter 8.

Table 4.2
Enterococci Bacteria Numeric Targets

Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)
≤ 30	≤ 110

cfu: colony forming units
ml: milliliters

The enterococci bacteria TMDL numeric targets are based on the U.S. EPA (2012) criteria that correspond to an illness rate of 32 NGI per 1,000 water contact recreators in order to provide additional protection. The sampling frequency and period of sampling is important to proper interpretation of monitoring results. Any ambient water quality monitoring of fecal indicator bacteria must be in accordance with an approved monitoring plan, which specifies the appropriate sampling frequency and period of sampling, as defined by the monitoring purpose, season of interest, and other relevant factors. The STV approximates the 90th percentile of the water quality distribution and is intended to be a value that should not be exceeded by more than 10% of the samples used to calculate the GM.

In summary, numeric targets are set in the Russian River Pathogen TMDL based on the most recent U.S.EPA guidance for protection of recreational uses of water. U.S.EPA (2012) establishes national criteria for *E. coli* and enterococci bacteria, which update the criteria developed in 1986 for the same metrics. The numeric targets are designed to be applied in the receiving water as a marker of progress towards attainment of the bacteria water quality objective and protection of the REC-1 beneficial use. As described in Chapter 8 (TMDLs, Loading Capacities, and Margin of Safety), the waste load allocations and load allocations are also based on U.S. EPA (2012) national criteria. As such, the numeric targets, TMDL, waste load allocations, and load allocations are identical. As described in Chapter 9 (Implementation), the waste load allocations may be expressed differently when translated into effluent limitations in permits or orders.

CHAPTER 5
SOURCE ANALYSIS

This chapter identifies the major sources of fecal waste contributing to elevated concentrations of fecal indicator bacteria found in the surface waters of Russian River Watershed.

Sources of fecal waste are analyzed in three ways:

1. By assessing the type of human and animal fecal waste found in the Russian River and its tributaries and identifying areas of higher and lower DNA matches in the watershed.
2. By assessing indicator bacteria concentrations from different types of land uses.
3. By identifying the types of point source and nonpoint source facilities and activities that discharge or have the potential to discharge fecal waste to surface waters.

5.1 HUMAN, GRAZER, & BIRD FECAL WASTE SOURCES & DISTRIBUTION

Regional Water Board staff collected water samples for development of this TMDL project from 2011 to 2013 (NCRWQCB 2012, 2013a, 2013b, 2013c). The monitoring included microbiological source identification in the Russian River Watershed. Over one hundred samples were analyzed by the Lawrence Berkeley National Laboratory using the PhyloChip™ phylogenetic DNA microarray, which evaluates 16S rRNA gene sequences to estimate the percentage of the bacteria DNA gene sequences found in a water sample that match a specific DNA profile of a reference fecal waste source. The analysis results (Dubinsky and Anderson 2014) are summarized in this section and in a memo to the file record (Butkus 2014a), which can be found on the Regional Water Board website.

Specific DNA profiles of fecal waste from humans, grazing mammals, and birds were collected, composited, and cataloged by the laboratory. The library of DNA profiles includes human waste samples from raw sewage, septic waste, and feces. The DNA profile for grazing mammals includes samples of droppings from cows, horses, deer, and elk. The profile for birds includes samples of droppings from gulls and pelicans. Water samples from the Russian River Watershed were compared to the library of DNA profiles from known human, grazer, and bird wastes to determine the percentage of the bacteria DNA gene sequences that match the known profiles.

Multiple water samples were collected concurrently during the wet and dry season to analyze for *E. coli*, enterococci, and *Bacteroides* bacteria, as well as DNA profile. Due to cost, not all waters samples were immediately analyzed using the phylogenetic DNA microarray. Instead, a set of all water samples collected was frozen to be analyzed later using the phylogenetic DNA microarray. However, sets of all samples were analyzed for E*. coli*, enterococci, or *Bacteroides* bacteria. Around 100 frozen water samples were thawed and analyzed using the phylogenetic DNA microarray when any of the other measured metrics were shown to be elevated. This allowed for an assessment of the source, based on DNA profile, of each of the samples otherwise shown to have elevated concentrations of *E. coli*, enterococci, or *Bacteroides* bacteria.

5.1.1 RESULTS

The results for human fecal waste are mapped in Figure 5.1. The ten locations with the highest human fecal waste measured are shown in Table 5.1. There is a wide range of human fecal waste DNA matches found in the Russian River and its tributaries. The highest percent matches are found in the Laguna de Santa Rosa Watershed and in the Lower Russian River area. For example, in water samples collected in an unnamed stream in Monte Rio at Foothill Drive, 89% of the measured bacteria DNA gene sequences match known human waste gene sequences.

The results for grazer fecal waste are mapped in Figure 5.2. The ten locations with the highest grazer fecal waste measured are shown in Table 5.1. The majority of the sites with elevated percent matches are in the Laguna de Santa Rosa Watershed.

The results for bird fecal waste are mapped in Figure 5.3. The ten locations with the highest bird fecal waste measured are shown in Table 5.1. Elevated percent matches are fairly evenly distributed throughout the tributaries in the watershed.

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Table 5.1
Locations with the Highest Percent of Matches between Bacteria DNA Sequences in Russian River Watershed Samples and Known Human, Grazer, and Bird Fecal Waste

Hydrologic Area Name	Hydrologic SubAreas	Sample Location	Gene Sequences Percent Match
		Human Fecal Waste Top Ten Sites	
Middle Russian River	Laguna	Copeland Creek at Commerce Drive	24
		Crane Creek at Snyder Lane	21
	Santa Rosa	Piner Creek at Fulton Road	32
Lower Russian River	Guerneville	Unnamed stream in Monte Rio at Foothill Drive	89
		Russian River at Monte Rio Beach	59
		Unnamed stream in Forestville at Trenton Road	54
		Russian River at Johnson's Beach (Oct. 6, 2011)	54
		Unnamed Creek at Old Redwood Highway	52
		Russian River at Johnson's Beach (Sept. 26, 2011)	50
		Unnamed stream in Forestville at Trenton Road	41
		Grazer Fecal Waste Top Ten Sites	
Middle Russian River	Laguna	Unnamed Stream near Sebastopol at Daywalt Road	34
		Crane Creek at Snyder Lane	34
		Copeland Creek at Commerce Drive	33
		Blucher Creek at Lone Pine Road	33
		Gossage Creek at Gilmore Avenue	30
	Santa Rosa	Abramson Creek at Willowside Road Levy	36
Lower Russian River	Guerneville	Unnamed Stream in Monte Rio at Foothill Drive	23
		Russian River at Monte Rio Beach	20
		Unnamed Creek at Old Redwood Highway	20
		Russian River at Forestville Access Beach	19
		Bird Fecal Waste Top Ten Sites	
Middle Russian River	Warm Springs	Palmer Creek at Palmer Creek Road	12
		Lambert Creek at Lambert Bridge Road	11
	Laguna	Crane Creek at Synder Lane	10
	Santa Rosa	Piner Creek at Fulton Road	19
		Abramson Creek at Willowside Road Levy	14
	Mark West	Unnamed Creek at River Road	10
Lower Russian River	Guerneville	Limerick Creek at Old Redwood Highway	11
		Unnamed Stream in Monte Rio at River Road	10
		Unnamed Stream near Monte Rio at Foothill Drive	10
		Dutch Bill Creek at Fir Road	10

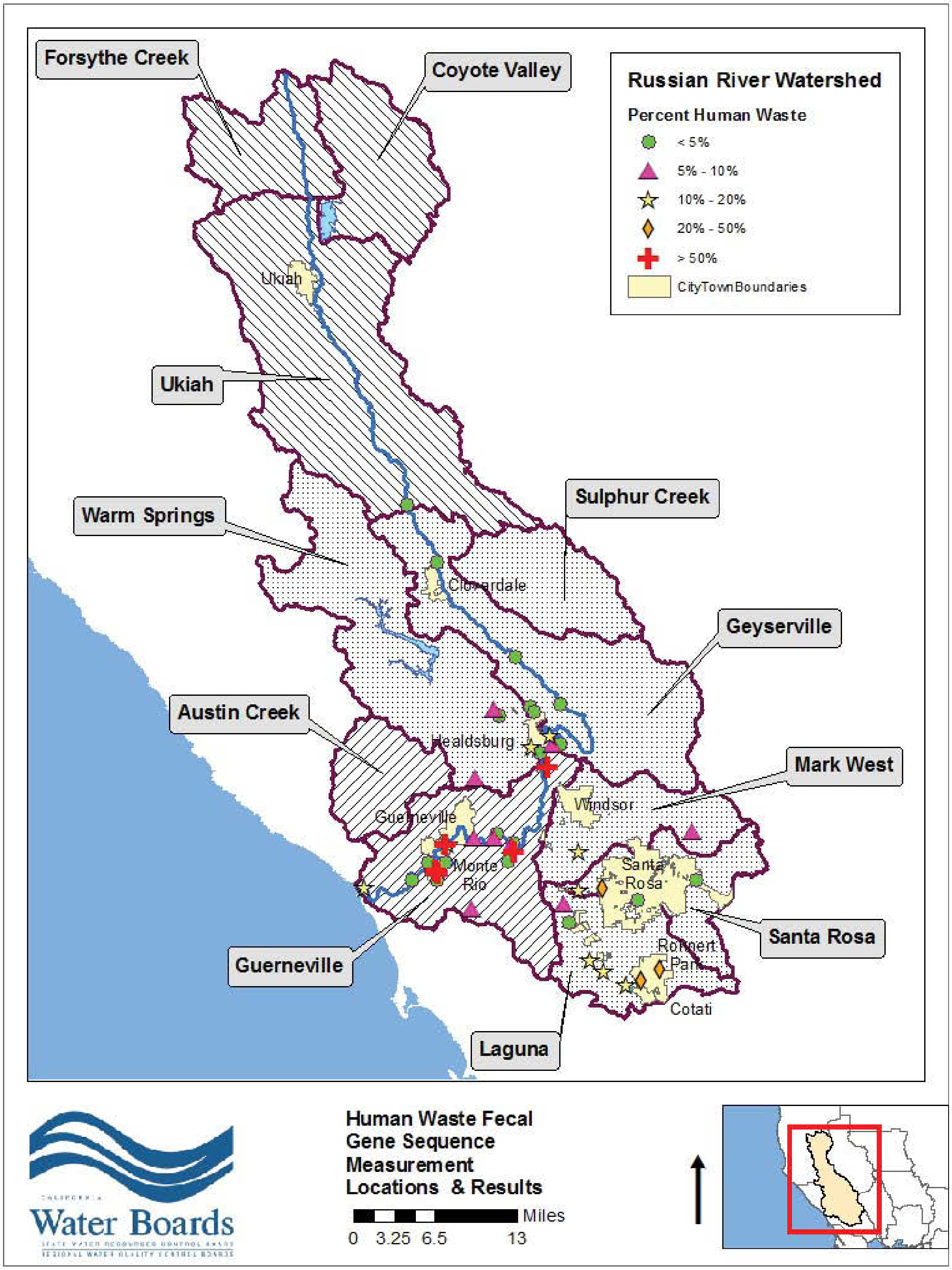


Figure 5.1: Human Fecal Waste Gene Sequence Measurement Locations and Results

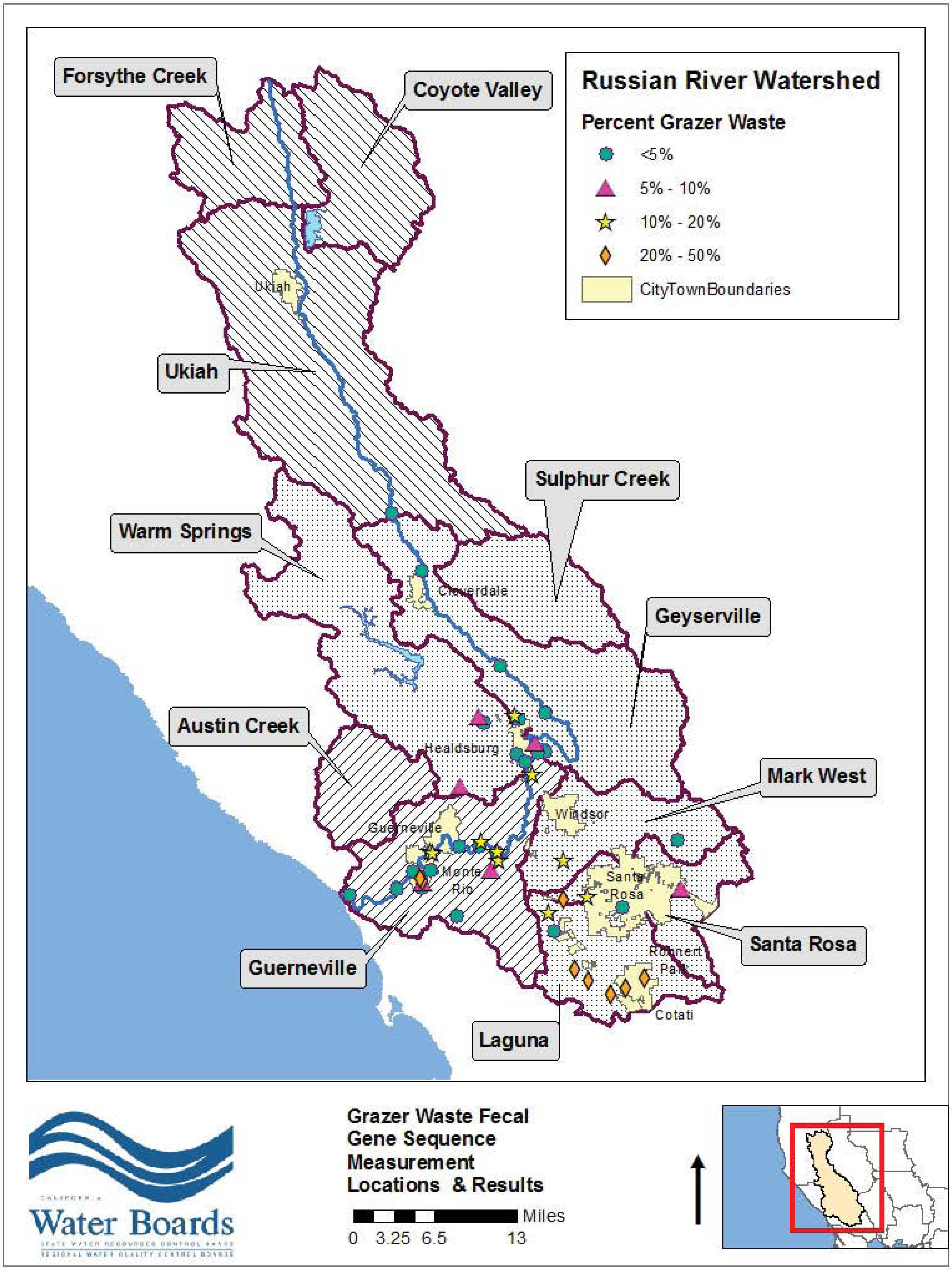


Figure 5.2: Grazer Fecal Waste Gene Sequence Measurement Locations and Result

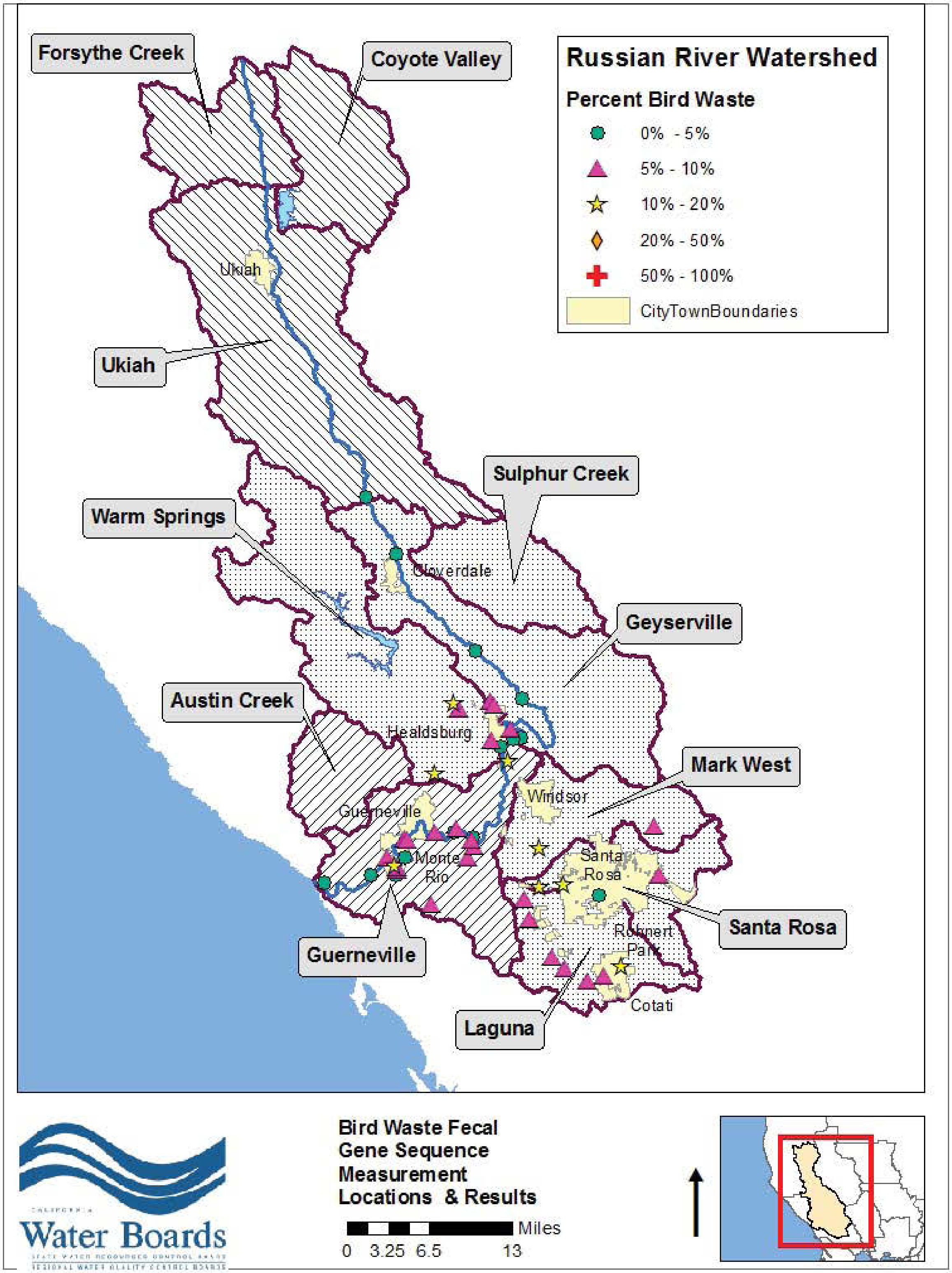


Figure 5.3: Bird Fecal Waste Gene Sequence Measurement Locations and Results

5.2 SOURCES BY LAND COVER TYPE

Regional Water Board staff assessed the relative contributions, magnitude, and variability of pathogenic indicator bacteria in the Russian River Watershed based on different land cover types during both dry and wet weather periods. Methods and sample concentrations are documented in a monitoring report by the Regional Water Board staff (NCRWQCB 2012). An assessment of the data, including a statistical analysis, is documented in a memorandum (Butkus 2013a). A summary is provided here.

Water samples were collected from streams that drain watersheds primarily composed of one type of land use to evaluate the influence of different land uses on pathogenic indicator bacteria concentrations[9]. Five land cover categories were selected. These land cover categories are based on the National Land Cover Dataset (Fry et al. 2011) and Urban Service Areas (PRMD 2010). The land cover categories are defined through remote sensing by Anderson et al. (1976), and are summarized as follows:

- **Forest Land** – Areas with a 10 percent or more tree-crown areal density (crown closure percentage).
- **Shrubland** – Areas where the potential natural vegetation is predominantly grasses, grass-like plants, forbs, or shrubs. Anderson et al. (1976) previously defined this land cover as “Rangeland.” These areas do not include animal pastures or dry croplands.
- **Agriculture** – Areas were defined by visual indications of agricultural activity through distinctive geometric field or road patterns and the traces produced by livestock or mechanized equipment.
- **Developed Sewered** - Urban and residential areas identified by Fry et al. (2011) where much of the land is covered by structures including cities, towns, villages, strip developments along highways, transportation, power, and communications facilities. Residential land uses range from low density (where houses are on lots of more than an acre) to high density, multiple-unit structures. The boundaries of the Urban Service Areas (PRMD 2010) were used to identify those urban and residential areas that are sewered to receive domestic wastewater treatment.
- **Developed Non-Sewered** – Residential land uses identified by Fry et al. (2011) where the houses are outside of the boundaries of the Urban Service Areas (PRMD, 2010) and assumed to use individual onsite wastewater treatment systems, cesspools, or direct discharges for disposal of domestic waste.

For each of the five land cover categories, six water samples were collected at three different locations during both wet and dry periods. Samples were analyzed for *E. coli*, human-specific *Bacteroides*, and bovine-specific *Bacteroides* bacteria. Visual comparison

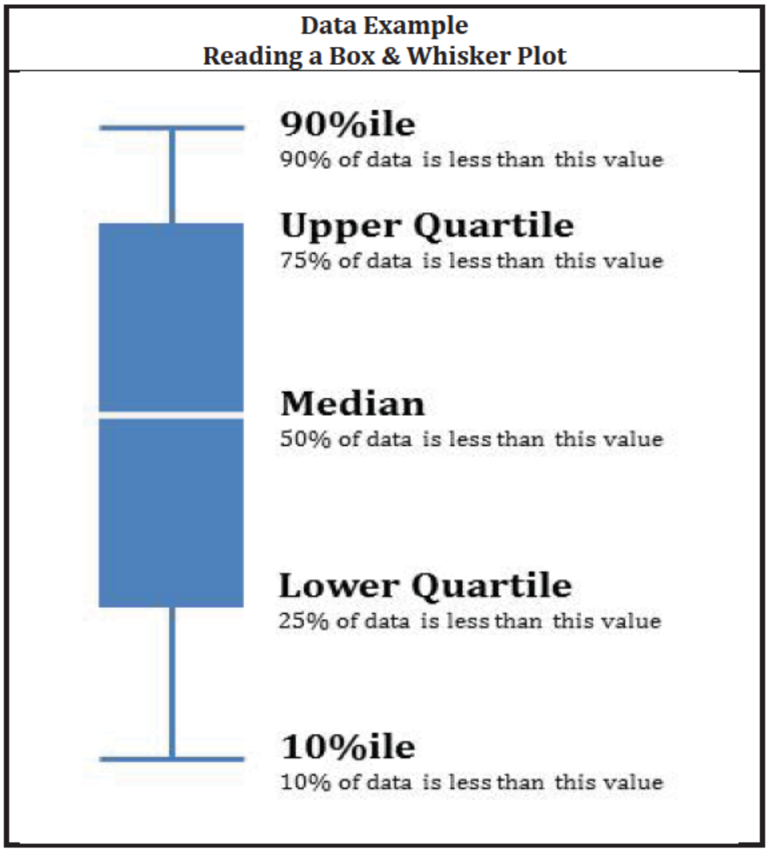
[9] All the sampling locations drained watersheds with 50% or more of their area in one type of land cover category, except for sampling locations representing the developed non-sewered category. There was a relatively low percentage of land in this category as developed non-sewered areas are interspersed with other categories, especially agricultural lands.

and statistical hypothesis tests were made between different data groupings. More information on the assessment methods is available in Butkus (2013a).

5.2.1 RESULTS

The results of the land cover analysis are presented in box-and-whisker plots in Figures 5.4 through 5.11. An explanation of how to interpret box-and-whisker plots precedes the figures. Human-source *Bacteroides* bacteria were present in all locations and in all land use categories. *E. coli*, enterococci, and Bacteroides bacteria concentrations in wet periods had statistically-significant higher concentrations than dry periods. Runoff from forest lands had statistically-significant lower concentrations of fecal indicator bacteria than runoff in all other assessed land cover categories. Runoff from shrubland, agricultural areas, and forested areas had statistically-significant lower *E. Coli*, enterococci, and Bacteroides indicator bacteria concentrations than runoff from developed areas (both sewered and non-sewered areas). Bacteroides bacteria concentrations were statistically the same for wet and dry period runoff draining from developed sewered areas, developed areas on Onsite Wastewater Treatment Systems (OWTS), agricultural areas and shrublands. *E. Coli*, enterococci, and Bacteroides bacteria concentrations were statistically the same for wet and dry period runoff draining from developed sewered areas and developed areas on Onsite Wastewater Treatment Systems (OWTS).

A stable isotope analysis, which measures oxygen and nitrogen in the water sample, was also conducted on samples from different land use categories to help identify the source of the water associated with the bacteria in samples. The results show that most of the nitrate measured in the samples was from soil, which was likely carried into the water column through rainfall-induced erosion. The results also show that several of the samples collected during wet weather in both sewered and non-sewered developed areas were likely derived from domestic wastewater, which suggests that storm events may be transporting untreated domestic wastewater from sanitary sewer overflows and exfiltration, failing sanitary sewer pipelines and sewer laterals, and failing septic systems into streams. Sampling under this study was conducted in such a manner as to prevent capture of surface water discharges from municipal wastewater treatment facilities, by locating sample collection upstream of their discharge locations.



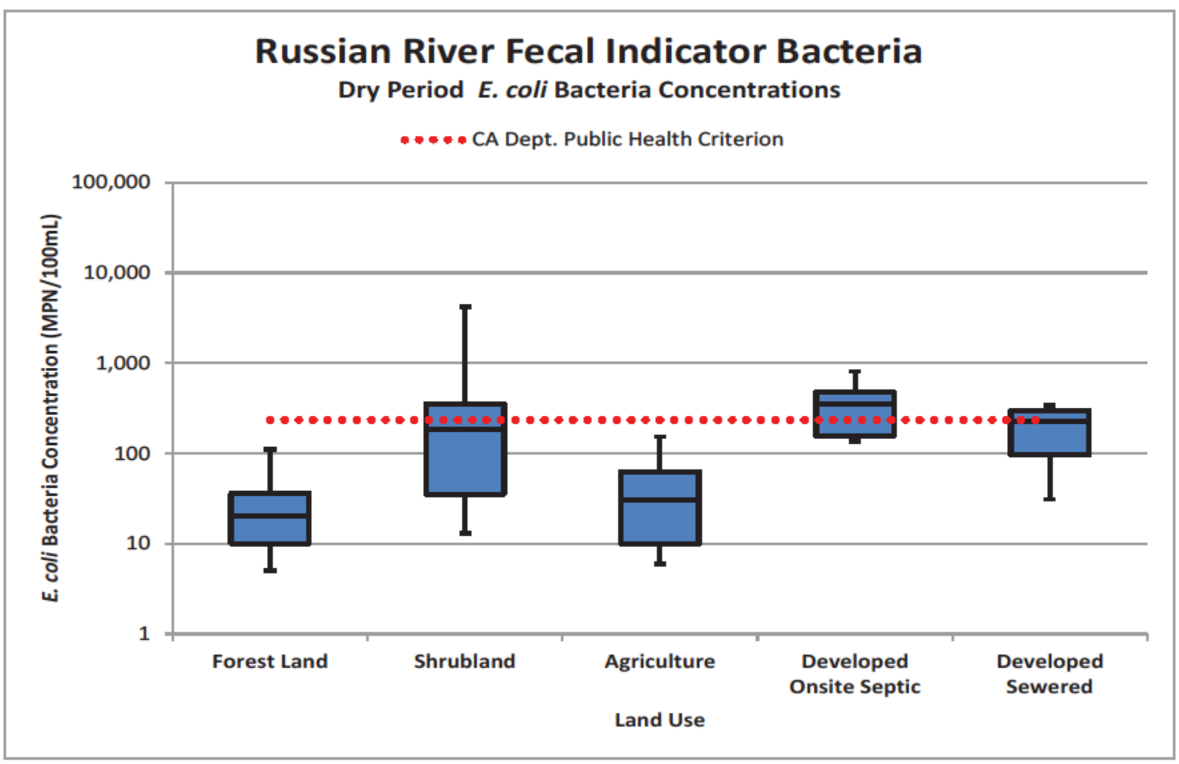


Figure 5.4: ***E. coli*** **Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.**
Source: North Coast Regional Water Quality Control Board

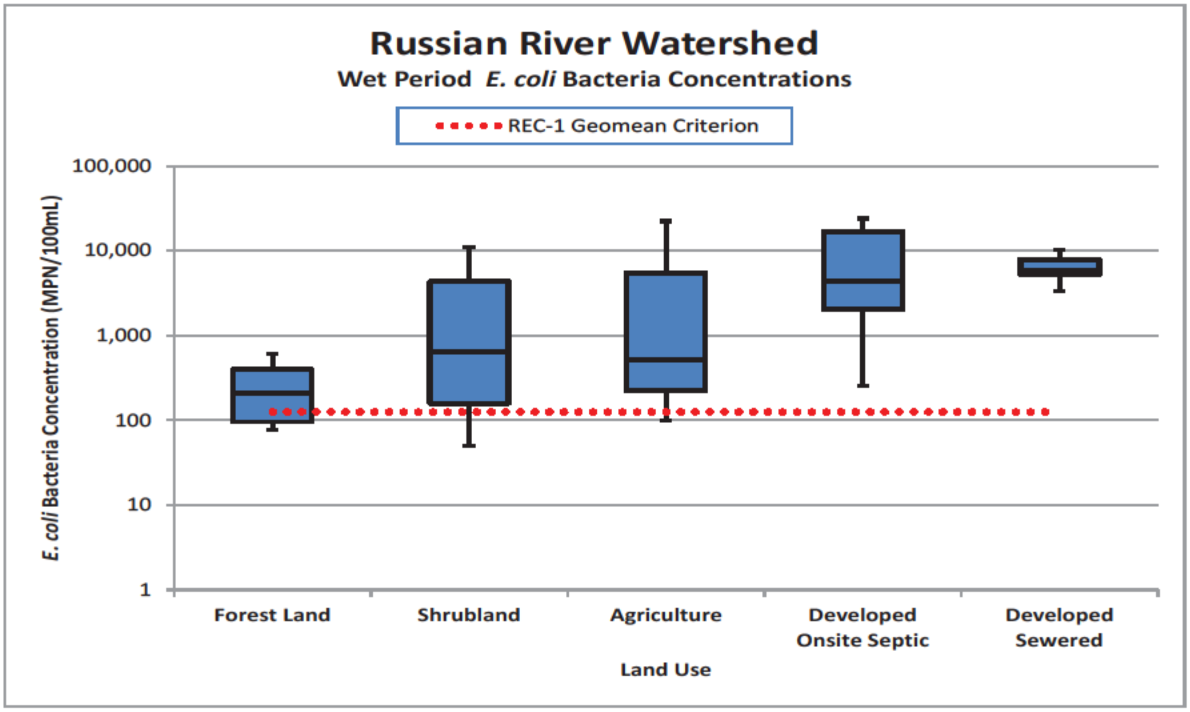


Figure 5.5: *E. coli* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category
Source: North Coast Regional Water Quality Control Board

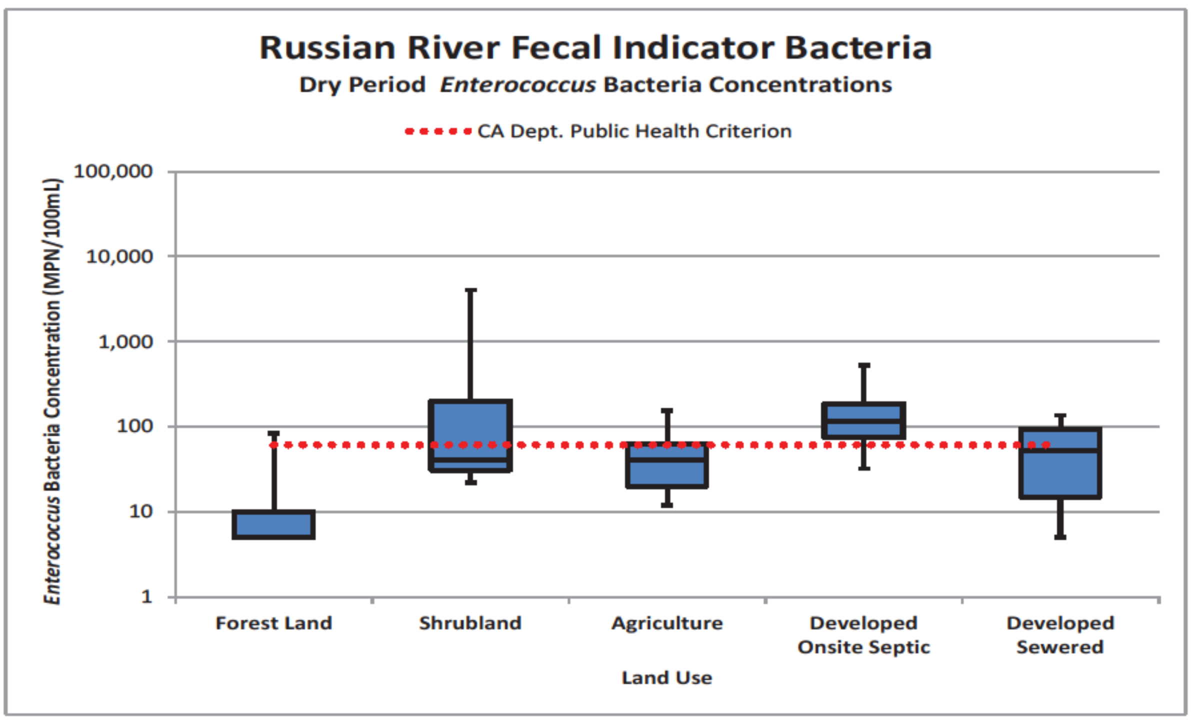


Figure 5.6: Enterococci Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category
Source: North Coast Regional Water Quality Control Board

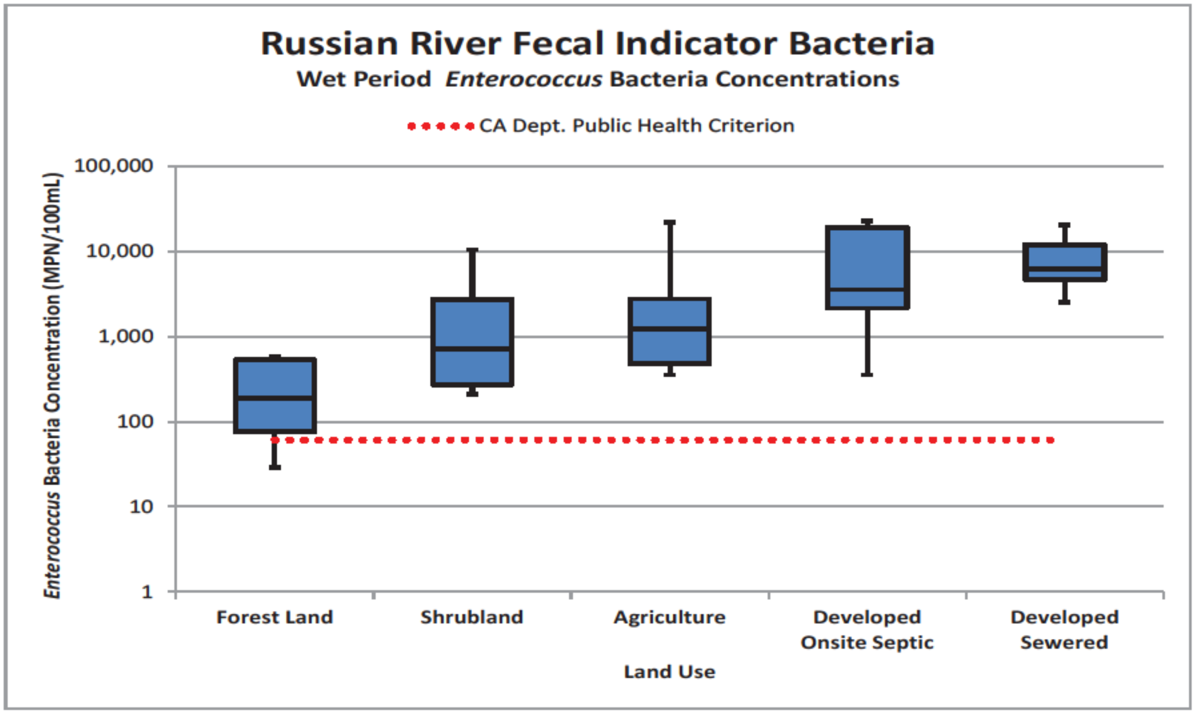


Figure 5.7: Enterococci Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category
Source: North Coast Regional Water Quality Control Board

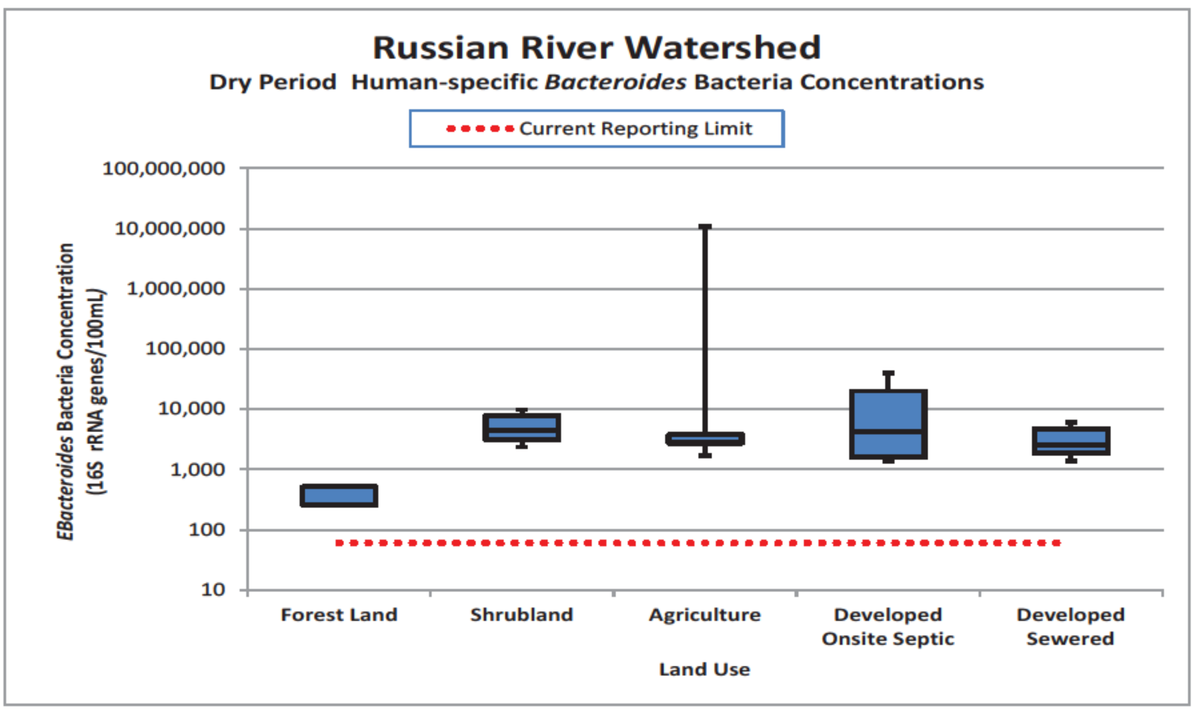


Figure 5.8: Human-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

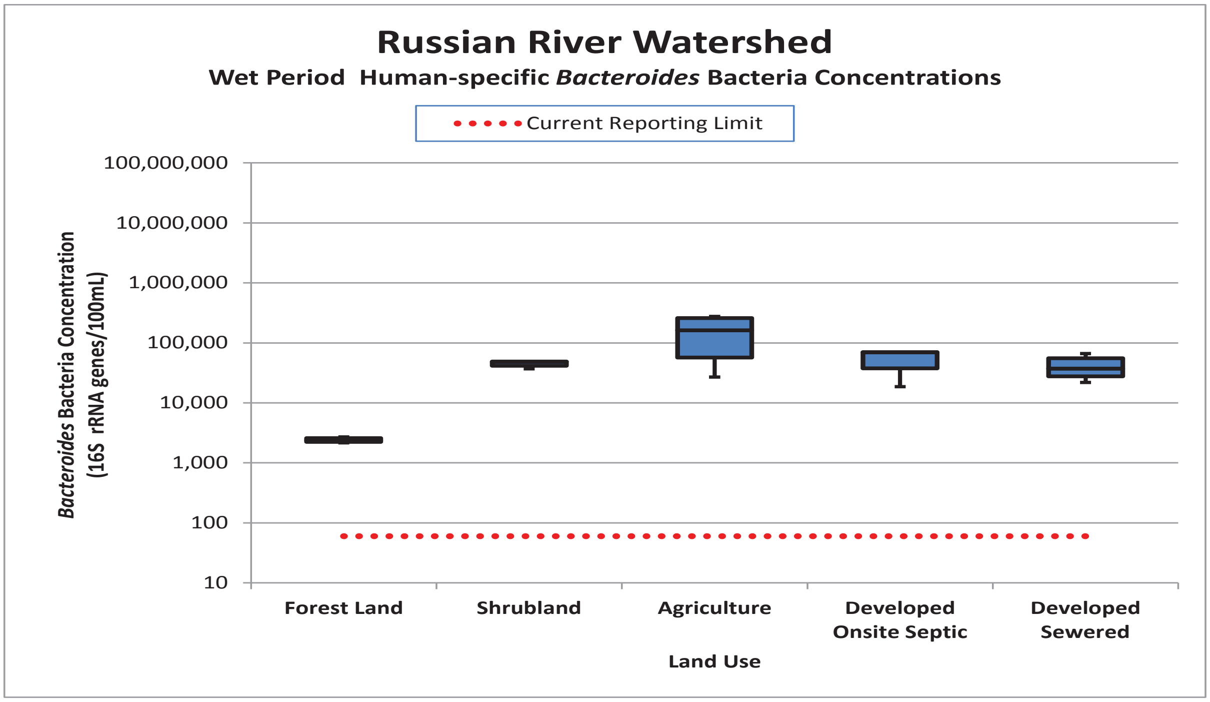


Figure 5.9: Human-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Human-specific *Bacteroides* were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

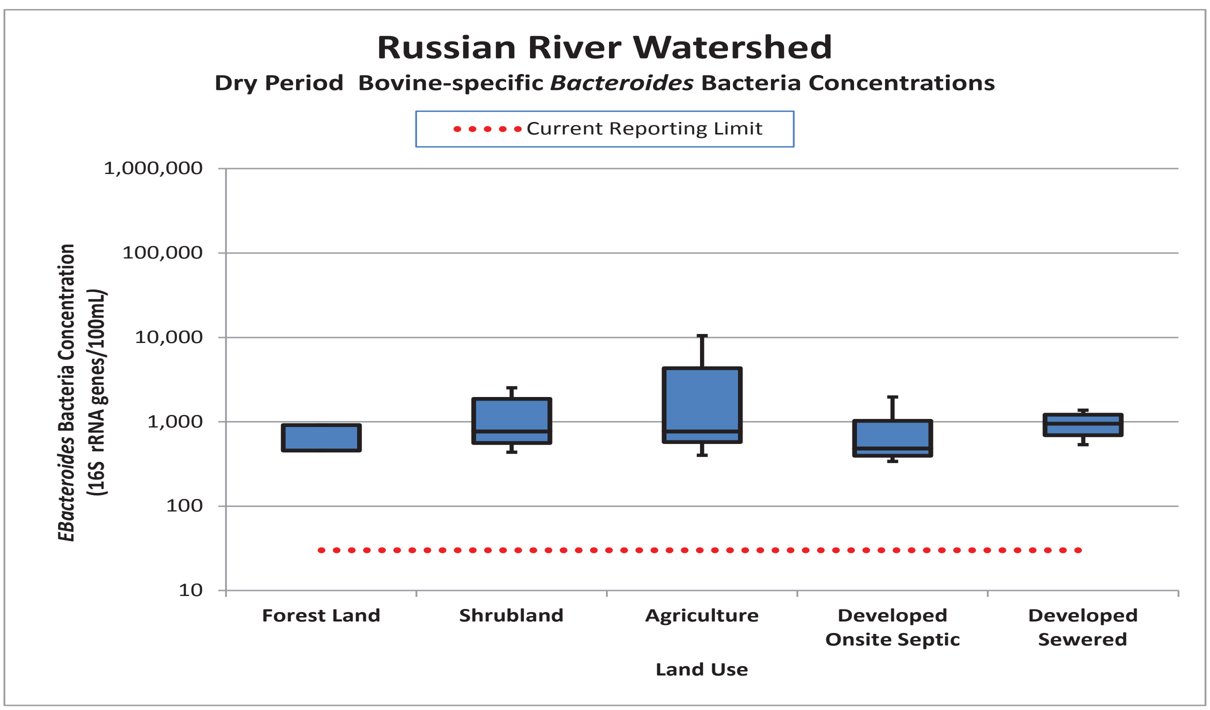


Figure 5.10. Bovine-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Dry Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

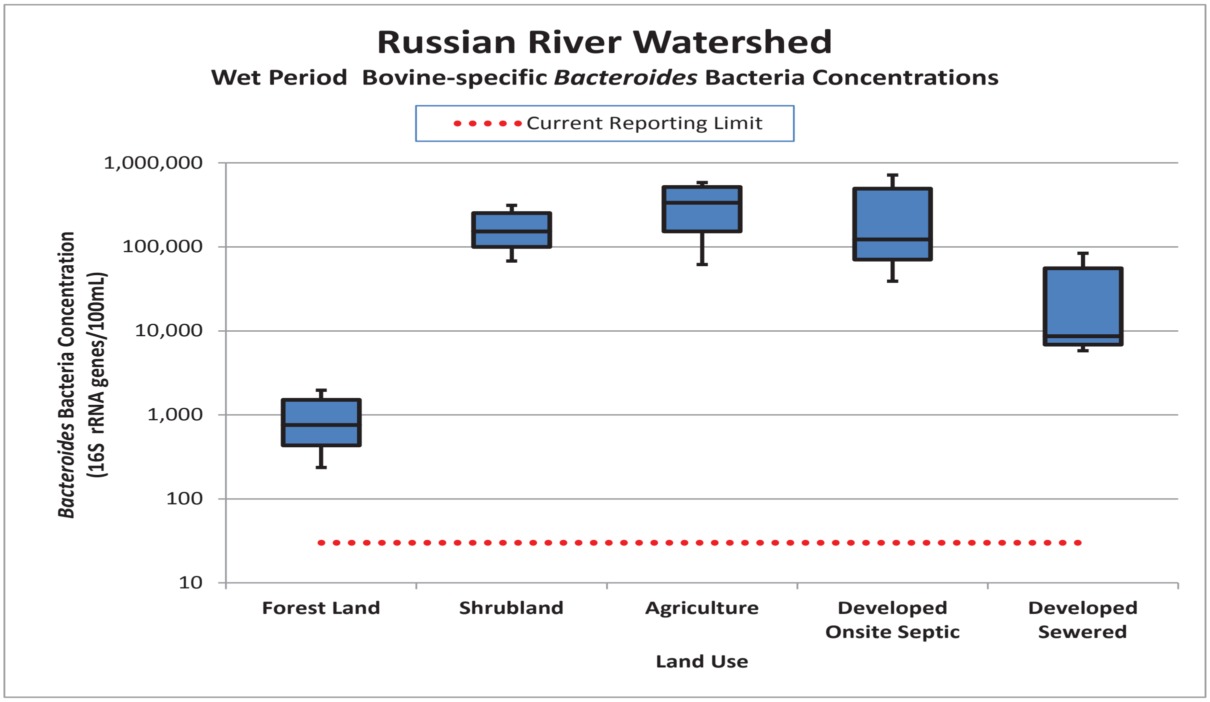


Figure 5.11: Bovine-specific *Bacteroides* Bacteria Concentrations Measured in the Russian River Watershed during Wet Periods by Land Cover Category.
Source: North Coast Regional Water Quality Control Board. Bovine-specific *Bacteroides* were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

5.3 POINT SOURCE FACILITIES AND ACTIVITIES

This section describes potential point sources of pathogens in the Russian River Watershed. Clean Water Act section 402 addresses direct discharges of waste into navigable waters. "Point source", as defined in the Clean Water Act, means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft. This term does not include agricultural storm water discharges and return flows from irrigated agriculture. (33 U.S.C. §1362). Point source discharges to waters of the United States are regulated under the federal National Pollutant Discharge Elimination System (NPDES) program, through NPDES permits. Point source discharges to waters of the state are regulated under waste discharge requirements (WDRs) that also serve as NPDES permits.

The point sources described in this section were identified by querying the California Integrated Water Quality System (CIWQS) database for existing facilities regulated by a NPDES permit.

5.3.1 WASTEWATER DISCHARGES TO SURFACE WATERS

Wastewater discharges to surfaces waters in the Russian River Watershed occur from both direct permitted discharges and from unpermitted spills and leaks. The following sections identify potential sources in the watershed.

5.3.1.1 MUNICIPAL WASTEWATER DISCHARGES TO SURFACE WATERS

The watershed contains nine municipal wastewater treatment facilities that are authorized under NPDES permits to discharge treated domestic wastewater into surface waters. Table 5.2 summarizes these facilities (per information obtained from CIWQS in Nov. 2013) and describes their level of treatment. Figure 5.12 shows the locations of these facilities in the watershed. All facilities in the watershed treat to secondary or tertiary levels. Secondary treatment refers to physical, chemical, and biological unit processes used to meet federal standards in 40 C.F.R. §133.102 for biochemical oxygen demand (BOD), total suspended solids (TSS), and pH. Tertiary treatment is generally defined as treatment beyond secondary levels to achieve a higher level of BOD or TSS removal or to remove constituents of concern such as nutrients or toxic compounds.

To achieve water quality objectives, protect beneficial uses, protect public health, and prevent nuisance, surface water discharges within the Russian River are prohibited from May 15 through September 30. During the remainder of the year, discharges are limited to one percent of the flow volume in the receiving water unless specifically exempted in the NPDES permit. For authorized discharges of wastewater to the Russian River and its tributaries during October 1 through May 14, the Basin Plan requires that discharges of municipal waste "*shall be of advanced treated wastewater in accordance with effluent limitations contained in NPDES permits for each affected discharger, and shall meet a median* *coliform level of 2.2 MPN/100 mL."* The Regional Water Board has defined advanced wastewater treatment in individual permits as treated effluent meeting, in part, disinfection standards, including total coliform thresholds, consistent with tertiary treated recycled water requirements set forth in title 22 of the California Code of Regulations.

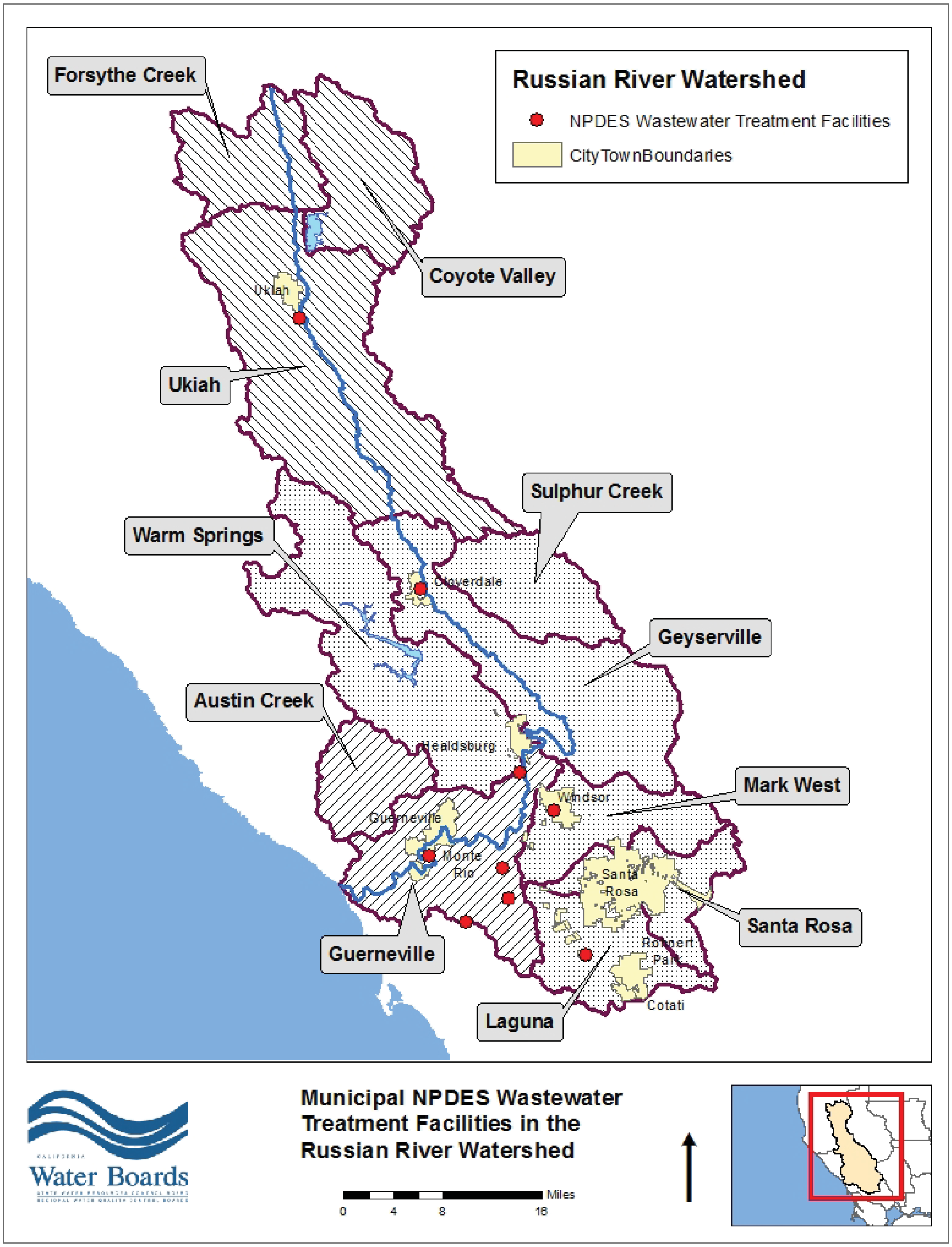


Figure 5.12: Municipal NPDES Wastewater Treatment Facilities in the Russian River Watershed

Disinfection standards in municipal NPDES permits consist of effluent limitations for total coliform bacteria and other process requirements to ensure adequate effluent disinfection. For surface water discharges, municipal NPDES permits in the Russian River Watershed prescribe uniform effluent limitations for total coliform bacteria that require:

- The 7-day median concentration not exceed an MPN of 2.2 per 100 mL;
- The number of coliform bacteria not exceed an MPN of 23 per 100 mL in more than one sample in any 30-day period; and
- No single sample exceed an MPN of 240 total coliform bacteria per 100 mL.

In addition to effluent limitations for total coliform bacteria, municipal NPDES permits also require compliance with disinfection process requirements depending on the permitted facility's method of disinfection. For wastewater treatment facilities that employ an ultraviolet (UV) disinfection process, permittees are required to ensure a minimum UV dose, maintain a minimum UV transmittance, and perform appropriate operation and maintenance activities specified by Division of Drinking Water of the State Water Resources Control Board. For wastewater treatment facilities that utilize chlorine as a means of disinfection, permittees must demonstrate a continuous chlorine residual after treatment or provide a minimum CT (the product of total chlorine residual and modal contact time) value of not less than 450 mg-min/L at all times.

Regional Water Board staff used discharger-specific effluent monitoring data from self-monitoring reports to assess total coliform bacteria concentrations in the effluent from these facilities. Table 5.2 shows that disinfection methods are highly effective at meeting effluent limitations for total coliform bacteria. Consequently, direct discharges to surface water of treated municipal wastewater that meet effluent limitations for bacteria and discharge specifications for disinfection are not considered a significant source of bacteria. See Section 5.3.1.2 for discussion of the potential for bacterial contamination from discharges from holding ponds.

5.3.1.2 RECYCLED WATER HOLDING PONDS

The beneficial reuse of treated wastewater, which is also known as recycled water, is common in the Russian River Watershed as a means to conserve scarce potable water supply and to comply with stringent discharge requirements imposed in NPDES permits in the watershed, including the Basin Plan's prohibition against summertime discharges of waste to the Russian River and its tributaries. For these and other reasons, storage ponds for many wastewater treatment facilities serve a dual purpose: 1) to temporarily store recycled water in large holding ponds for later distribution to recycled water users or 2) to temporarily store treated wastewater until conditions are suitable and permitted for discharge to surface waters. It is the experience of Regional Water Board staff that discharges from holding ponds to surface waters outside of the prescribed discharge season or as a result of rain-induced pond overflows are rare, and are not considered a significant source of pathogen indicator bacteria in the Russian River Watershed.

Although advanced wastewater treatment systems in the Russian River Watershed are operated to produce recycled water that is essentially pathogen-free and suitable for water recycling, compliance with effluent limitations for bacteria has been historically measured at municipal treatment plants at a point immediately after completion of the disinfection process. The point at which disinfection is complete, for example, at the end of a chorine contact chamber, may be separated from the surface water discharge by both distance and time. As a result, this same recycled water, when stored in open-air holding ponds, may become contaminated as a result of regrowth of bacteria or through contribution of fecal waste from wildlife, particularly birds that frequent the storage ponds. Thus, the original bacterial water quality of the recycled water demonstrated immediately after disinfection cannot be guaranteed during storage.

Many studies document the occurrence of fecal indicator bacteria and other opportunistic pathogens in open-air reservoirs, but the public health risk associated with pathogens in recycled water storage ponds has not been well-documented. Regional Water Board staff evaluated monitoring data for treated effluent discharges from the open-air, recycled water storage ponds at Vintage Greens used by the Town of Windsor. Monitoring results from the Town of Windsor for the period 2007-2011 indicate measureable concentrations of *E. coli* recycled water storage ponds after completion of disinfection. These results are shown in Figure 5.13.

In the Russian River Watershed, municipal wastewater treatment facilities that discharge to surface waters directly or indirectly after storage employ either chlorine or ultraviolet light as a means of wastewater disinfection. Research assessing the regrowth or photoreactivation of bacteria or pathogens in storage ponds is sparse; most recent work has focused on photoreactivation after exposure to ultraviolet light. One study reviewed by Regional Water Board staff used biochemical fingerprinting to show that the fecal contamination in a golf course pond supplied with chlorine-disinfected recycled water was not related to the recycled water and that the fecal indicator bacteria did not regrow in the ponds (Casanovas-Massana 2012). Another case study (Basu 2007) of fecal coliform bacteria regrowth in a full-scale operating wastewater treatment facility using ultraviolet disinfection concluded that bacterial regrowth in recycled water systems is a concern, but that exceedances of effluent limitations for fecal coliform in this study could be attributed to poor effectiveness of the ultraviolet disinfection system. The report also summarized recent research on the topic, indicating that photoreactivation of bacteria diminishes drastically after exposure to dosages of ultraviolet radiation above 50 MJ/cm^2.

Table 5.2
Municipal NPDES Wastewater Treatment Facilities in the Russian River Watershed and Percent Compliance with Total Coliform Effluent Limitations

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name	Permit No.	Capacity (mgd)	Treatment Type	Percent Compliance		
						Daily Max.	7-Day Median	Monthly Max.
Upper Russian River	Ukiah	City of Ukiah Wastewater Treatment Plant	CA0022888	3.01	Tertiary	100.0 %	93.9%	100.0%
Middle Russian River	Geyserville	City of Cloverdale Wastewater Treatment Plant	CA0022977	1.0	Secondary	100.0 %	100.0%	100.0%
	Warm Springs	City of Healdsburg Water Reclamation Facility	CA0025135	1.4	Tertiary	100.0 %	98.4%	100.0%
	Santa Rosa, Laguna, Mark West	Santa Rosa Subregional Water Reclamation System	CA0022764	21.34	Tertiary	99.9 %	100.0%	99.9%
	Mark West	Town of Windsor Wastewater Treatment, Reclamation, and Disposal Facility	CA0023345	1.9	Tertiary	100.0 %	96.1%	100.0%
Lower Russian River	Guerneville	Graton Community Services District Wastewater Treatment, Reclamation, and Disposal Facility	CA0023639	0.397	Tertiary	100.0 %	100.0%	100.0%
		Forestville Water District Wastewater Treatment, Reclamation, and Disposal Facility	CA0023043	0.130	Tertiary	99.9 %	83.6%	99.7%
		Russian River County Sanitation District Wastewater Treatment Facility	CA0024058	0.71	Tertiary	100.0 %	100.0%	100.0%
		Occidental County Sanitation District Wastewater Treatment Facility	CA0023051	0.05	Secondary	100.0 %	97.6%	100.0%

Based on these studies reviewed by Regional Water Board staff, discharges of treated wastewater from recycled water holding ponds may contain *E. coli* and in concentrations above the TMDL targets. However, the studies indicate that the sources of detected *E. coli* bacteria in recycled water storage ponds are not necessarily of human origin and therefore may not pose a more significant threat to public health or be relevant to protection of the REC-1 beneficial use. More site-specific information is necessary to determine the sources of *E. coli* or other fecal indicator bacteria in recycled water storage ponds and whether the discharge from a recycled water storage pond contains human pathogens before the holding pond can be eliminated as a pathogen source.

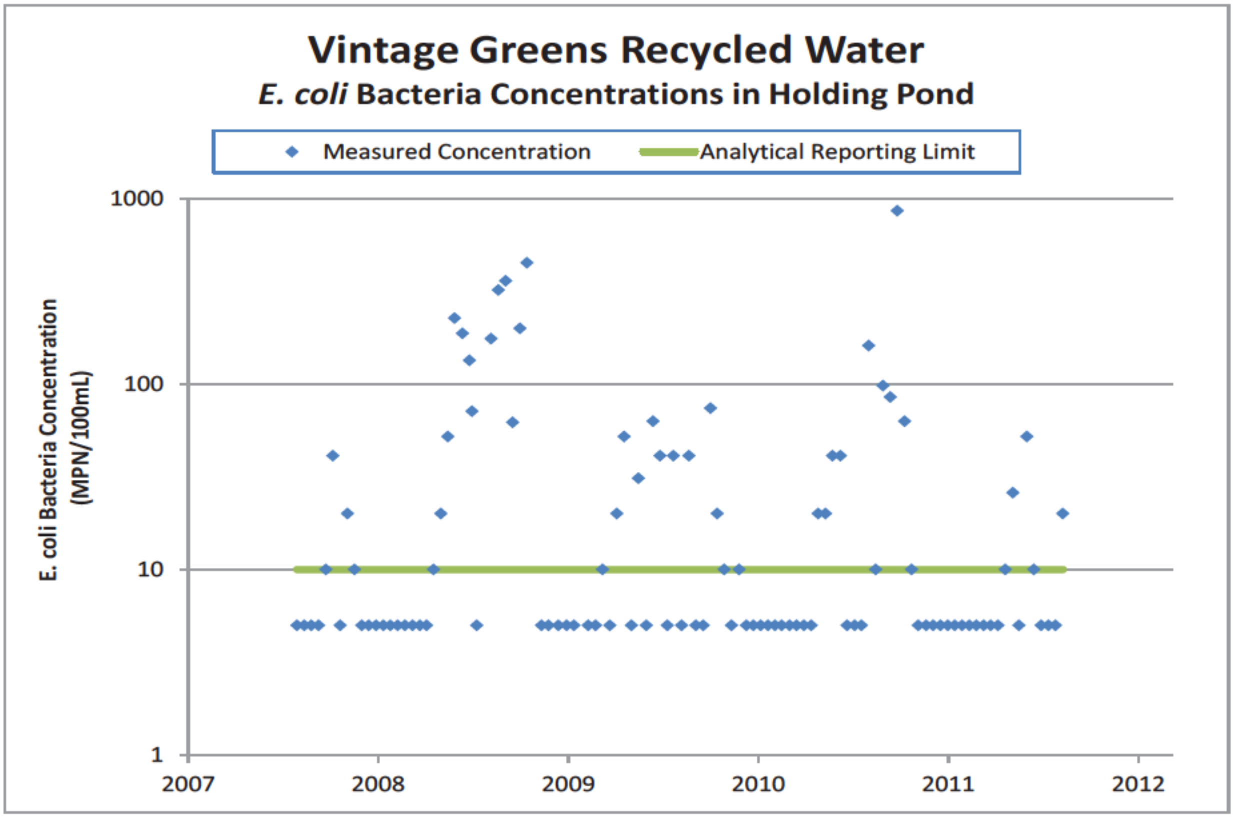


Figure 5.13: ***E. coli*** **Bacteria Concentrations in a Recycled Water Holding Pond at Vintage Greens in Windsor**
Source: Town of Windsor / North Coast Regional Water Quality Control Board

5.3.1.3 SANITARY SEWER SYSTEMS

Sanitary sewer systems collect and transport municipal wastewater from private residences, commercial buildings, industrial facilities, and institutional buildings to a wastewater treatment facility for treatment and disposal and/or reuse. Some sanitary sewer systems also convey storm water and groundwater that may inadvertently enter the system. Sanitary sewer infrastructure is comprised of some or all of the following components: service laterals, collector sewers, connections between laterals and collector sewers, interceptor sewers, manholes and cleanouts, pump stations, and force mains. Typically a public entity (e.g., municipality or county sanitation district) owns and is responsible for maintaining all components of the system except the service laterals, which connect the individual building to the sewer system and are located on private property. Where sewers are installed on private property such as a mobile home park or apartment complex, ownership and maintenance responsibility, including the connection point, is the responsibility of the property owners unless there are subdivision covenants or written agreements and easements which clearly indicate otherwise.

There are twenty-one public sanitary sewer systems in the watershed, as shown in Table 5.3 and based on CIWQS data from November 2013 and sanitary sewer management plans submitted by municipalities.

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Table 5.3
Sanitary Sewer Systems in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Sanitary Sewer System	Population Served	Number of Service Connections	Miles of Force Main	Miles of Gravity Sewer	Miles of Laterals
Upper Russian River	Ukiah	Calpella County Water District	450	100	0.3	2.9	1
		Hopland Public Utility District	1,200	288	0.6	4.4	6
		Ukiah Valley Sanitation District	5,000	4,971	1	43	44
		City of Ukiah	16,500	5,642	0	44	44
Middle Russian River	Geyserville	City of Cloverdale	8,500	3,200	0.1	32.3	21
		City of Healdsburg	11,700	4,600	2.9	53.1	87
		Geyserville Sanitation Zone	809	267	1	4.3	1.3
	Laguna	City of Cotati	7,265	2,300	1	32	26.6
		City of Rohnert Park	40,794	8,427	7.5	77	71.8
		City of Sebastopol	7,750	2,800	2	25	53
		Sonoma State University	10,000	18	0	2.5	1.2
		South Park County Sanitation District	10,400	1,717	0	18.3	25.3
	Santa Rosa	City of Santa Rosa	167,815	48,396	6.3	582	355
	Mark West	Airport/Larkfield/Wikiup Sanitation Zone	9,306	1,937	1	10	9.2
		Town of Windsor	26,950	8,250	1	92	60
Lower Russian River	Guerneville	Forestville Water District	865	438	1.5	6	3.4
		Graton Community Services District	1,815	445	0.3	6.5	4
		Occidental County Sanitation District	636	71	1.5	1	0.3
		Russian River County Sanitation District	7,377	2,467	5	35	11.7
		Totals	343,179	100,040	34	1,151	863

Overflows of wastewater from the sanitary sewer can be caused by grease blockages, root blockages, sewer line flood damage, pump station power or mechanical failures, and surcharged pipe conditions from excessive storm water or groundwater inflow and infiltration (I/I). Releases of wastewater from the sanitary sewer can also occur as a result of poor sewer design, pipe or material failures, construction-related damage, or lack of a preventive maintenance program, which includes sufficient planning for system rehabilitation and replacement. Private building laterals can crack, become disjointed or displaced, and blocked with roots or other debris and result in an overflow. Untreated sewage from sanitary sewer system releases can contain high levels of pathogenic microorganisms and other pollutants.

All federal and state agencies, municipalities, counties, districts and other public entities that own or operate sanitary sewer systems greater than one mile in length that collect and/or convey untreated or partially treated wastewater to a wastewater treatment facilities are required to enroll for coverage under General Waste Discharge Requirements for Sanitary Sewer Systems, Water Quality Order No. 2006-0003-DWQ (General Order). The General Order establishes minimum requirements to prevent sanitary sewer overflows (SSOs). Reporting requirements are included to ensure adequate and timely notifications are made to appropriate local, state, and federal authorities in the event of SSOs from publicly-owned sewer infrastructure. Table 4.6 lists the details for SSOs reported to the CIWQS SSO database since 2007 that equaled or exceeded 1,000 gallons, resulted in a discharge to a drainage channel and/or surface waters, or discharged to a storm drain and were not fully captured and returned to the sanitary sewer system. These data are based on information retrieved from CIWQS in November 2013. Though any SSO is a violation of permit conditions, the reported levels shown in Table 5.4 indicate that SSOs are not a large source of bacterial contamination of the Russian River Watershed.

Private sewer laterals are owned and maintained by the property owner. Private sewer laterals are not regulated under the General Order and, therefore, owners of private laterals are not required by permit to report SSOs that occur as a result of a failure or blockage in the lateral. Because of the sheer number of private laterals connected to a municipal sewer system and the limited jurisdiction that municipalities have over sewer laterals on private property, SSOs from private sewer laterals often go unreported and corrective actions to stop the SSO may be delayed. Most municipalities have established local ordinances that require property owners connected to the municipal system to design and install new laterals in accordance with local standards and maintain existing service laterals and cleanouts in good working order at the owner’s expense. Local ordinances that require property owners to inspect their private service laterals at a property transfer, in response to chronic SSOs, or changes in use are rare in the Russian River Watershed. At least one public sanitation district within the Russian River Watershed offers a program that enables eligible ratepayers to replace leaking or deteriorating service laterals at the expense of the municipality.

Although number of SSOs per mile of sanitary sewer line is relatively low, SSOs are potentially a significant source of pathogenic indicator bacteria in surface waters within the Russian River Watershed.

Table 5.4
Sanitary Sewer Overflows in the Russian River Watershed from 2007 to November 2013

Hydrologic Area Name	Hydrologic Subarea Name	Responsible Agency	Number of SSOs	Volume of SSO (gallons)	Volume that Reached Surface Water (gallons)	% that Reached Surface Water
Upper Russian River	Ukiah	Calpella County Water District	1	1,500	990	66%
		City of Ukiah	9	2,045	1,677	82%
		Ukiah Valley Sanitation District	3	1,750	1,085	62%
Middle Russian River	Geyserville	City of Healdsburg	3	1,887	1,774	94%
	Laguna	City of Rohnert Park	2	305	241	79%
		City of Sebastopol	10	41,991	33,024	79%
	Santa Rosa	City of Santa Rosa	7	24,213	19,855	82%
	Mark West	Airport/Larkfield/Wikiup Sanitation Zone	1	60	50	83%
		Town of Windsor	7	6,612	4,298	65%
Lower Russian River	Guerneville	Forestville Water District	2	155	70	45%
		Graton Community Services District	2	600	198	33%
		Occidental County Sanitation District	2	316	215	68%
		Russian River County Sanitation District	3	1,704	699	41%
		Total SSOs since 2007	52	216,638	196,112	91%

5.3.1.4 SANITARY SEWER EXFILTRATION

Exfiltration is different from SSOs. Sanitary sewer overflows from small diameter pipelines are usually caused by pipe blockages. In larger diameter pipelines, excessive infiltration and inflow (I/I) can lead to surcharged pipe conditions. These conditions can result in direct overflows to receiving water or land or cause sewer backups into residential or commercial buildings. In contrast, exfiltration is generally described as a sewer leaking from its inside to its surrounding outside and occurs primarily at defective joints and cracks in service laterals, local mains and trunk sewer lines. Factors that contribute to exfiltration include: size and length of sewer lines, age of sewer lines, construction materials, and depth of flow in the sewer. Geological and climatic conditions that contribute to exfiltration include groundwater depth, soil type, faults, and rainfall.

Exfiltration from sanitary sewer systems is not explicitly regulated in the North Coast Region. However, compliance with requirements for proper operation and maintenance of public sanitary sewer systems set forth in the Sanitary Sewer Systems General Order may help reduce or eliminate exfiltration over time. The occurrence of exfiltration is thought to be limited to those areas where sewer elevations lie above the groundwater table. Since groundwater elevations near surface waterbodies are typically near the ground surface, sewers near surface waterbodies generally are below the groundwater table and infiltration (rather than exfiltration) might be expected to dominate the mode of sewer leakage in these areas.

Where conditions and other factors are present that could result in exfiltration of untreated wastewater from sanitary sewer system, sanitary sewers systems are potential sources of pathogens, measured as fecal indicator bacteria to surfaces waters in the Russian River Watershed.

5.3.1.5 OTHER NPDES FACILITIES

Fish Hatcheries

There is one fish hatchery within the Russian River Watershed: Warm Springs Dam Fish Hatchery. The facility is owned by the U.S. Army Corps of Engineers and is operated by the California Department of Fish and Wildlife located at the base of Warm Springs Dam in Healdsburg. The facility is regulated under Waste Discharge Requirements Order No. 97-61 (NPDES Permit No. CA0024350).

The facility is designed to raise approximately 161,000 pounds (800,000 fish) per year for release to the Russian River, and it feeds up to 40,000 pounds of feed during the month of maximum feeding. Influent to the facility comes from Warm Springs Dam (Lake Sonoma) and, if necessary, from a series of wells adjacent to Dry Creek. Influent flow is aerated and routed to twenty ponds/raceways, which discharge to a single pollution control pond with a minimum detention time of 2.5 hours. Treated wastewater from the pollution control pond is discharged to Dry Creek, which is tributary to the Russian River, and also is used for landscape irrigation on less than five acres at an adjacent visitor center and day use area.

Waste Discharge Requirements Order No. 97-61 contains effluent limitations and monitoring requirements for effluent flow, suspended solids, settleable solids, and chloride. Fish intestines have been shown to contain *E. coli* bacteria, but the bacteria comes from ingestion of the bacteria from other sources and are not produced within the fish. A study of the role of fish as contributors of *E. coli* bacteria showed that the source of the *E. coli* in fish feces were likely from ingested bacteria from sediments, Canada geese, mallard ducks, and wastewater. Fish simply serve as a transport vehicle for *E. coli* bacteria transmission from other sources (Hansen et al. 2008). The fish themselves are not a direct source of bacteria. Therefore, fish hatcheries are not considered a source of *E. coli* bacteria for this TMDL.

Other Permittees

There are a number of other permittees in the Russian River Watershed that are regulated under NPDES permits for waste discharges to surface waters, but do not receive, treat or discharge domestic wastewater under conditions of the permit (Table 5.5). Domestic wastewater from the Sonoma West Holdings Food Processing Facility is treated in a lined aerated pond, then filtered and disinfected before application to land. Treated discharges are required to meet effluent limitations for total coliform bacteria as a condition of discharge. Discharges permitted under the aquatic herbicide and aquatic pesticide general NPDES permits and for JDS Uniphase, which is covered under an individual NPDES permit, are not expected to contain human or animal waste, and are therefore not probable sources of pathogen indicator bacteria. Utility structures may contain pathogens as measured by fecal indicator bacteria from natural sources or as a result of pass-through from municipal separate storm sewer systems. Even though there is a potential for bacteria to be present in these discharge, these permitted discharges are not expected to be an original source of pathogens that contribute to the pathogen impairment in the watershed.

Table 5.5
Other NPDES Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Permittee Name	Permit No.	Facility Type
Upper Russian River	Coyote Valley	Potter Valley Irrigation District	CAG990005	Aquatic Herbicide
	Ukiah	Mendocino Forest Products Ukiah Sawmill	CA0005843 (terminated)	Sawmill
Middle Russian River	Laguna	Sonoma West Holdings Plant #2 Facility	CA0023655	Food Processing
		JDS Uniphase	CAG911001	Laboratory
Upper, Middle and Lower Russian River	Multiple HSAs	AT&T Statewide Cable System	CAG990002	Utility Structure
		Pacific Bell (AT&T)	CAG990002	Utility Structure
		Pacific Gas & Electric Company	CAG990002	Utility Structure
		Sprint	CAG990002	Utility Structure
		Verizon California	CAG990002	Utility Structure
		Sonoma County Water Agency	CAG990005	Aquatic Herbicide
		Marin/Sonoma Mosquito and Vector Control District	CAG990004	Pesticide/Vector Control
		City of Santa Rosa	CAG990005	Aquatic Herbicide
		Sonoma County Regional Parks	CAG990005	Aquatic Herbicide

5.3.3 STORM WATER

The NPDES Storm Water Program regulates storm water discharges from municipal separate storm sewer systems (MS4s), construction activities, industrial facilities, and state highways. Permitted facilities in the watershed are listed in Table 5.6. Most storm water discharges are considered point sources, and operators of these sources may be required to receive an NPDES permit before they can discharge. In 1987, the U.S. Congress broadened the definition of "point source" to include construction and industrial storm water discharges and municipal separate storm sewer systems (CWA §402(p)). As described below, storm water discharges to the Russian River Watershed are considered an important source of fecal waste in the watershed.

Table 5.6
Permitted Storm Water Facilities in the Russian River Watershed

Program	Number of Enrollees
Municipal Phase I MS4	3
Municipal Phase II MS4	6
Storm Water Construction	83
Storm Water Industrial	169
Caltrans	1
Total	260

5.3.3.1 MUNICIPAL STORM WATER

The 1987 amendments to the Clean Water Act required the U.S. EPA to address storm water runoff in two phases. Phase I of the NPDES Storm Water Program began in 1990 and applied to large (serving 250,000 people or more) and medium (serving between 100,000 and 250,000 people) municipal separate storm sewer systems (MS4) and eleven industrial categories including construction sites disturbing five acres of land or more. Phase II of the NPDES Storm Water Program began in 2003 and applies to small MS4s (serving less than 100,000 people) including non-traditional small MS4s, which are facilities such as military bases, public campuses, prison and hospital complexes and construction sites disturbing from one up to five acres of land. The CWA requires that MS4 permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable (MEP), including management practices, control techniques and systems, design engineering methods and such other provisions as the [U.S. EPA] Administrator or the state determines appropriate for the control of such pollutants."

The current Phase I MS4 Permit, Order No. R1-2009-0050 (NPDES Permit No. CA0025054), names the City of Santa Rosa, County of Sonoma, and the Sonoma County Water Agency as permittees. However, a number of communities within the Russian River Watershed that are enrolled under the Phase II Small MS4 Permit (Order No. 2013-0001- DWQ effective July 1, 2013) are meeting their Phase II MS4 requirements by voluntarily complying with the Phase I MS4 Permit. These communities are the City of Cotati, the City of Rohnert Park, the Town of Windsor, the City of Sebastopol, the City of Ukiah, the City of Healdsburg, and the unincorporated communities of Guerneville, Monte Rio, Forestville, Graton, and Occidental.

Under terms of the Phase I MS4 Permit, permittees are required to possess the legal authority to prohibit discharges of non-storm water to the MS4 from dumping and disposal of materials such as litter, household refuse, and other materials that have the potential to impact water quality, including sources of pathogenic bacteria. Permittees are also required to implement, in coordination with other public entities, as appropriate, a Public Information and Participation Program (PIPP) that includes education materials to inform the public on the proper disposal and storage of animal wastes.

Pathogens in Urban Storm water Systems was prepared by Urban Water Resources Research Council (UWRRC 2014). The report describes potential sources of pathogen indicator bacteria in urbanized areas (areas within MS4 boundaries) to include SSOs, illicit discharges to storm sewer systems (e.g., power washing), failing OWTS, wastewater treatment plants, urban wildlife, domestic pets, and agriculture. Further, the report found fecal indicator bacteria concentrations in wet weather discharges from urban MS4s orders of magnitude above primary contact recreation standards. Storm water samples are also collected as a requirement of the MS4 permit for the City of Santa Rosa, County of Sonoma, and Sonoma County Water Agency. Single storm water samples were collected from Santa Rosa Creek upstream and downstream of the urban area. These single samples cannot be directly assessed with the Basin Plan water quality objective for fecal coliform bacteria which requires 5 samples collected in a 30-day period. However, the fecal coliform concentrations measured in Santa Rosa Creek during storm events range from 170 – 5,000,000 MPN/100mL. These very high concentrations supplement other evidence that Santa Rosa Creek is impaired due to high bacterial loads, especially during wet weather.

Additionally, the wet weather measurements of *E. coli* and enterococci bacteria concentrations draining from developed and sewered areas described in Section 4.2 were much higher than the U.S. EPA (2012) criteria. *E. coli* bacteria concentration measurements showed a geometric mean of 5,372 MPN/100mL, as compared to the numeric target of 100 MPN/100mL. Enterococci bacteria concentrations measurements showed a geometric mean of 6,860 MPN/100mL, as compared to the numeric target of 30 MPN/100mL. These results confirm that municipal storm water is an existing source of bacteria.

5.3.3.2 INDUSTRIAL STORM WATER

The most common pollutants of concern in industrial storm water are suspended solids, oxygen-demanding substances (BOD), nutrients, and heavy metals. Most industrial categories are related to heavy industry and certain light industrial facilities and are unlikely to discharge a significant level of bacteria or other pathogens found in human domestic waste. However, some facilities that require coverage under a storm water permit, such as concentrated animal feeding operations, solid waste transfer stations, sewage treatment plants, and composting operations, are potential sources of pathogenic bacteria and other public health-related pollutants.

Storm water discharges associated with industrial activities, unless otherwise excluded, are regulated under NPDES Industrial General Permit (Order 2014-0057-DWQ, NPDES No. CAS000001). Beginning on July 1, 2015, storm water discharges associated with industrial activities, unless otherwise excluded, will be regulated under the NPDES Industrial General Permit (Order 2014-0057-DWQ). Industrial facilities obtain permit coverage based on whether or not their Standard Industrial Classification (SIC) code is included in those specific categories. The Industrial General Permit requires the implementation of Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or prevent pollutants in storm water discharges and authorized non-storm water discharges. .

Compliance with requirements in the General Permit will ensure that storm water discharges from industrial sites are not a significant source of pathogenic bacteria.

5.3.3.3 CONSTRUCTION STORM WATER

Construction activities that result in a land disturbance equal to or greater than one acre are required to have coverage under the Construction General Permit (Order 2009-0009-DWQ, as amended by Order 2010-0014-DWQ and Order 2012-006-DWQ). The objective of the Construction General Permit is to prevent or minimize the discharge of construction-related pollutants from sites during and after construction.

The primary potential sources of pathogens at construction sites are temporary sanitary facilities on sites that are poorly designed or maintained and thus are a potential source of pathogenic bacteria. Operators of construction sites where there are no permanent sanitary facilities or where permanent facilities are too far from the construction site will provide sanitary facilities for construction personnel in one or more locations throughout the site. A well-designed and maintained site will include BMPs for portable sanitary facilities that include setbacks from waterbodies, storm drains, and gutters, location of toilets on surface areas that will absorb spills instead of transporting contamination to surface waters, and provisions to prevent vandalism and toppling of the enclosures due to exposure to high winds. Recommended maintenance activities include establishment of an appropriate cleaning and maintenance schedule, and inspection schedules to detect damage, leaks, and spills, and disposal for rinse water from cleaning activities into a sanitary sewer system.

Compliance with requirements in the Construction General Permit will ensure that storm water discharges from construction sites are not a significant source of pathogenic bacteria.

5.3.3.4 CALTRANS STORM WATER

The California Department of Transportation (Caltrans) is responsible for the design, construction, management, and maintenance of the state highway system, including freeways, bridges, tunnels, and associated properties. Major state highways in the Russian River Watershed include Highways 101, 116, 128, and 12.

Caltrans is subject to the storm water permitting requirements of Clean Water Act section 402(p). Caltrans is currently operating under a statewide storm water permit (Order 2012-011-DWQ) that regulates all storm water and non-storm water discharges from Caltrans MS4s and maintenance facilities. Caltrans' Storm Water Management Plan, which is updated annually, describes the procedures and practices used to reduce or eliminate the discharge of pollutants to storm drainage systems and receiving waters. Construction activities associated with Caltrans projects are covered by Order 2009-0009-DWQ, as amended.

The State Water Board adopted Order 2014-0077-DWQ as an amendment to the Caltrans permit to add requirements related to completed TMDLs. Under the statewide permit and TMDL amendment, Caltrans is required to prioritize reaches across the state and then to implement best management practices and control measures to achieve 1,650 Compliance Units each year in the highest priority reaches. One Compliance Unit is equal to one acre of Caltrans right-of-way from which runoff is retained, treated, or otherwise controlled prior to discharge to the relevant reach. Caltrans is encouraged to establish cooperative implementation agreements with other parties that have responsibility to attain a TMDL.

Also under the statewide storm water permit, Caltrans is required to prepare a TMDL Status Review Report to be submitted with each Annual Report. The TMDL Status Review Report includes (1) a summary of the effectiveness of the control measures installed for each reach that has been addressed, as a result of BMP effectiveness assessment, (2) a determination as to whether the control measures have been or will be sufficient to achieve WLAs and other performance standards by the final compliance deadlines, (3) where the control measures are determined not to be sufficient to achieve WLAs or other performance standards by the final compliance deadlines, a proposal for improved control measures to address the relevant pollutants, and (4) a summary of the estimated amount of pollutants that were prevented from entering into the receiving waters. The TMDL Status Review Report is subject to public review and comment.

Homeless encampments within the Caltrans right-of-way are a source of both trash and pollutants in waterways. As described in a 2013 study for the Contra Costa County Flood Control and Water Conservation District, larger, well-established encampments usually have a designated "toilet area," but it is likely that occupants also use the water to dispose of waste (DeVuono-Powell 2013). Where the disposal of urine and human fecal waste in water occurs, there is a high potential that this is a source of pathogenic indicator bacteria. In areas within Caltrans rights-of-way that do not contain bacteria-generating sources such as homeless encampments, restroom facilities, garbage binds, etc., Caltrans finds that the contribution of pathogen indicator bacteria to waterbodies is not believed to be a significant source of pathogens that present a human health risk (Caltrans 2012).

5.4 NONPOINT SOURCES

The term "nonpoint source" is defined as any source of water pollution that is not from a discernible, confined, and discrete conveyance. Per definitions in the Clean Water Act, agricultural discharges are also considered nonpoint sources even when conveyed through a pipe. Nonpoint source pollution comes from many diffuse sources and is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into streams and other waters.

This section primarily focuses on controllable nonpoint sources in developed areas and agricultural areas, since the runoff from these areas show the highest concentrations of pathogenic indicator bacteria.

5.4.1 ONSITE WASTEWATER TREATMENT SYSTEMS

About one-fourth of all American households rely on onsite wastewater treatment systems (OWTS) to dispose of their wastewater, which translates to about 20 million individual systems nationwide (Wilhelm et al. 1994). Table 5.7 presents estimates of the houses and population that are connected to sanitary sewers in the Russian River Watershed. The estimates show that about 31% of the houses in the watershed are not connected to a sanitary sewer and are assumed to use OWTS for treatment of domestic waste. The estimates were made from the 2010 U.S. Census.

Table 5.7
Estimates of Houses, Population & Acres of Sewered and Non-Sewered Areas in the Russian River Watershed

Areas	Houses		Population		Acres	
	Count	Percent	Count	Percent	Count	Percent
Sewered	113,631	69%	288,225	72%	83,644	9%
Non-sewered	51,537	31%	111,147	28%	866,608	91%
Total within Russian River Watershed	165,168	100%	399,372	100%	950,252	100%

Conventional OWTS operate simply: after solids are trapped in a septic tank, typically a 1,000 to 1,500-gallon concrete or fiberglass tank, wastewater is distributed to a subsurface drain field and allowed to percolate through the soil. Bacteria in the wastewater are effectively removed by filtering and straining water through the soil profile. Viruses are not effectively filtered in soil because of their small size. Instead viruses are removed through adsorption to soil particles and by inactivation in the soil.

Effective pathogen removal in OWTS is dependent on proper siting and installation of the OWTS components, proper maintenance, and operation of the system within design specifications. OWTS can fail when wastewater rises to the ground surface, is intercepted by high groundwater, or passes through the soil profile without adequate treatment.

Regional Water Board staff conducted a focused study on the potential influence of OWTS on the discharges of pathogens, as measured by fecal indicator bacteria concentrations in receiving surface waters. The sampling methods, results, and an analysis of the data are presented in the “Onsite Wastewater Treatment System Impact Study Report” (NCRWQCB

2013a). The study compared water samples collected downstream of small watersheds that drain areas with densely situated OWTS and watersheds that drain areas with a relatively low density of OWTS. Results show that a higher parcel density in areas with only OWTS is directly associated with higher concentrations of both *Bacteroides* and *E. coli* bacteria, confirming that OWTS contribute to the potential for pathogens, as measured by fecal indicator bacteria in surface waters of the Russian River Watershed. Figure 5.15 shows the distribution of these concentrations by parcel densities. High parcel densities range from 0.8 to 4 parcels per acre (0.2 to 1.3 acres/parcel). Low parcel densities ranged <0.1 parcels per acre (9 to 100 acres/parcel).

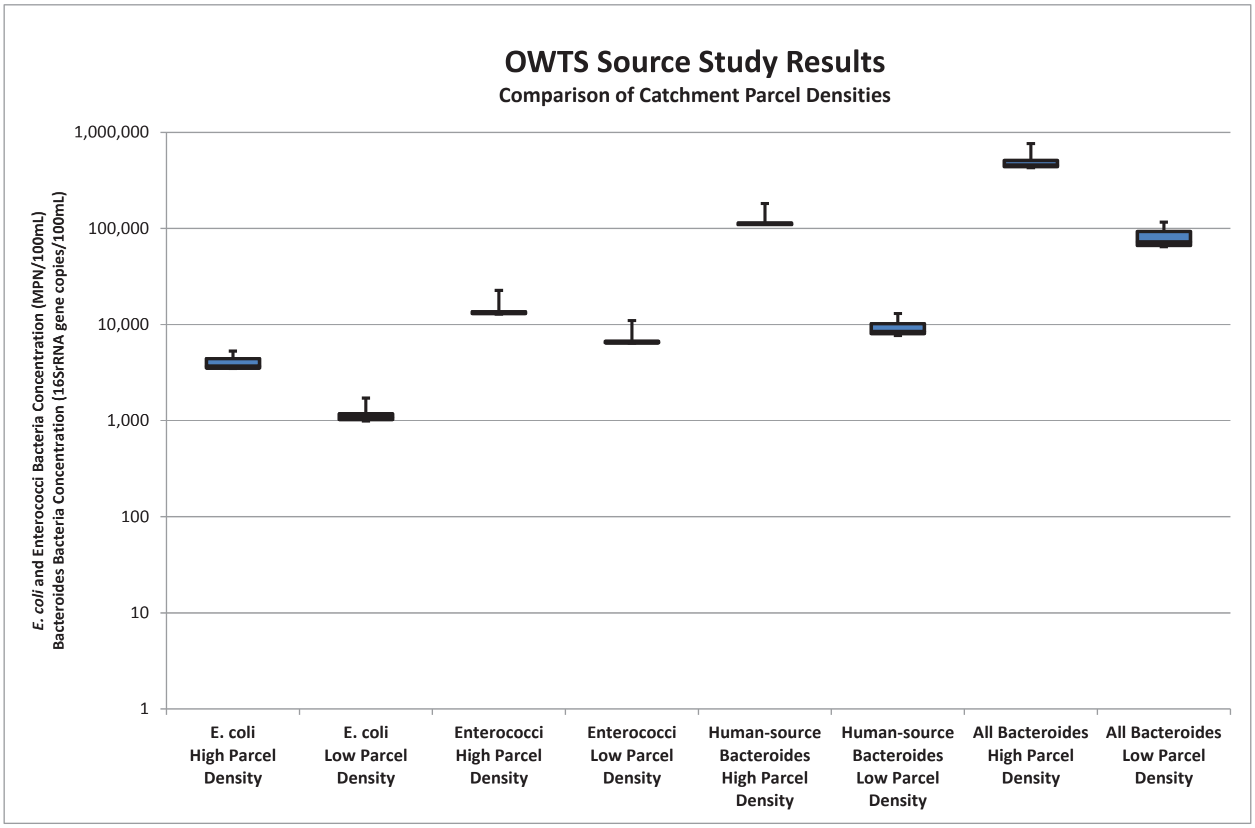

Figure 5.14. Comparison of the distribution of *E. coli,* Enterococci and *Bacteroides* bacteria concentrations by parcel densities.
Source: North Coast Regional Water Quality Control Board*.* *Bacteroides* bacteria were analyzed with the AllBac and HuBac genetic marker following U.S. EPA (2010) Method B.

5.4.2 RECREATION AT PUBLIC BEACHES

There are many public swimming beaches along the mainstem Russian River. Several of the most popular beaches are shown in Table 5.8 and Figure 5.16. Swimming and other water contact recreation in the river can be a source of bacteria and other pathogens through direct human urination or defecation in the water or along the shore. Pathogens may also be washed off the body during immersion.

Regional Water Board staff conducted a focused study on the potential influence of intensive recreation on pathogenic indicator bacteria concentrations at public beaches

(NCRWQCB 2013b; Appendix B). Water samples were collected for analysis of *E. coli*, enterococci, and human-source *Bacteroides* bacteria at Veterans Memorial Beach and Monte Rio Beach during the week of the Independence Day holiday in 2013.

Table 5.8
Popular Swimming Beaches along the Russian River

Hydrologic Area Name	Hydrologic Subarea Name	Recreational Beach Name	Location
Upper Russian River	Coyote Valley	Mill Creek Park	Potter Valley
	Forsythe Creek	Mariposa Swimming Hole	Redwood Valley
	Ukiah	Vichy Springs Park	Ukiah
		Mill Creek Park	Ukiah
Middle Russian River	Geyserville	Cloverdale River Park	Cloverdale
		Alexander Valley Campground	Healdsburg
Lower Russian River	Guerneville	Veteran Memorial Beach	Healdsburg
		Riverfront Park	Windsor
		Mirabel Park Campground	Forestville
		Steelhead Beach	Forestville
		River Access Beach	Forestville
		Sunset Beach	Forestville
		Johnson's Beach	Guerneville
		Monte Rio Beach	Monte Rio
		Casini Ranch Campground	Duncans Mills

Figure 5.15: Popular Swimming Beaches along the Russian River

Water samples were collected during the afternoon when human recreational use was the highest. Sonoma County Park staff counted recreators on the beach and in the water at Veterans Memorial Beach each day at 14:00 hours (Figure 5.17). Recreator counts were not available for Monte Rio Beach. Figures 5.18 through 5.20 show photographs of both beaches on Independence Day. Figures 5.21 and 5.22 show that *E. coli* concentrations measured at those beaches were elevated above the *E. coli* bacteria targets on Independence Day and generally below the targets measured on other days during the study.

Relationships between these variables were investigated using the Spearman's rank correlation coefficient (ρ) (Helsel and Hirsch 2002). Spearman's rank correlation coefficient is a nonparametric statistical measure of the dependence between two variables. Spearman correlation coefficients approach either plus one ($\rho\sim+1.0$) or minus one ($\rho\sim-1.0$), as the relationship become stronger. A small correlation coefficient (between -0.5 and 0.5) indicates a weak relationship between the variables.

The study found that the percentage of human-specific *Bacteroides* showed a relatively strong positive correlation (Spearman Correlation Coefficient = 0.72) with swimming recreation, with the higher percentages of human-specific *Bacteroides* observed on days with a larger number of people swimming (Figure 5.23). Moderately positive correlations were found for *E. coli* bacteria concentrations (Spearman Correlation Coefficient = 0.55) and enterococci bacteria concentrations (Spearman Correlation Coefficient = 0.51) with swimming recreation (Figures 5.24 and 5.25). The results indicate that intensive human contact recreation at public beaches on the most popular hot summer days contributes to *E. coli,* enterococci and *Bacteroides* bacteria concentrations in surface waters. The less intensive recreation that is more common during summer weekdays and throughout the non-summer season results in lower *E. coli,* enterococci and *Bacteroides* indicator bacteria concentrations.

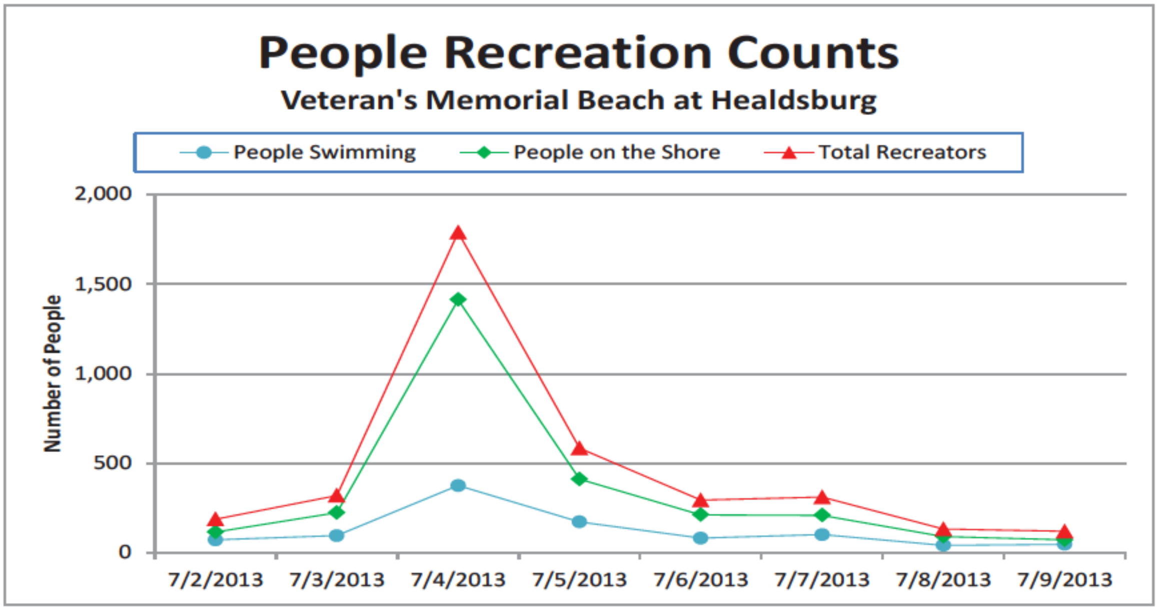

Figure 5.16: Counts of People Recreating at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

Figure 5.17: Veteran Memorial Beach on Thursday, July 4, 2013 at 12:30
Source: North Coast Regional Water Quality Control Board.

Figure 5.18: East Monte Rio Beach on Thursday, July 4, 2013 at 14:00
Source: North Coast Regional Water Quality Control Board.

Figure 5.19: West Monte Rio Beach on Thursday, July 4, 2013 at 14:00
Source: North Coast Regional Water Quality Control Board.

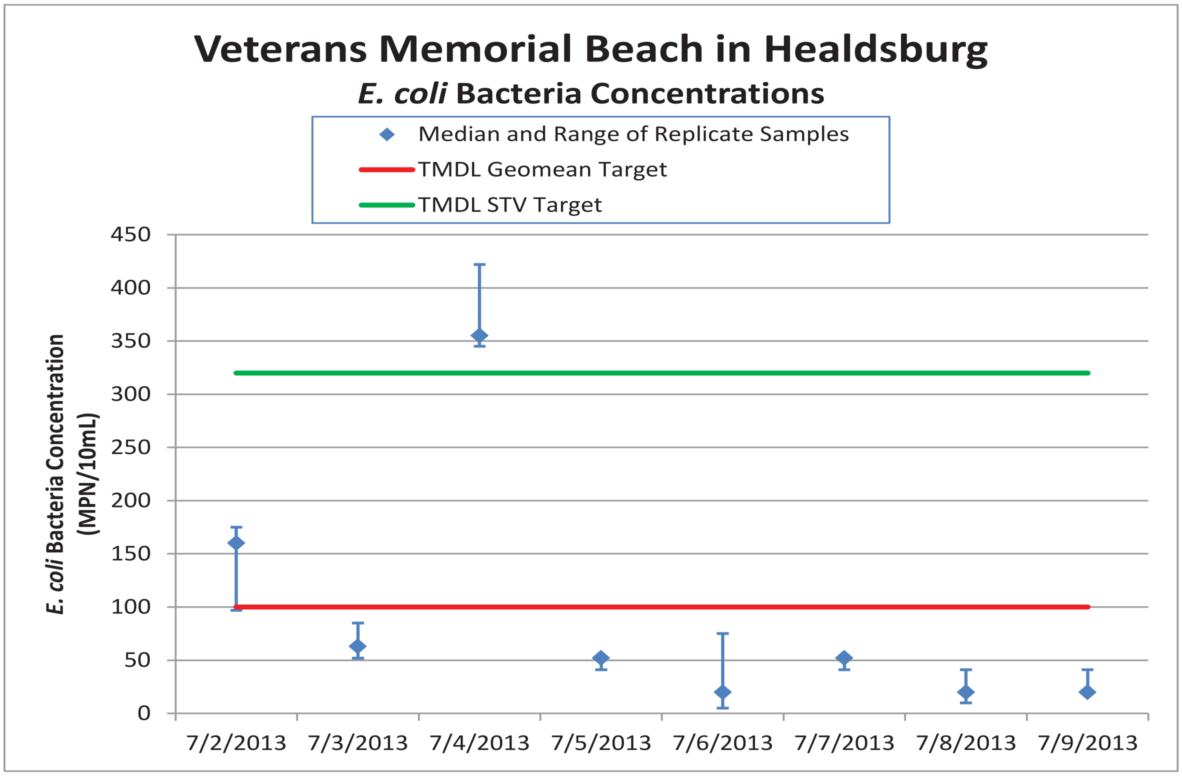

Figure 5.20: ***E. coli*** **Bacteria Concentrations Measured at Veteran Memorial Beach in Healdsburg**
Source: North Coast Regional Water Quality Control Board.

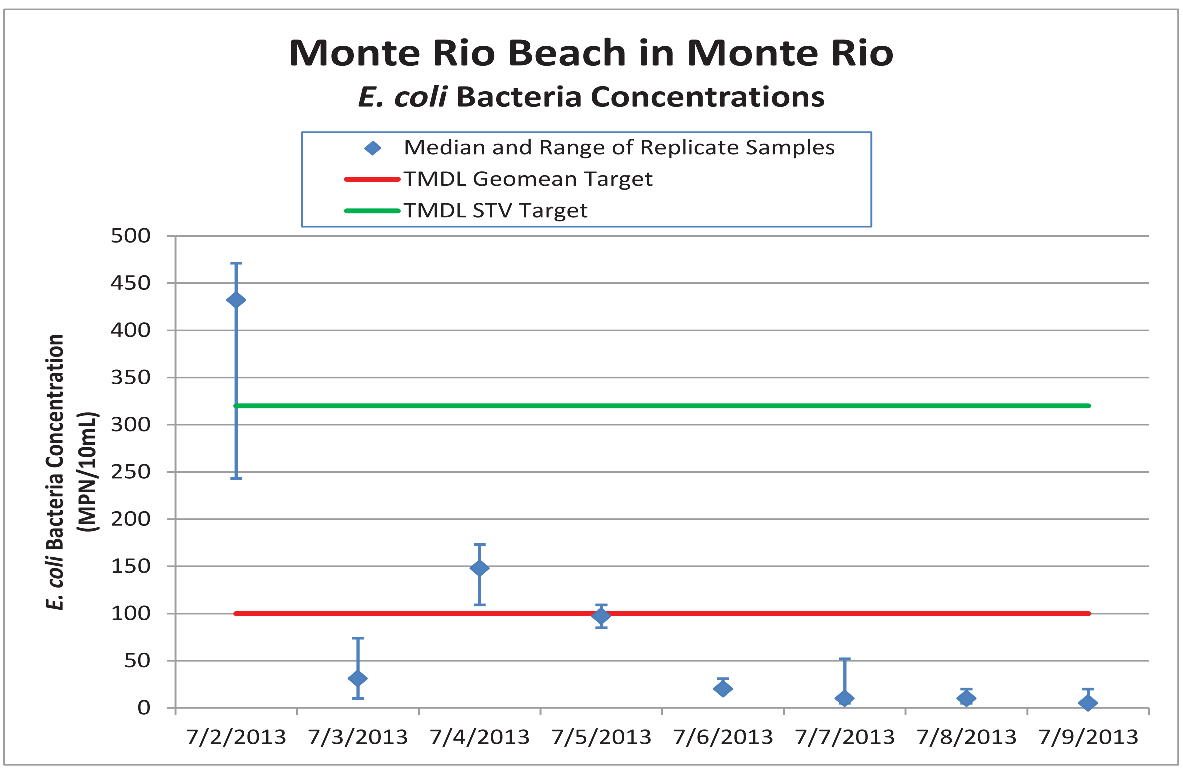

Figure 5.21: ***E. coli*** **Bacteria Concentrations Measured at Monte Rio Beach in Monte Rio**
Source: North Coast Regional Water Quality Control Board.

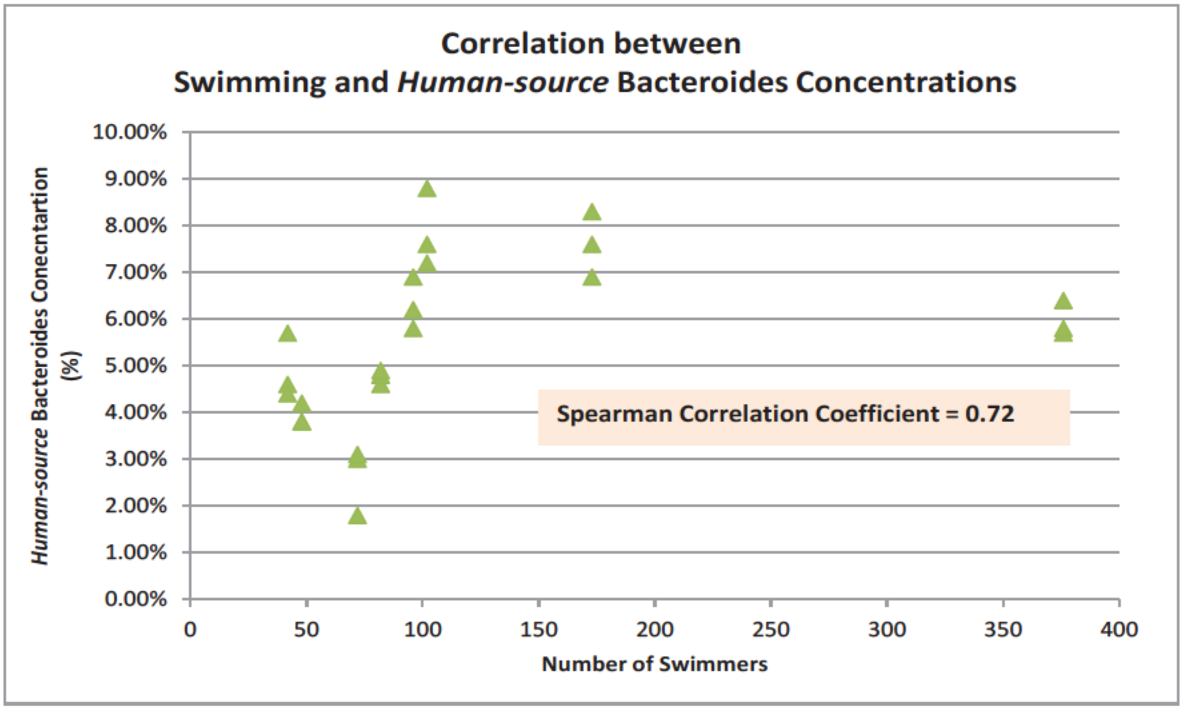

Figure 5.22. Correlation between Number of Swimmers and the Percentage of Human-source *Bacteroides* Bacteria Concentrations at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

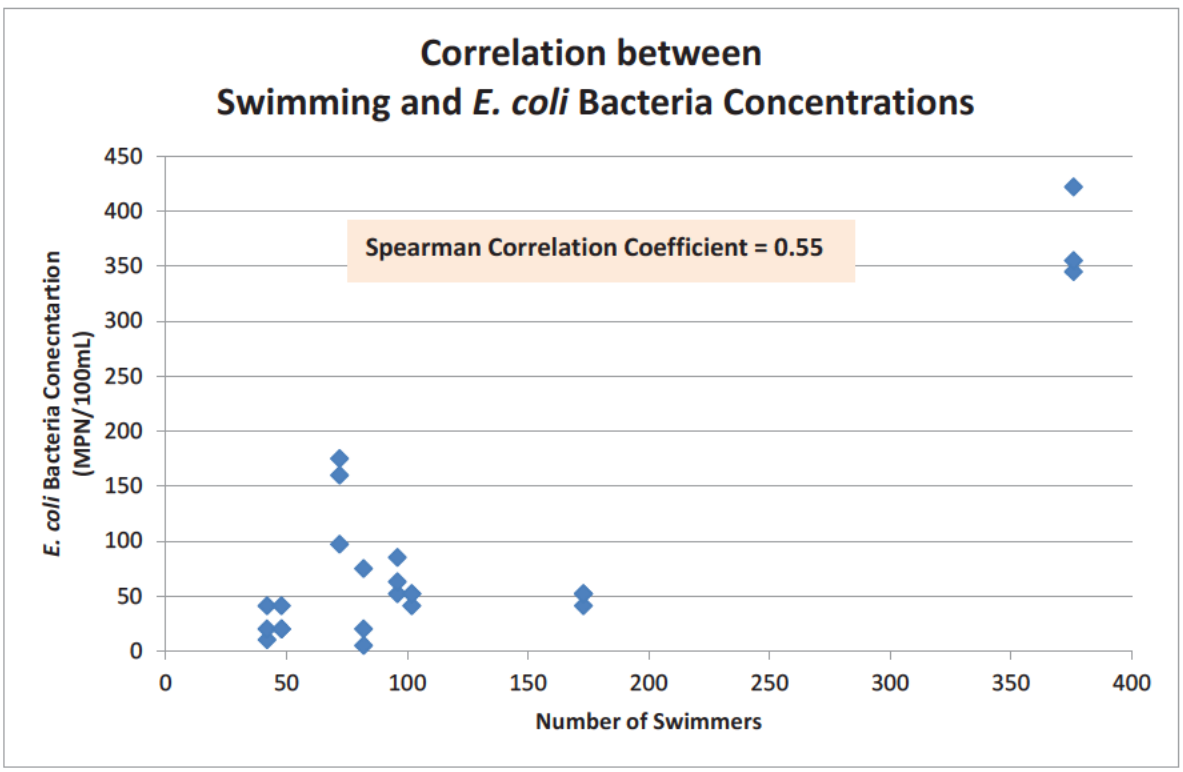

Figure 5.23: Correlation between Number of Swimmers and *E. coli* Bacteria Concentrations at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

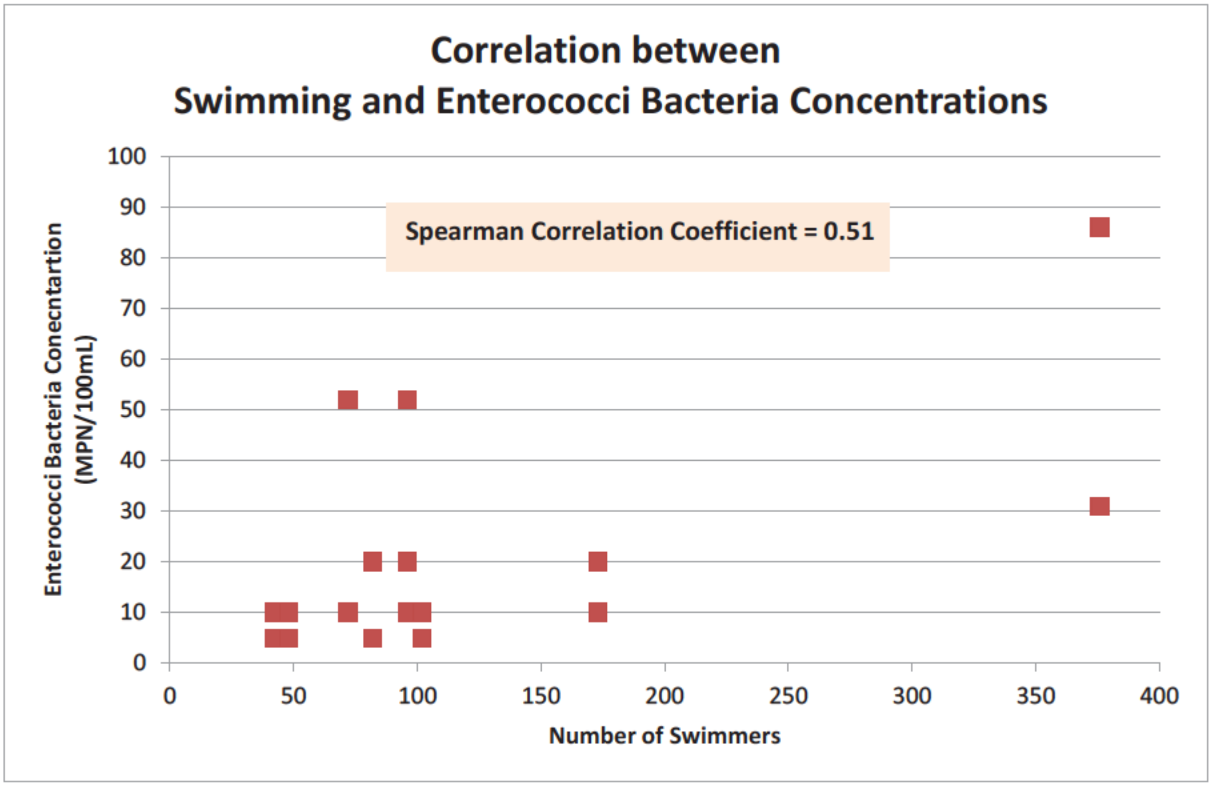

Figure 5.24: Correlation between Number of Swimmers and *E. coli* Bacteria Concentrations at Veterans Memorial Beach in Healdsburg.
Source: North Coast Regional Water Quality Control Board.

5.4.3 HOMELESS ENCAMPMENTS

Homeless encampments are potential sources of bacteria. Many riparian areas within the Russian River Watershed attract homeless people and these areas most often do not have sanitary disposal facilities. The discharge of untreated human waste directly to surface waters within these riparian corridors from homeless encampments could be one of the causes of the presence of human-source indicator bacteria found in undeveloped areas.

The Russian River Watershed covers large areas of Mendocino and Sonoma counties. Applied Survey Research (2005) estimates that 5,335 people were homeless in Mendocino County in 2005 and 78% of those were unsheltered. This represents 6% of the overall population of 90,816 people in Mendocino County. Applied Survey Research also estimates that 9,749 people were homeless in Sonoma County in 2005 and 77% of those were unsheltered. This represents 2% of the overall population of 484,102 people in Sonoma County.

Information about farmworkers, both permanent and itinerant, in the Russian River Watershed is similarly difficult to obtain. Based on estimates for Napa County (BAE 2013), which has a similar agricultural profile to Sonoma County, it can be similarly estimated that agriculture employers in Sonoma County hire as many as 7,000 workers during peak farm employment periods, which correspond to the May-June growing season and the August-October harvest period. While many of these seasonal workers obtain permanent or semi-permanent lodging in private accommodations or in County-subsidized housing, many other farmworkers seek temporary lodging in encampments where adequate restroom facilities are not available. Where itinerant farmworker encampments are located near water courses, there is an increased opportunity for human waste contamination.

5.4.4 RECYCLED WATER DISCHARGES FROM LANDSCAPE IRRIGATION

Although advanced wastewater treatment systems in the Russian River Watershed are operated to produce recycled water that is essentially pathogen-free and suitable for water recycling, this same recycled water, when stored in open-air holding ponds, may become contaminated as a result of regrowth of bacteria or through contribution of fecal waste from wildlife, particularly birds that frequent the storage ponds.

Most major municipalities in the watershed are either actively participating in water recycling programs or are contemplating becoming involved. The largest water recycling program in the region, the Santa Rosa Subregional Water Reclamation System, accepts and treats municipal wastewater from the communities of Santa Rosa, Cotati, Rohnert Park, and Sebastopol for use as recycled water for urban and agricultural irrigation on over 6,400 acres of land. Other communities, such as the Town of Windsor, Guerneville, and the Airport-Larkfield-Wikiup communities also use recycled water for local irrigation projects. Currently, there is no recycled water used for landscape irrigation in Mendocino County. Recycled water producers are regulated under General Waste Discharge Requirements (Order 2014-0090-DWQ) or individual waste discharge requirements.

The Santa Rosa Non-Storm Water Discharge Best Management Practices (BMP) Plan was required by NPDES MS4 Permit Order No. R1-2009-0050 and sets forth approved protective measures that are required of all applicable recycled water uses in order to minimize or prevent the effects of non-storm water discharges (City of Santa Rosa 2013). The BMP Plan describes runoff control measures to be implemented for both landscape irrigation in urban settings and agricultural irrigation in rural settings. By controlling runoff from recycled water use areas, these BMPs will also help reduce human-source bacteria entering receiving waters. The non-storm water BMP Plans for Sonoma County Water Agency and Sonoma County are in development or are being reviewed by Regional Water Board staff.

Although local recycled water programs are well-managed, unintentional spills of recycled water occur periodically. Large volume spills are rare, but when they occur are typically the result of broken recycled water lines in rural properties, but can occur as a result of operator error or inattention. Large volume spills of recycled water have the potential to adversely impact water quality, but are a low risk to contribute pathogenic indicator bacteria because the recycled water has been disinfected to meet tertiary treatment standards prior to entering the recycled water distribution system. Small volume spills occur more frequently, though not common, as a result of unintentional overspray, mechanical breaks, vandalism, or other unforeseen conditions. The contribution of pathogen indicator bacteria from small volume spills and other incidental runoff events is de minimus and not expected to be a source of pathogens in amounts that contribute to the pathogen impairment in the watershed.

5.4.5 PET WASTE

Domesticated pets can be a major source of pathogenic indicator bacteria, especially dogs and cats. Domesticated dogs can be a significant source of fecal waste based on their population density, high defecation rate, and pathogen infection rates (Schueler 2000). A single gram of dog feces contains 23 million fecal coliform bacteria (van der Wel 1995). Dogs have been found to be significant hosts for *Giardia, Salmonella*, and *Pseudomonas* bacteria (Pitt 1998). Lim and Oliveri (1982) concluded that dog feces were the single greatest source contributing fecal coliform and fecal streptococcus bacteria in urbanized Baltimore catchments. Trial et al. (1993) reported that cats and dogs were the primary source of fecal coliform bacteria in urban catchments in the Seattle area.

Improper pet waste disposal has the potential to deliver pathogens to surface waters through storm water discharges. Since storm drains do not normally connect to treatment facilities, untreated animal feces often end up in surface waters.

Most pet waste management programs focus on increasing public awareness. Many communities implement pet waste management programs by posting signs in parks or other pet-frequented areas, by mass mailings, and by broadcasting public service announcements. Sign posting is one of the most common outreach strategies. Signs can designate areas where dog walking is prohibited, where waste must be recovered, or where dogs can roam freely. A "pooper-scooper" ordinance is an effective solution. Many communities have pooper-scooper laws that mandate pet waste cleanup. Because pet waste management is focused toward individual pet owners, the program is dependent on the participation and cooperation of all pet owners, and pet waste management programs must be enforced. With an increase in public knowledge of storm water regulations, proper disposal of pet wastes can lead to a significant reduction of bacteria discharged in storm water.

The monitoring and source assessment completed for the Russian River Watershed did not explicitly evaluate the contribution of pet waste to bacteria concentrations in surface waters. However, given the human population density in the watershed, it is assumed that pet waste is a source of indicator bacteria in the watershed.

5.4.6 LIVESTOCK WASTE

A large number of bacterial pathogens found in manure from livestock have the potential to cause illness in humans. These organisms include, but are not limited to, *Salmonella, Campylobacter, E. coli, Leptospira,* and *Clostridium* bacteria (U.S. EPA 2009). Human-infectious pathogens relevant to livestock sources in the Russian River Watershed also include *Giardia* (cattle), *Campylobacter jejuni* (chickens), and hepatitis E serogroup C (hogs). Several viruses found in livestock waste have the potential to cross from animals to humans, and thus have the potential to cause disease in humans (Mattison et al. 2007; McAllister and Topp 2012). Pathogens can be discharged directly to watercourses when livestock have access to streams. They can also be carried to surface waters in storm water runoff or in runoff resulting from over-application of liquefied manure to pasture land. The estimated number of different types of animals in Sonoma and Mendocino counties is shown in Table 5.9. The Russian River Watershed covers large areas of both counties. Data presented in this table were obtained from several sources, as described below. Discussion of categories of livestock animals as potential sources of fecal waste to the Russian River Watershed is provided in greater detail in the following sections.

Table 5.9
Inventory of Livestock Animals in Mendocino and Sonoma Counties

Animal Type	Mendocino County		Sonoma County	
	Number of Animals	Citation	Number of Animals	Citation
Laying Hens and Pullets	8,973	USDA (2007)	5,764,700	Linegar (2013)
Cows	18,800	Morse (2012)	68,762	Linegar (2013)
Horses	2,509	USDA (2007)	17,794	Benito (2005)
Sheep and lambs	9,200	Morse (2012)	22,543	Linegar (2013)
Goats	1,454	USDA (2007)	2,146	Linegar (2013)
Hogs	1,450	Morse (2012)	1,029	Linegar (2013)

5.4.7 DAIRIES, MANURE HOLDING PONDS, & LANDSCAPE APPLICATIONS OF MANURE

Any release of manure to surface waters from holding ponds and landscape application from confined animal facilities has a significant potential to impact bacterial water quality due to the large amount of stored and land-applied manure and the high concentration of bacteria in raw manure (up to 100 million fecal coliform per gram). Most commercial dairies in the Russian River Watershed store manure in large lagoons that can hold millions of gallons of liquid manure. Waste lagoons can break, spill, leak, or fail. Lagoon linings can crack and allow liquefied manure to seep into surface waters or shallow groundwater. Pipes and hoses connecting to lagoons or spray fields may fail or leak (Marks 2001). In addition, many dairies spread or spray liquefied manure on pasture land. When liquid waste is over-applied or inappropriately applied to farm fields through irrigation, runoff of manure to surface waters can result.

The Regional Water Board implements the Water Quality Compliance Program for Cow Dairies and Concentrated Animal Feeding Operations (CAFOs). Initiated in 2012, this program includes a NPDES permit for CAFOs that discharge directly to surface waters, a General WDR permit for dairies that do not meet minimum standards for the protection of surface water and groundwater, and a Conditional Waiver for dairies that meet minimum standards in Title 27 of the California Code of Regulations for confined animal facilities. These regulatory tools require management of process water, manure, and other organic materials at dairy operations including holding ponds and the application of such materials to cropland.

In accordance with Title 27, the dairy permits require retention ponds and manured areas at confined animal facilities in operation on or after November 27, 1984, to be protected from inundation or washout by overflow from any stream channel during 20-year peak stream flows. Retention ponds are required to be lined with, or underlain by, soils which contain at least 10 percent clay and not more than 10 percent gravel or artificial materials of equivalent impermeability. Manure ponds constructed after January 19, 2012, must include a pond liner that does not exceed a unit seepage rate of $1X\ 10^{-6}$ centimeters per second. While these permit requirements protect against manure discharges from holding ponds, discharges can occur when streams exceed the 20-year peak stream flow rate. The dairy permits specify that waste storage facilities constructed after January 19, 2012 shall be located outside of 100-year floodplains, unless site restrictions require location within a floodplain, in which case, the waste storage facility shall be protected from inundation or damage from a 100-year flood event. The dairy permits also authorize the application of manure and process waters to land only if such application is at rates that are reasonable for the crop, soil, climate, special local situations management systems, and type of manure.

As described in Section 5.2, wet weather measurements of *E. coli* and enterococci bacteria concentrations of draining from agricultural areas were much higher than the U.S. EPA (2012) criteria. *E. coli* bacteria concentrations measurements showed a geometric mean of 880 MPN/100mL, as compared to the numeric target of 100 MPN/100mL. Enterococci bacteria concentrations measurements showed a geometric mean of 1,556 MPN/100mL, as compared to the numeric target of 30 MPN/100mL. These results confirm that runoff from agricultural areas is an existing source of bacteria. Additionally, the results for grazer fecal waste are mapped in Figure 5.2. The ten locations with the highest grazer fecal waste measured are shown in Table 5.1. The majority of the sites with highest percent matches are in the Laguna de Santa Rosa Watershed.

Figure 5.26 shows the results of the Bovine-source *Bacteroides* bacteria concentration measurements and the locations of dairies in the Middle Russian River Hydrologic Area. Visual comparison show that higher concentrations of Bovine-source *Bacteroides* bacteria are near or downstream of the dairies. Figure 5.27 shows the results of the grazer fecal waste gene sequence measurements and the locations of dairies in the Middle Russian River Hydrologic Area. Visual comparison shows that higher levels of grazer fecal waste gene sequence measurements are near or downstream of the dairies. This source analysis approach does not distinguish between the various types of grazers, and in particular between cattle and dairy cows. However, based on an assessment of the data and the known distribution of cattle versus dairy operations, general assumptions regarding the relative contribution from cattle versus dairy cows are appropriate.

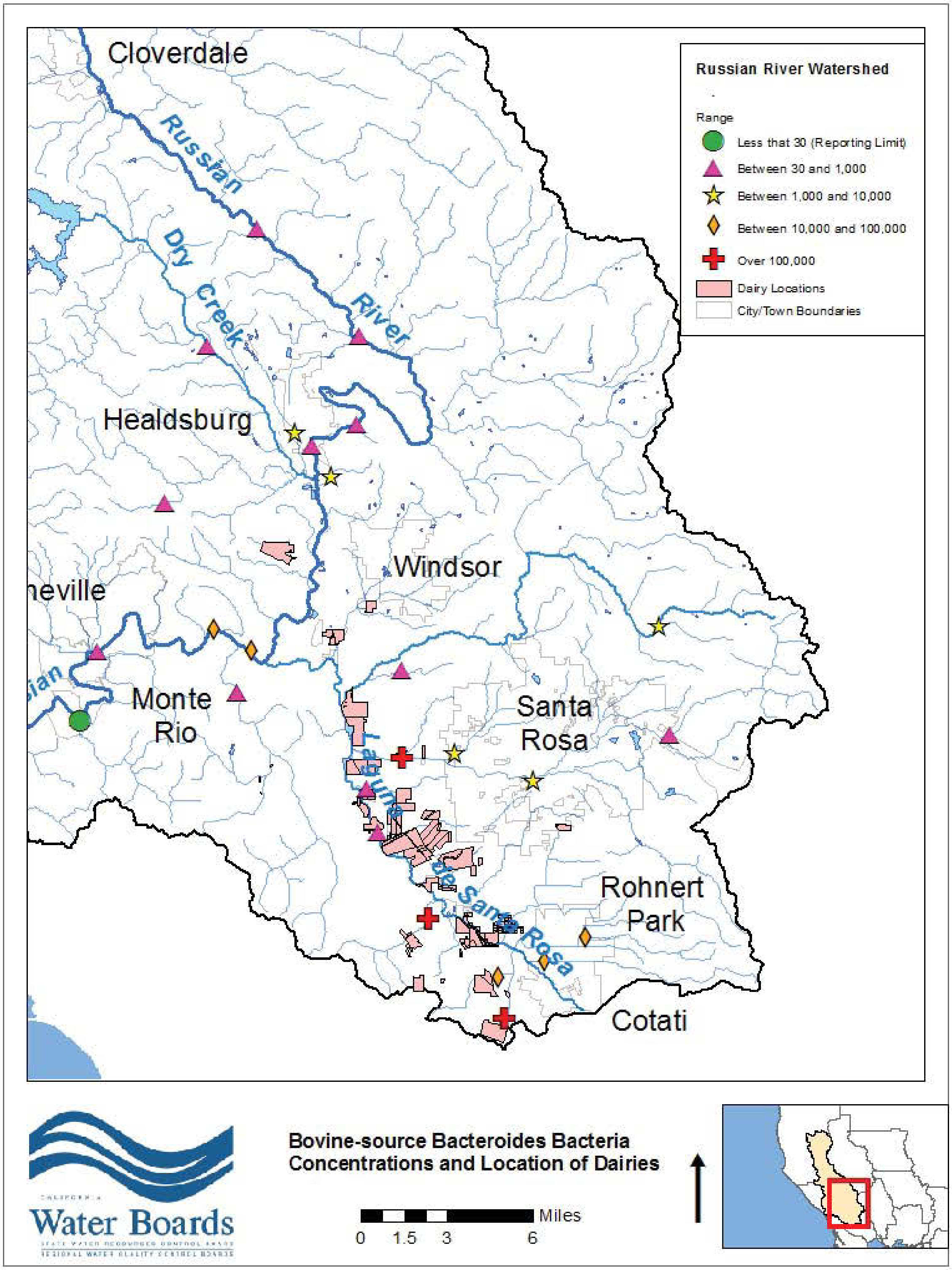

Figure 5.25: Locations of the Bovine-source *Bacteroides* Results and Dairies in the Middle Russian River Watershed.

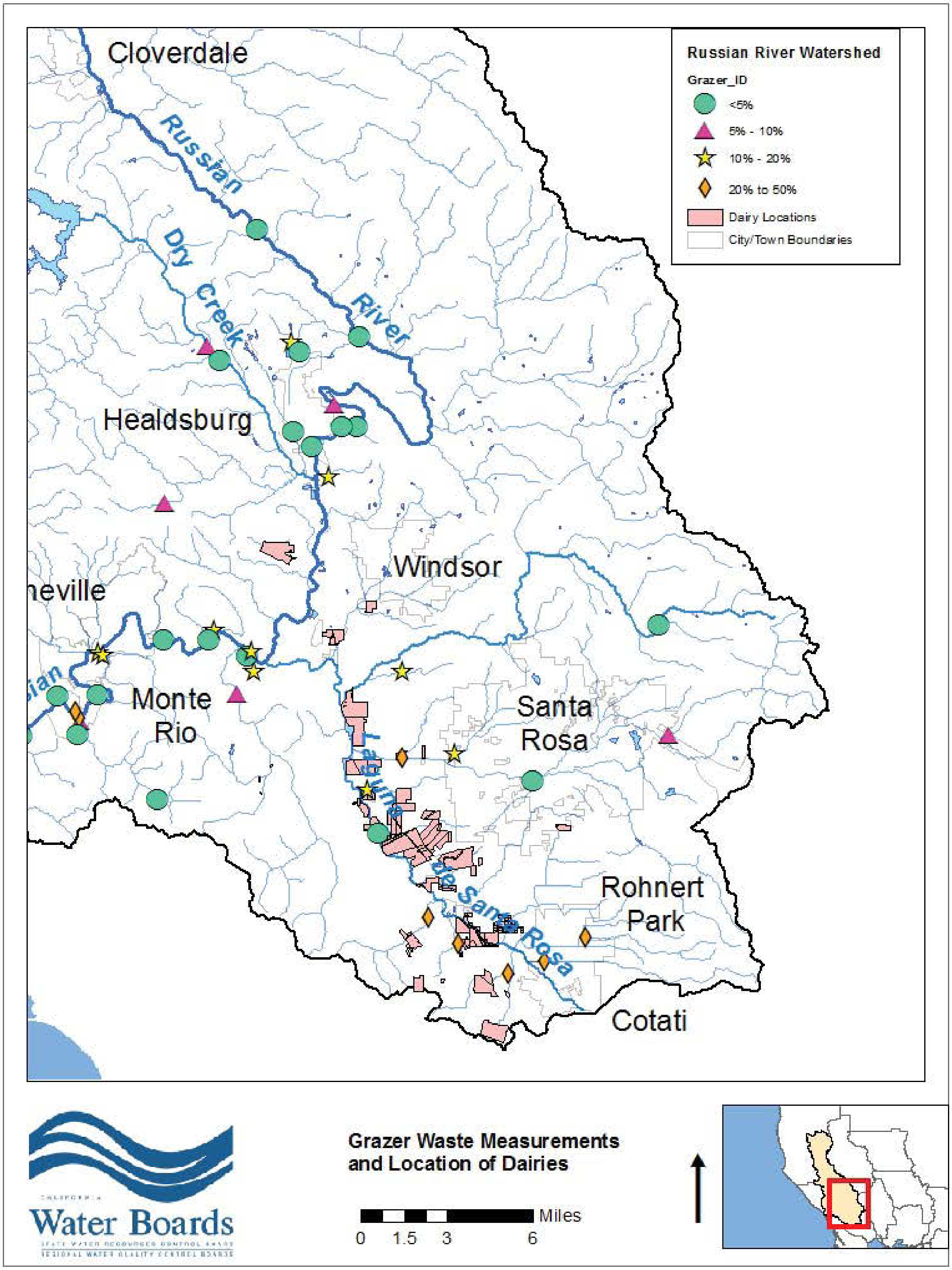

Figure 5.26: Locations of the Grazer Waste Results and Dairies in the Middle Russian River Watershed.

5.5.1 WASTEWATER DISCHARGES TO LAND

The following sections identify known wastewater discharges to land in the Russian River Watershed and discuss the likelihood that discharges are sources of pathogens to the Russian River and its tributaries via indirect discharge.

5.5.1.1 MUNICIPAL WASTEWATER DISCHARGES TO LAND

The Russian River Watershed contains five municipal wastewater treatment facilities that are authorized under WDRs to discharge treated domestic wastewater to land (Figure 5.28). Table 5.10 summarizes these facilities (based on information obtained from CIWQS in November 2013) and describes their treatment capabilities and methods of effluent disposal or reuse.

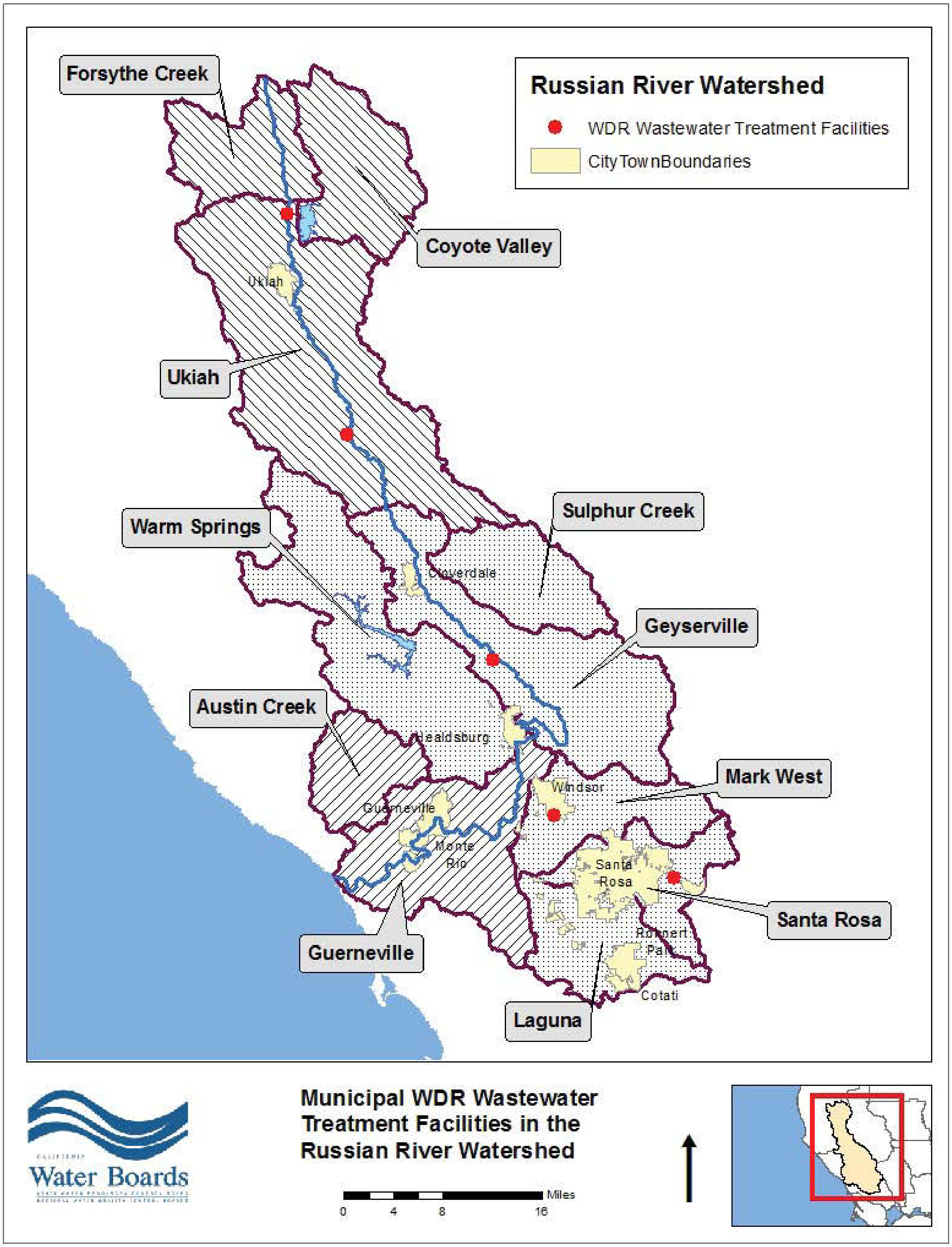

Figure 5.27: Municipal WDR Wastewater Treatment Facilities in the Russian River Watershed

Table 5.10
Municipal WDR Wastewater Treatment Facilities in the Russian River

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name	Permit No.	Capacity (mgd)	Treatment Type/Disposal Method
Upper Russian River	Ukiah	Calpella County Water District	86-16	0.04	Aerated pond treatment, disinfection and percolation disposal
		Hopland Public Utility District	R1-2008-0003	0.09	Aerated pond treatment, disinfection, and percolation disposal
Middle Russian River	Geyserville	Geyserville Sanitation Zone	97-67	0.092	Aerated pond treatment, disinfection, and percolation disposal
	Santa Rosa	Santa Rosa Oakmont Wastewater Treatment Plant	88-52	0.065	Activated sludge, filtration, disinfection, spray irrigation or transfer to Laguna Treatment Plant
	Mark West	Airport-Larkfield-Wikiup Sanitation Zone	R1-2001-0069	0.9	Aerated pond treatment, microfiltration, disinfection, and spray irrigation disposal

Municipal wastewater treatment facilities discharging to land in the watershed rely primarily on aerobic pond systems for waste treatment to achieve the effluent quality necessary to protect groundwater quality. Disinfection using chlorine is commonly used to comply with an average monthly effluent limitation for total coliform of 23 MPN/100 mL. Final disposal of treated effluent is through percolation or irrigation to pasture land. The eventual receiving water for these discharges is groundwater. Through adequate treatment and disposal system design, which includes disinfection units and separation of the disposal area from streams, lakes, and reservoirs, the risk of transport of pathogens to surface waters is low.

Municipal wastewater disposed through surface irrigation from facilities that are operating properly and whose discharge conforms to conditions prescribed in waste discharge requirements is not expected to cause bacterial contamination of groundwater or surface waters. Municipal wastewater discharged to percolation ponds that are proximate to surface waters have the potential to contribute to bacterial loading in surface waters via shallow groundwater connection to surface water and unpermitted releases, depending on site specific conditions. Importantly, groundwater monitoring data to assess the water quality impact of wastewater discharges to land in the Russian River Watershed is currently lacking and should be addressed in future permit updates.

5.5.1.2 LAND APPLICATION OF MUNICIPAL BIOSOLIDS

Both Class A (Exceptional Quality) and Class B municipal biosolids contain pathogens, including bacteria, parasites, and viruses. Exposure to these pathogens may occur through direct contact with biosolids, through inhalation, ingestion of food that has come into contact with biosolids or through contact with vectors (flies, mosquitos, birds, rodents, etc.) that can transport from biosolids to humans. Federal regulations establish minimum standards for the regulation of biosolids using various risk assessment methodologies. (40 C.F.R. part 503.) Compliance with these regulations is assumed to minimize the human health risk associated with the land application of municipal biosolids.

In July 2004, the State Water Board adopted General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities, Water Quality Order No. 2004-12-DWQ (General Order). The General Order incorporates the minimum standards established by the Part 503 Rule and expands upon them to fulfill requirements of the California Water Code.

When biosolids are applied to ground surfaces where there is an increased risk that biosolids may migrate off the application site, the Regional Water Board Executive Officer may require an Erosion Control Plan to assure containment of biosolids on the application site. Site specific conditions that may require submission of an Erosion Control Plan include, but are not limited to: sites where ground slopes are greater than 10 percent and areas with minimal riparian buffer between the biosolids application area and surface waters.

The City of Santa Rosa is the only public or private entity that is permitted to apply municipal biosolids to land in the Russian River Watershed. The City of Santa Rosa is currently land applies Class B biosolids at three city-owned properties: Alpha Farm, Brown Farm, and Stone Farm, all of which are located within the Laguna Hydrologic Subarea.

5.5.1.3 PRIVATE DOMESTIC WASTEWATER DISCHARGES TO LAND GREATER THAN 1,500 GPD

Land discharges of large and medium-sized domestic wastewater or combined industrial/domestic wastewater systems are regulated under state-issued WDRs. Large systems have the capacity to treat more than 20,000 gallons per day (gpd) and are regulated by the Regional Water Board through individual WDRs. Typically, medium-sized systems, which have a capacity of 1,500 gpd to 20,000 gpd, have been regulated by individual or general WDRs.

In the Russian River Watershed, small volume domestic wastewater systems (e.g., septic systems with design flows less than 1,500 gpd and with subsurface effluent disposal) are typically regulated by local permits issued by the Sonoma County Permit and Resource Management Department or the County of Mendocino Department of Public Works. Small systems are treated as nonpoint sources in this TMDL project due to their relatively diffuse occurrence in the watershed.

There are nineteen large and medium-sized domestic wastewater treatment facilities in the Russian River Watershed currently regulated under WDRs that discharge to land through conventional septic tank/leachfield systems, subsurface drip irrigation systems, percolation ponds, or spray irrigation. Table 5.11 summarizes these facilities and describes their treatment capabilities and methods of disposal.

WDRs for large wastewater discharges include effluent limitations, discharge prohibitions, and other conditions established to protect water quality and beneficial uses. Septic systems are designed in accordance with minimum standards for siting, design, and operation contained in the Basin Plan and other requirements set forth by the applicable local regulatory agency. Minimum standards that are critical to effective onsite treatment and disposal of waste include adequate separation to groundwater and drinking water sources, favorable soil characteristics and geology to maximize soil treatment, and suitable waste application rates. Land disposal systems conforming to prescribed minimum standards and operating properly are not expected to cause bacterial contamination of groundwater and surface waters. Land disposal through percolation ponds that are proximate to surface waters have the potential to contribute to bacterial loading in surface waters, depending on site specific conditions. Importantly, groundwater monitoring data to assess the water quality impact of wastewater discharges to land in the Russian River Watershed is currently lacking and should be addressed in future permit updates.

Table 5.11
Private Domestic WDR Wastewater Treatment Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name (Location)	Permit No.	Capacity (gpd)	Treatment Type/ Disposal Method
Upper Russian River	Ukiah	Camp Wente (Ukiah)	97-10-DWQ	10,875	Conventional septic tank/leachfield system
Middle Russian River	Warm Springs	EJ Gallo Winery (Healdsburg)	R1-2012-0099 (waiver)	3,060	Conventional septic tank/leachfield system
	Geyserville	Coppola Winery (Geyserville)	97-10-DWQ	12,000	Aerobic pretreatment, disinfection, and subsurface drip irrigation
		Jordan Vineyard and Winery (Healdsburg)	97-10-DWQ	3,500	Aerobic pretreatment and mound disposal
		Old Crocker Inn (Cloverdale)	97-10-DWQ	1,875	Conventional septic tank/leachfield system
		Rio Lindo Academy (Healdsburg)	87-094	75,000	Solids separation with evaporation/percolation disposal
		Salvation Army-Lytton Springs Rehabilitation Facility (Healdsburg)	97-10-DWQ	11,000	Aerated pond treatment, disinfection, and spray irrigation disposal
	Mark West	Camp Newman (Santa Rosa)	97-10-DWQ	20,000	Aerobic pretreatment with subsurface drip irrigation
		Humane Society of Sonoma County	R1-2003-0068	2,423	Aerobic pretreatment and mound disposal
		Kendall-Jackson Wine Center (Fulton)	97-10-DWQ	5,850	Aerobic pretreatment with subsurface drip irrigation
		Mayacamas Golf Club (Santa Rosa)	R1-2003-0029	4,900	Aerated pond, microfiltration, disinfection, spray irrigation
		Sonoma-Cutrer Vineyards (Santa Rosa)	97-10-DWQ	1,800	Aerobic pretreatment with subsurface drip irrigation
		Vintner's Inn (Santa Rosa)	R1-2002-0087	32,000	Activated sludge system with surface drip irrigation
Lower Russian River	Guerneville	Bohemian Grove (Monte Rio)	R1-2006-0053	2,250,000	Aerated pond treatment, disinfection, and spray irrigation disposal
		Gurdjieff Foundation (Guerneville)	97-10-DWQ	2,490	Aerobic pretreatment with subsurface drip irrigation and at-grade disposal system
		Odd Fellows Recreation Club (Forestville)	98-125	45,000	Clustered, conventional septic tank/leachfield system

Table 5.11
Private Domestic WDR Wastewater Treatment Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name (Location)	Permit No.	Capacity (gpd)	Treatment Type/ Disposal Method
		Rodney Strong Vineyard (Healdsburg)	88-064	60,000	Aerated pond treatment, disinfection, and percolation disposal
		The Farmhouse Inn (Forestville)	97-10-DWQ	3,285	Aerobic pretreatment and subsurface drip irrigation
	Austin Creek	Camp Royaneh (Cazadero)	97-10-DWQ	16,600	Aerated pond treatment and percolation disposal

5.5.1.4 WINE BEVERAGE AND FOOD PROCESSORS

Wine, beverage, and food (WBF) processing facilities located within the Russian River Watershed include, but are not limited to alcoholic (e.g., wineries, breweries, cider houses) and non-alcoholic beverage producers, fruit and vegetable processors, meat wrapping, and dairy product manufacturers. These facilities range in size from small in-home operated, non-commercial establishments to large, industrial or commercial establishments. The Regional Water Board currently regulates discharges to land from WBF processing facilities that could affect the quality of waters of the state through the issuance of facility-specific WDRs, enrollment under a general WDR for wineries, or issuances of conditional waivers of WDRs.

Process wastewater from these facilities is not expected to contain human pathogenic bacteria, and not considered a source of pathogenic bacteria in this TMDL. Domestic, human waste is commonly disposed of in individual onsite wastewater treatment systems (OWTS) separate from the process wastewater disposal systems and regulated by the local regulatory agency or by the Regional Water under WDRs. WBF processing facilities that combine process and domestic wastewater streams and dispose of the effluent through land application are potential sources of pathogen indicator bacteria in surface waters unless permit conditions contain disinfection requirements or disposal requirements to prevent the migration of pathogenic organisms in the effluent to groundwater and surface water.

There are five food processing facilities in the watershed that discharge process wastewater to land and are regulated under individual WDRs or a waiver of WDRs (Table 5.12). These facilities were identified as a result of a query of the CIWQS database in November 2013. None of these permits contain effluent limitations. Other food processing facilities in the watershed have been identified by Regional Water Board staff. It is expected many of these facilities will enroll under a general waste discharge requirement permit or waiver of WDRs for WBF processors that are under development.

Generally, Good Manufacturing Practices (GMPs) and Sanitation Standard Operating Procedures (SSOPs) are the foundations for food safety programs for food processors. GMP regulations are designed to control the risk of contaminating foods with chemicals and microbes during their manufacture, and include practices for the cleaning and sterilization of equipment, pest control, and quality assurance assessment. SSOPs are specific, written procedures necessary to ensure sanitary conditions in the facility. SSOPs are required in all meat and poultry processing plants, in accordance with CFR Title 9 Part 416. Compliance with these practices and procedures will prevent contamination or adulteration of food products and will minimize the bacterial load discharged from the facility.

The concentration of bacteria associated with process wastewater effluent from food processors is not currently known. However, proper and appropriate sanitation safeguard implemented during food processing will ensure that bacterial contaminants do not enter the waste stream from the food processing stream. Domestic wastes discharges related to the operation of food processing facilities are separate from the process wastewater stream and treated in domestic waste treatment system permitted by the State or authorized by local permits or programs. Consequently, Regional Water Board staff has determined that these facilities are not expected to be a source of pathogens that contributes to the pathogen impairment in the watershed.

Table 5.12
Private Food Processors WDR Wastewater Treatment Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name (Location)	Permit No.	Design or Permitted Flow	Treatment Type/ Disposal Method
Middle Russian River	Warm Springs	Timber Crest Farms (Healdsburg)	No. 80-047	10,000 gpd	Discharges wash water from the five individual wineries and one food processor renting space from the former dehydrated fruit processing facility to a spray irrigation system during the processing season (June-September).
	Laguna	Olive Leaf Press (Sebastopol)	R1-2012-0116 (Waiver)	120,000 gallons storage capacity	Organic farm that produces olive oil from Sonoma County-grown olives. The facility is used for both the pressing of olives and grapes along with the manufacturing of olive oil. The facility is covered by the categorical waiver policy as an agricultural commodity. Wash water is stored in tanks and land applied to 50 acres of agricultural land.
		Santa Rosa Meat and Poultry Company (Santa Rosa)	No. 79-019	1,000 gpd	Specialty meat shop where industrial and domestic wastewater flows through a septic tank, one tank for industrial waste and one tank for domestic waste, the flows are then combined and chlorinated before disposal into an evaporation/percolation

Table 5.12
Private Food Processors WDR Wastewater Treatment Facilities in the Russian River Watershed

Hydrologic Area Name	Hydrologic Subarea Name	Facility Name (Location)	Permit No.	Design or Permitted Flow	Treatment Type/ Disposal Method
					pond.
		Sonoma West Holdings-South (Sebastopol)	No. 88-071	50,000 gpd	Multi-tenant food and beverage processing facility that generates wash water. During dry weather, wash water is spray irrigated on 2.6 acres. Runoff from the spray fields is collected and re-irrigated, discharged to percolation beds, and/or retained in storage tanks. During wet weather, all wash water is directed to the percolation ponds and/or to storage tanks. Domestic wastewater is disposed of through an OWTS.
Lower Russian River	Guerneville	Manzana Products Company (Graton)	No. 85-079	25,000 gpd	Apple processing and canning plant that discharges wash water to a spray irrigation system during seasonal operations.

5.5.1.5 MOBILE HOME PARKS AND CAMPGROUNDS

There are 133 mobile home and special occupancy (RV) parks in the Russian River Watershed (CDHCD 2014). About two-thirds of these mobile home parks, RV Parks, and campgrounds are located within municipal sewer districts and discharge domestic wastewater to treatment facilities. However, forty-one of these parks are located outside of sewered areas and consequently dispose of domestic waste onsite via individual septic systems. Figure 5.29 shows the locations of these facilities and provides an estimate of their wastewater flow volume based on the assumption that 250 gallons per day of wastewater is produced per mobile home or campground space (U.S. DHEW 1972). Septic systems associated with mobile home parks and campgrounds are commonly large capacity, located adjacent to surface water bodies, and often poorly maintained or overloaded. Consequently Regional Water Board staff has determined that these facilities, when they are poorly sited and inadequately operated and maintained, are a probable source of pathogenic bacteria in surface waters in the Russian River Watershed.

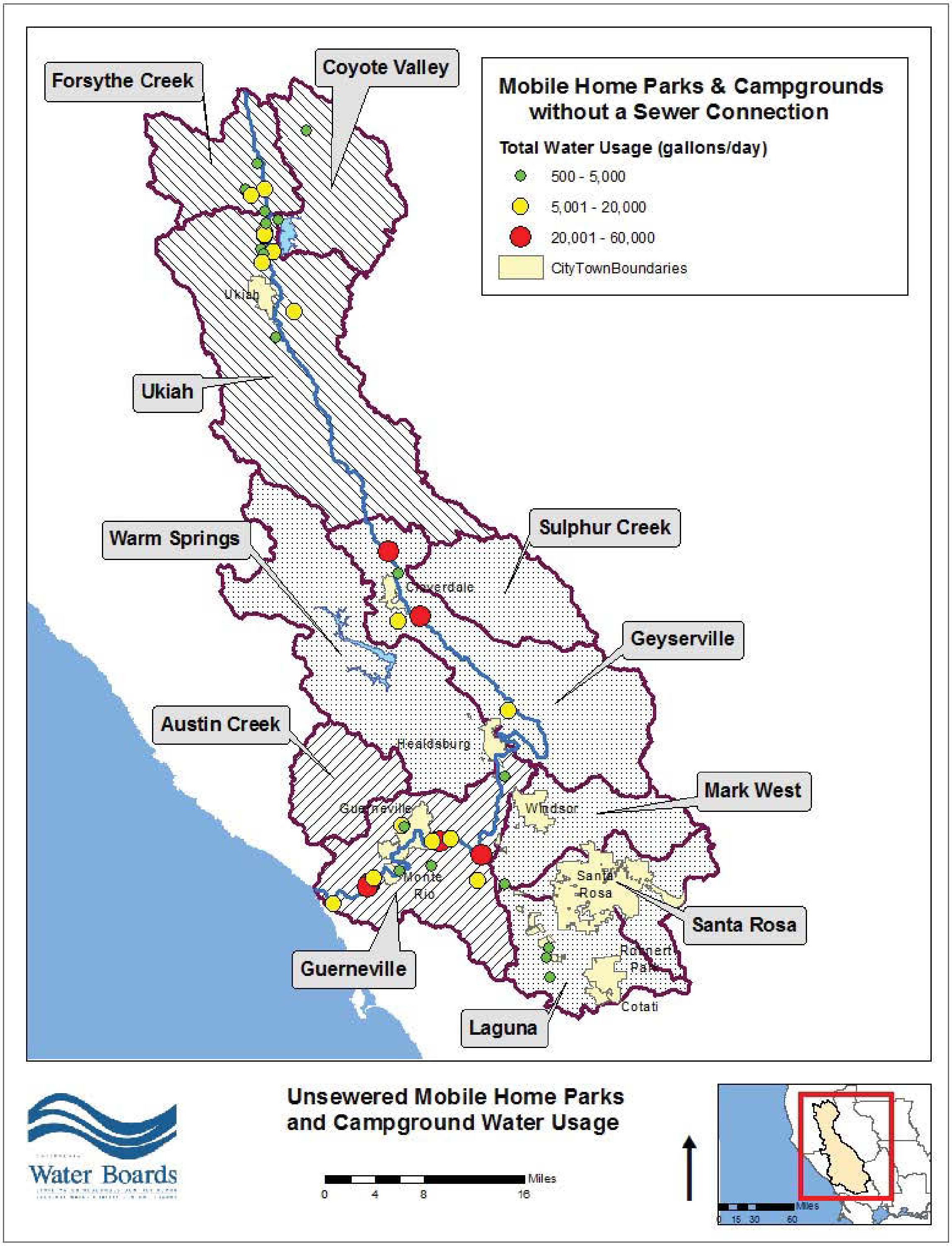

Figure 5.28: Unsewered Mobile Home Parks and Campgrounds

In summary, sources of fecal waste with the potential to enter the Russian River or its tributaries were analyzed in three different ways:
By using DNA profiles to identify human, grazer or bird contributions where elevated fecal indicator bacteria were measured;
By assessing indicator bacteria concentrations associated with different types of land uses; and
By identifying the types of point source and nonpoint source facilities and activities that discharge or have the potential to discharge fecal waste to surface waters.

The source analysis does not estimate the volume of fecal waste entering the Russian River Watershed from any given potential source, nor does it stratify the sources based on order of magnitude. But, the multiple lines of evidence provide an understanding of the locations within the watershed with greatest risk from pathogenic waste, the landuses of most concern, and the point and nonpoint sources deserving further evaluation. For example, with respect to the discharge of human-source fecal waste, the locations of greatest concern are within the Guerneville, Laguna, and Santa Rosa hydrologic subareas. With respect to the discharge of grazer-source fecal waste (e.g., livestock), the locations of greatest concern are also the Laguna, Guerneville, and Santa Rosa hydrologic subareas.

There is evidence of human and bovine fecal waste entering the waters of the Russian River Watershed during all times of the year, though higher during wet weather. Sewered and non-sewered developed areas are associated with exceedances of numeric targets for E. coli and enterococci bacteria, indicating a threat to recreational use. Similarly, agricultural areas are associated with exceedances of numeric targets for E. coli and enterococci bacteria.

Point and nonpoint sources of fecal waste within the Russian River Watershed are many and widespread. A significant number of potential sources are already covered under an individual or general permit and are controlled through use of treatment or best management practices.

From these multiple lines of inquiry, it is possible to determine several sources of fecal waste that have the potential to enter the Russian River and its tributaries and require site specific study/survey and management. Chapter 9 (Implementation) describes the implementation plan by which these site specific studies/surveys will be completed and new or upgraded management plans developed and implemented, including the existing and new regulatory mechanisms applicable to each source category.

CHAPTER 6
SEASONAL VARIATION AND CRITICAL CONDITIONS

This chapter describes the seasonal variation in fecal indicator bacteria, as measured during a wet and dry season in the Russian River Watershed. It describes the critical or extreme condition for the purposes of setting allocations to meet water quality standards.

6.1 SEASONAL VARIATION

6.1.1 WET PERIODS VS. DRY PERIODS

Regional Water Board staff collected water samples for measurement of fecal indicator bacteria at numerous locations in the Russian River Watershed from 2011 to 2013 (NCRWQCB 2012; NCRWQCB 2013a; NCRWQCB 2013b). Water samples were collected in both dry and wet periods for analysis of *E. coli*, enterococci, human-specific *Bacteroides*, and bovine-specific *Bacteroides* bacteria concentrations. Dry period samples were collected after 72 hours of no rainfall. Wet period samples were collected during storm events of at least 0.1 inches of rainfall that were preceded by 72 hours of no rainfall.

Figures 6.1 through 6.4 aggregate these data and compare the distribution of fecal indicator bacteria concentrations sampled during wet and dry weather periods. All three indicator bacteria show significantly higher concentrations measured during wet weather compared to dry weather samples. This finding indicates that higher pathogenic indicator bacteria levels are associated with higher flows that are associated with storm events.

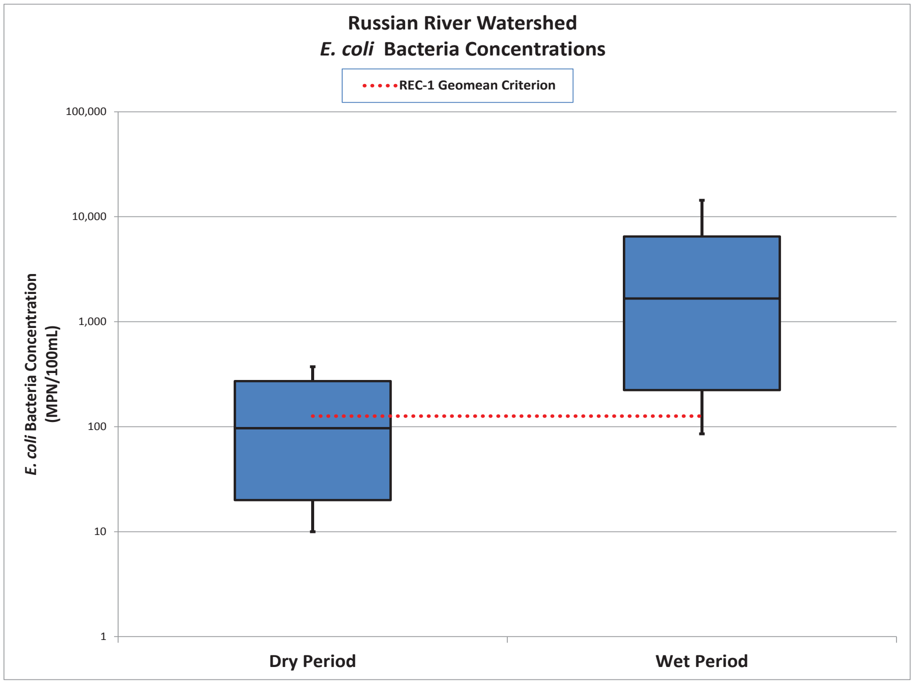

Figure 6.1: Distribution of E. coli Bacteria Concentrations collected during Dry and Wet Weather Periods

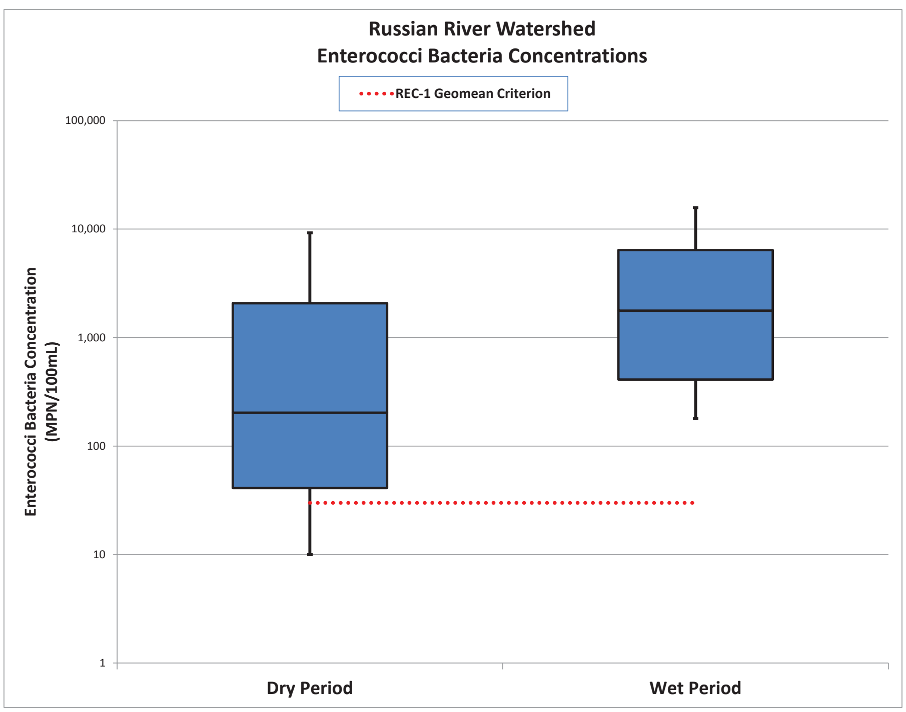

Figure 6.2: Distribution of Enterococci Bacteria Concentrations collected during Dry and Wet Weather Periods

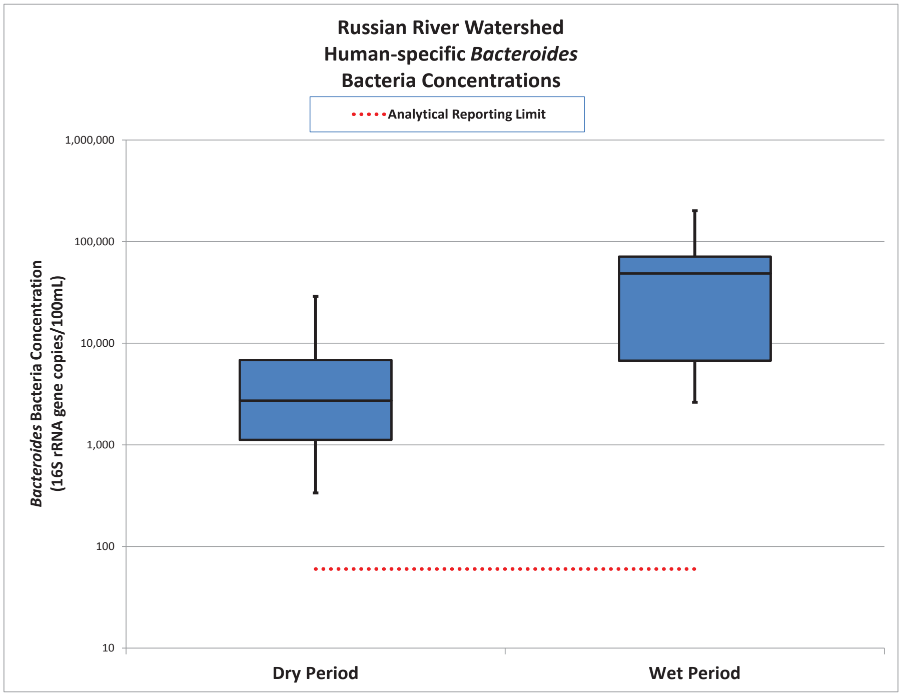

Figure 6.3: Distribution of Human-specific Bacteroides Bacteria Concentrations collected during Dry and Wet Weather Periods. Human-specific Bacteroides were analyzed with the HuBac genetic marker following U.S. EPA (2010) Method B.

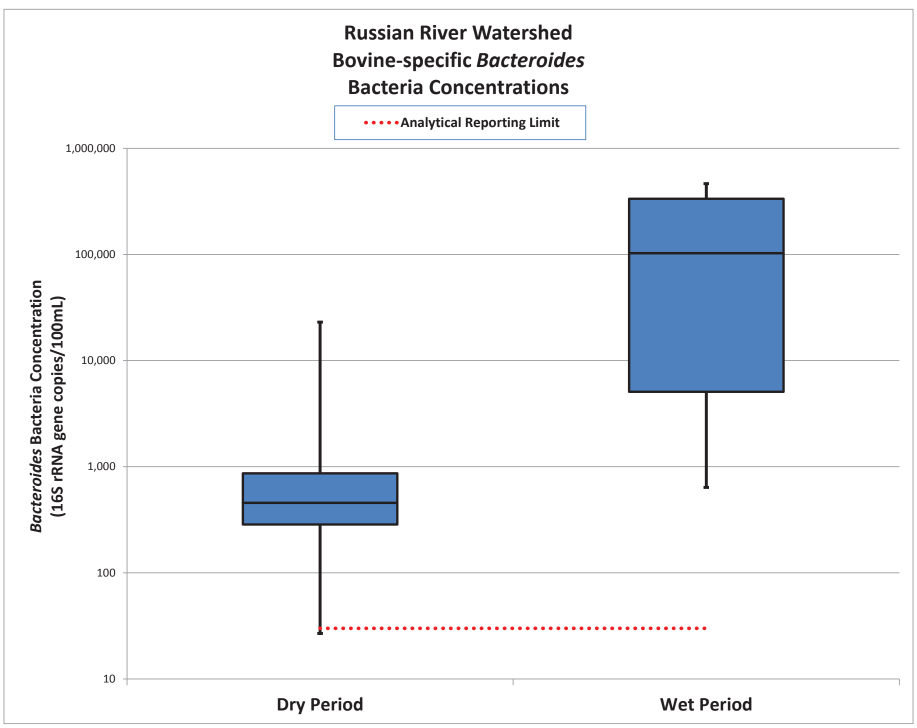

Figure 6.4. Distribution of Bovine-specific Bacteroides Bacteria Concentrations collected during Dry and Wet Weather Periods. Bovine-specific Bacteroides were analyzed with the BoBac genetic marker following U.S. EPA (2010) Method B.

6.1.2 EFFECTS OF LOW MAINSTEM FLOWS

Regional Water Board staff also evaluated the relationship between *E. coli* bacteria concentrations and dry season stream flows in the mainstem Russian River (Butkus 2014b). The assessment found that there is not a statistically significant correlation between summer daily mean stream flow rates and *E. coli* bacteria concentrations at Camp Rose Beach, Veteran Memorial Beach, Steelhead Beach, Johnson's Beach, or Monte Rio Beach, as shown in Figures 6.5 through 6.9. In other words, *E. coli* levels do not vary significantly due to flows in the mainstem during dry summer periods.

This conclusion is supported by an additional analysis undertaken to evaluate if *E. coli* concentrations are different in years with lower flows under a Temporary Urgency Change Petition (TUCP)[10] than in years without a petition (Butkus 2014b; Appendix C). There is no statistically significant difference in *E. coli* concentrations in years with reduced stream flows due to TUCPs in the Russian River at Camp Rose Beach, Veteran Memorial Beach, Steelhead Beach, and Johnson's Beach. Only data from Monte Rio beach showed a statistically significant difference in that *E. coli* concentrations were lower in TUCP years with reduced flows. The reason for the lower *E. coli* levels in lower flows at Monte Rio beach are unknown, but could include less rainfall and runoff or changes in management practices that reduced inputs in years with TUCPs.

6.2 CRITICAL CONDITIONS

In developing a TMDL, the critical condition can be thought of as the "worst case" scenario of environmental conditions in the waterbody, a condition where the pollutant loading is greatest, but the waterbody continues to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., stream flow, air temperature, etc.) that result in the attainment of standards with an acceptably low frequency of occurrence (U.S. EPA 1999).

During wet weather periods, pathogenic indicator bacteria concentrations are much higher than during dry periods, and often exceed the numeric targets. Therefore, wet weather conditions can be considered a critical condition for bacteria levels. However, during the summer, low-flow period there is much more exposure to pathogenic indicator bacteria through recreation. Therefore, summer recreation periods can also be considered a critical

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[10] The Sonoma County Water Agency (SCWA) controls and coordinates water supply releases from Coyote Valley and Warm Springs dams in accordance with minimum instream flow requirements specified by the State Water Board. These minimum instream flow requirements vary based on water supply conditions. Since 2002, SCWA has requested temporary changes to the Decision 1610 minimum instream flow requirements from the State Water Board. TUCPs filed from 2010 through 2014 were required by the Russian River Biological Opinion under the Endangered Species Act to reduce instream flow conditions to improve habitat for the threatened and endangered salmonid species.

period. Since both wet and dry periods are critical conditions, the same loading capacities apply throughout the year and should not vary according to season.

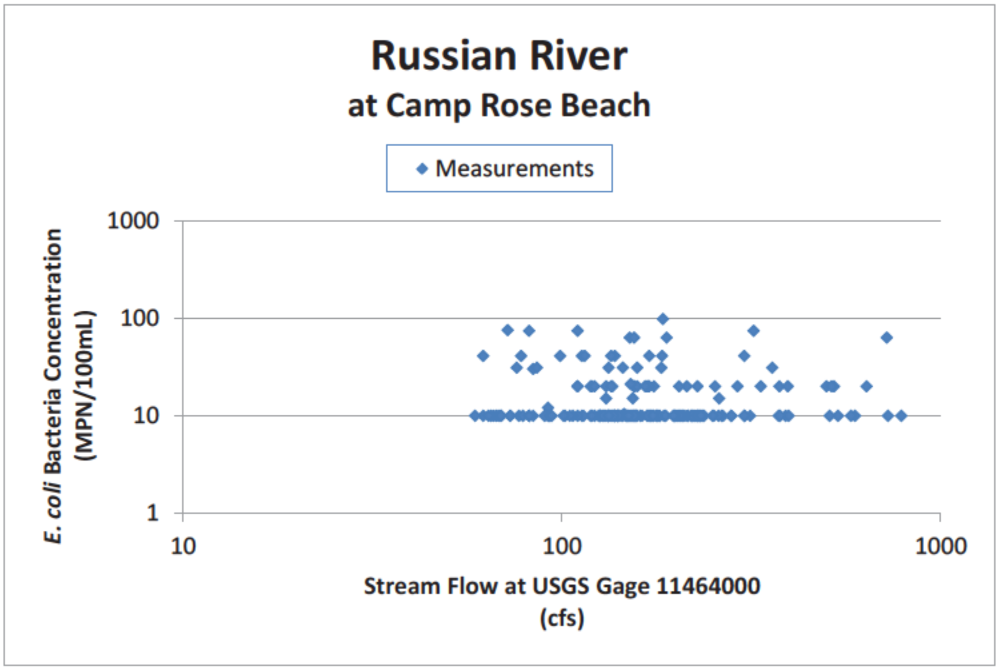

Figure 6.5: Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Camp Rose Beach during the dry season

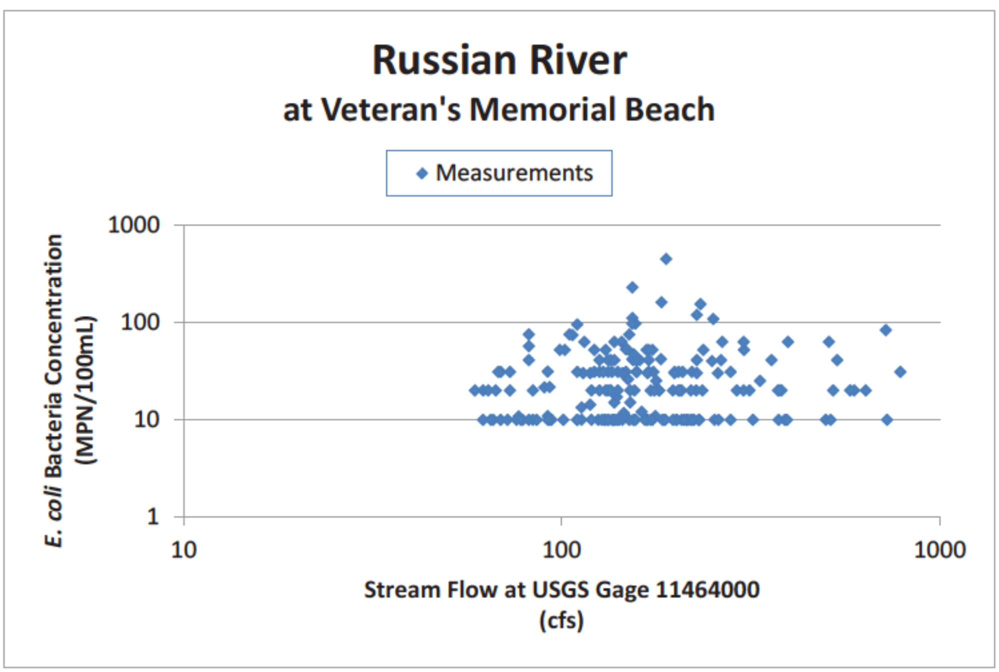

Figure 6.6: Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Veteran Memorial Beach during the dry season

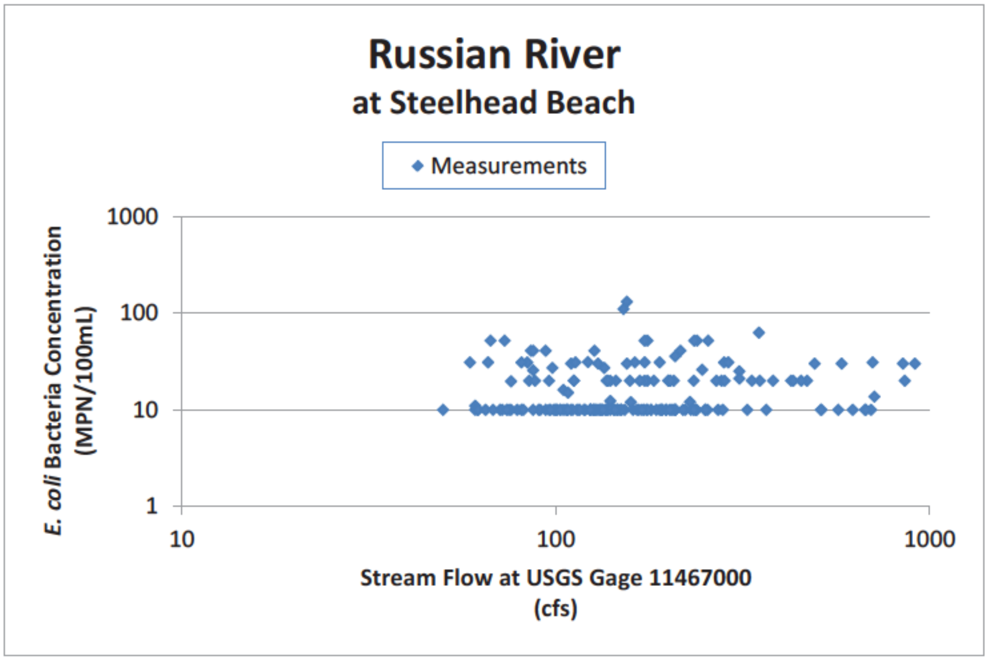

Figure 6.7: Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Steelhead Beach during the dry season

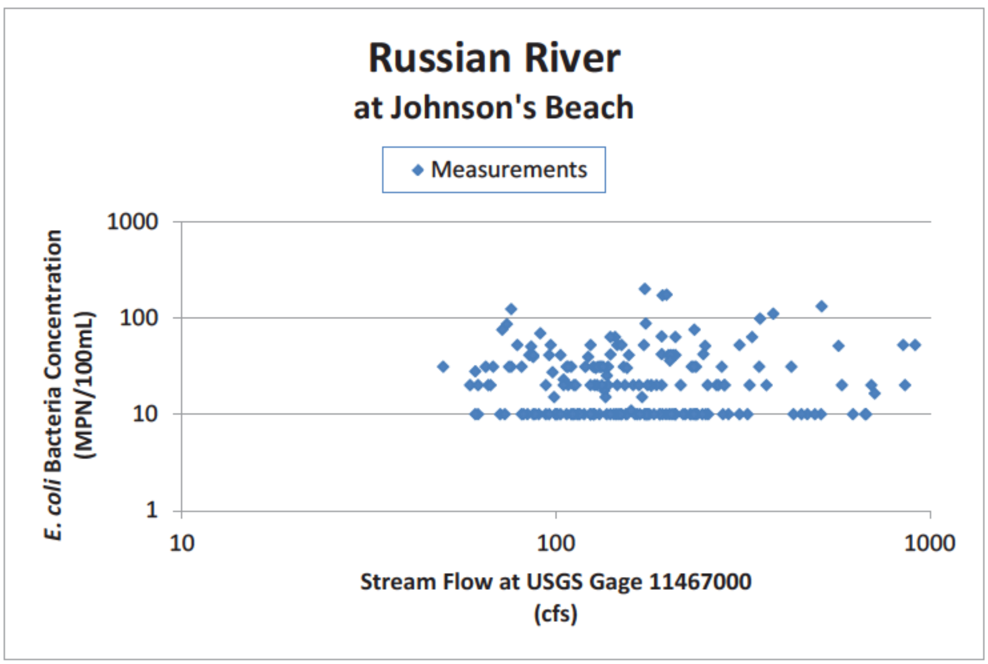

Figure 6.8: Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Johnson's Beach during the dry season

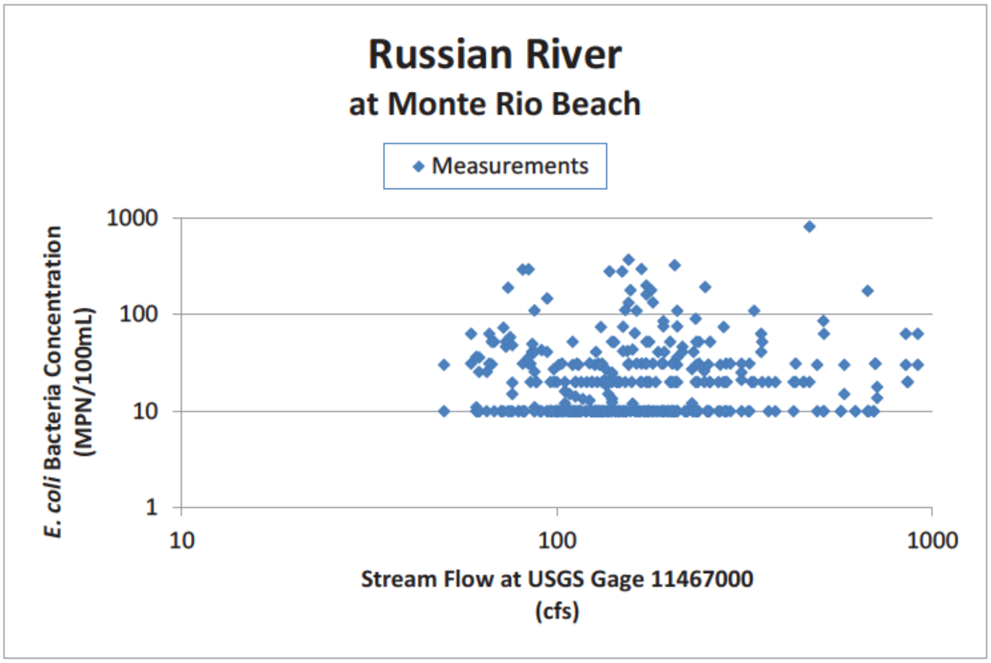

Figure 6.9: Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Monte Rio Beach during the dry season

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 science[11]. 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

[11] 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.

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.

CHAPTER 8
TMDL CALCULATIONS AND ALLOCATIONS

A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The TMDL equals the loading capacity of the waterbody for the pollutant plus a margin of safety to account for any uncertainties. For this TMDL project, an implicit margin of safety is included in the determination of the loading capacities so the loading capacities are equivalent to the TMDL values. The loads are allocated among the various sources of the pollutant. Anthropogenic pollutant sources are characterized as either point sources that receive a wasteload allocation or nonpoint sources that receive a load allocation. Point sources include all sources subject to regulation under the NPDES program (e.g., wastewater treatment facilities and some storm water discharges). Nonpoint sources include a variety of diffuse sources transported by water moving over and through the ground.

8.1 TMDLS, LOADING CAPACITIES & MARGIN OF SAFETY

The TMDLs for the Russian River Watershed are shown in Table 8.1 and are expressed as concentrations of *E. coli* and enterococci bacteria in surface waters and discharges. In accordance with 40 CFR §130.2(i), the TMDLs are to be expressed as concentrations instead of loads. This is appropriate since public health risks associated with recreation are based on concentrations of pathogen indicator bacteria in water and not the total load of bacteria passing through the Russian River in a day.

The TMDLs are set to equal the loading capacities for each parameter and attain standards.[12] The TMDLs are equivalent to the numeric targets and the wasteload and load allocations.

[12] As discussed in Chapter 2, this TMDL is established at levels expected to implement the proposed state bacteria water quality objective. 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.

Table 8.1 TMDLs, Loading Capacities, Wasteload Allocations, and Load Allocations		
Parameter	**Portion of the Bacteria Objective the Target will Attain**	**TMDL, Loading Capacity, Wasteload Allocation & Load Allocation**
E. coli Geometric Mean	Recreation	The geometric mean of the samples collected* within the permitted period shall not exceed 100 cfu/100mL**.
E. coli Statistical Threshold Value	Recreation	No more than 10% of the samples collected* within the permitted period shall exceed 320 cfu/100mL**.
Enterococci Geometric Mean	Recreation	The geometric mean of the samples collected* within the permitted discharge period shall not exceed 30 cfu/100mL**.
Enterococci Statistical Threshold Value	Recreation	No more than 10% of the samples collected* within the permitted discharge period shall exceed 110 cfu/100mL**.

* The sampling frequency and period of sampling is important to proper interpretation of monitoring results. Any WLAs or LAs monitoring of fecal indicator bacteria must be in accordance with the appropriate sampling frequency and period of sampling defined in the controlling regulatory mechanism.
** Colony forming units (cfu) are equivalent to the most probable number (MPN) values.

8.1.1 E. COLI AND ENTEROCOCCI BACTERIA TMDLS/LOADING CAPACITIES

The *E. coli* and enterococci geometric mean and statistical threshold value (STV) TMDLs/loading capacities are the same as the *E. coli* and enterococci bacteria numeric targets.

The sampling frequency and period of sampling is important to proper interpretation of monitoring results. But, the frequency and period are not defined here because they are , dependent on the monitoring purpose, season of interest, and other relevant factors. As such, any WLAs or LAs monitoring of fecal indicator bacteria must be in accordance with the appropriate sampling frequency and period of sampling defined in the controlling regulatory mechanism. It is recommended that a minimum of ten samples be collected within a year so as to calculate a meaningful geometric mean and STV. Such an approach may be appropriate to assess the impacts from storm water discharges, since they are episodic. In many cases, weekly sampling may be appropriate, especially for point source discharges that are already monitored on a weekly basis for other parameters. The geometric mean and STV should be calculated in a static, not rolling, fashion.

8.1.2 MARGIN OF SAFETY

The Clean Water Act and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between the load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). U.S. EPA (1991) guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

Implicit margins of safety are used for *E. coli* and enterococci bacteria TMDLs. For the *E. coli* and enterococci bacteria TMDLs, the implicit margins of safety are due to the selection of the U.S. EPA criteria (2012) associated with 32 illnesses per 1,000 recreators, instead of 36 illnesses per 1,000 water recreation users. By selecting the values linked to fewer illnesses, an additional MOS is provided for those partaking in water contact recreation in the watershed.

8.2 WASTELOAD ALLOCATIONS

Regulations require that a TMDL include wasteload allocations (WLAs), which identify the portion of the loading capacity allocated to individual existing and future point sources (40 C.F.R. §130.2(h); 40 C.F.R. §130.2(i)).

The concentration-based WLAs for *E. coli* and enterococci bacteria are shown in Table 8.1 and apply to all existing and new point source discharges that are likely to include pathogens or pathogen indicator bacteria in the Russian River Watershed. Examples of point sources include but are not limited to discharges from wastewater treatment facilities, municipal separate storm sewer systems, and confined animal feeding operations. Table 8.2 lists the existing point sources of pathogens in the watershed. The *E. coli* and enterococci bacteria WLAs shall be incorporated into permits for discharges of pathogen or pathogen indicator bacteria point sources at the time of permit adoption or permit renewal. The compliance point for the WLAs shall be at the point of effluent discharge from the point source to the receiving water, or at a location where sample results are representative of the targeted waste stream.

Table 8.2 NPDES Permittees with WLAs in the Russian River Watershed				
Hydrologic Area Name	**Hydrologic Subarea Name**	**Facility Name**	**Facility Type NPDES**	**Permit No.**
Upper Russian River	Ukiah	City of Ukiah	Phase II MS4 Storm Water	CAS0000004
		City of Ukiah WWTP	Municipal Wastewater	CA0022888
Middle Russian River	Warm Springs	City of Healdsburg	Phase II MS4 Storm Water	CAS0000004
	Geyserville	Cloverdale City WWTP	Municipal Wastewater	CA0022977
	Laguna	City of Cotati	Phase II MS4 Storm Water	CAS0000004
		City of Rohnert Park	Phase II MS4 Storm Water	CAS0000004
		Sonoma State University	Phase II MS4 Storm Water	CAS0000004
	Santa Rosa, Laguna	Santa Rosa Subregional Facility	Municipal Wastewater	CA0022764
	Mark West	Town of Windsor	Phase II MS4 Storm Water	CAS0000004
		Town of Windsor WWTP	Municipal Wastewater	CA0023345
Lower Russian River	Guerneville	City of Healdsburg WWTP	Municipal Wastewater	CA0025135
		Forestville Water District	Municipal Wastewater	CA0023043
		Occidental CSD	Municipal Wastewater	CA0023051
		SCWA Graton CSD	Municipal Wastewater	CA0023639
		SCWA Russian River CSD	Municipal Wastewater	CA0024058

Several NPDES permit holders in the Russian River Watershed are not a source of pathogens or pathogenic indicator bacteria. These include, but are not limited to, discharges from waterway modification permits related to aquatic pesticide application, discharges from log deck sprinkler water runoff, and discharges of highly treated groundwater that was previously contaminated with petroleum hydrocarbons and volatile organic compounds. Consequently, WLAs have not been assigned to these facility types in this TMDL.

8.3 LOAD ALLOCATIONS

Regulations require that a TMDL include load allocations (LAs), which identify the portion of the loading capacity allocated to existing and future nonpoint sources. LAs may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)).

The concentration-based LAs for *E. coli* and enterococci bacteria are shown in Table 8.1 and apply to all existing and new non-natural background, nonpoint sources in the Russian River Watershed. Examples of nonpoint sources include but are not limited to domestic wastewater discharges < 1,500 gpd, discharges from homeless encampments, pet waste, and livestock waste. The *E. coli* and enterococci bacteria LAs shall be incorporated into nonpoint source permits at the discretion of the Regional Water Board at the time of adoption of a new or renewed nonpoint source permit. Additional, non-permit implementation actions to attain the LAs are described in Chapter 9. These include efforts to identify, cleanup, and prevent nonpoint source discharges through the use of public outreach and education, best management practices, assessment, and adaptive management.

8.4 ESTIMATED REDUCTIONS NEEDED

Regional Water Board staff conducted an analysis of the reductions likely needed to achieve the TMDLs for *E. coli* and enterococci bacteria concentrations at numerous locations in the watershed (Butkus 2013d). Using multiple lines of evidence to assess the extent of fecal waste contamination, this TMDL demonstrates that both the mainstem and tributaries are impacted by fecal waste with the potential to deliver pathogens. Some waste sources of concern are identified due to exceedances of *E. coli* bacteria targets. Others sources are identified due to exceedances of enterococci bacteria targets. The estimated percent reductions needed are provided here to highlight priorities for implementation actions; but, they are not the load allocations, which are represented as *E. coli* and enterococci concentrations.

E. coli and enterococci bacteria measurements collected since 2001 were used to estimate the percent reduction needed to meet both TMDL values, as shown in Tables 8.3 and 8.4. In most cases, a larger percent reduction is needed to meet the STV as opposed to the geometric mean.

A large percentage of the locations in the mainstem Russian River met the TMDLs for *E. coli* bacteria concentrations and require no reductions. However, most of the tributaries do not meet the TMDLs for *E. coli* bacteria and will require controls to reduce fecal waste loads. Percent reductions of *E. coli* bacteria concentrations needed to meet the TMDLs in tributaries range from 49% to 99%. Percent reductions of enterococci bacteria concentrations needed to meet the TMDLs in the mainstem Russian River range from 18% to 50%. Percent reductions of enterococci bacteria concentrations needed to meet the TMDLs in tributaries range from 78% to 98%.

Table 8.3
Percent Reductions Needed to Meet *E. coli* Bacteria TMDLs in Tributaries

Hydrologic Area Name	Hydrologic Subarea Name	Tributary Location	*E. coli* Bacteria Reduction Needed To Attain	
			Geometric Mean ≤ 100 cfu/100mL	STV ≤ 320 cfu/100mL
Middle Russian River	Warm Springs	Foss Creek at Matheson Street	97%	99%
	Laguna	Laguna de Santa Rosa at Sebastopol Community Center	42%	92%
	Santa Rosa	Santa Rosa Creek at Highway 12	60%	66%
		Santa Rosa Creek at Railroad Street	79%	84%
Lower Russian River	Guerneville	Atascadero Creek at Green Valley Road	80%	91%
		Green Valley Creek at Martinelli Road	12%	49%

Table 8.4
Percent Reductions Needed to Meet Enterococci Bacteria TMDLs in the Russian River and Tributaries

Hydrologic Area Name	Hydrologic Subarea Name	Location	Enterococci Bacteria Reduction Needed To Attain	
			Geometric Mean ≤ 100 cfu/100mL	STV ≤ 320 cfu/100mL
Middle Russian River	Warm Springs	Foss Creek at Matheson Street	97%	97%
	Geyserville	Russian River at Crocker Road	35%	22%
	Laguna	Laguna de Santa Rosa at Sebastopol Community Center	78%	92%
	Santa Rosa	Santa Rosa Creek at Highway 12	72%	78%
		Santa Rosa Creek at Railroad Street	77%	90%
		Santa Rosa Creek at Wildwood Mountain Road	77%	78%
	Mark West	Mark West Creek at Trenton-Healdsburg Road	88%	92%

Table 8.4 Percent Reductions Needed to Meet Enterococci Bacteria TMDLs in the Russian River and Tributaries				
Hydrologic Area Name	Hydrologic Subarea Name	Location	Enterococci Bacteria Reduction Needed To Attain	
			Geometric Mean ≤ 100 cfu/100mL	STV ≤ 320 cfu/100mL
Lower Russian River	Guerneville	Atascadero Creek at Green Valley Road	92%	98%
		Green Valley Creek at Martinelli Road	76%	93%
		Russian River at Bridgehaven	0%	36%
		Russian River at Duncans Mills	0%	18%
		Russian River at Jenner Boat Ramp	0%	25%
		Russian River at Riverfront Park	0%	50%

In summary, the TMDLs and load allocations are established as concentrations of E. coli and enterococci bacteria, at levels equivalent to the numeric targets and U.S. EPA's national criteria. Substantial reductions in the discharge of fecal waste in the Middle and Lower Russian River hydrologic areas are particularly necessary to attain the TMDLs and protect the full-body contact recreational beneficial use.

CHAPTER 9
IMPLEMENTATION

The purpose of the Implementation Plan is to describe the steps necessary to reduce pathogen concentrations and achieve the TMDLs. The Implementation Plan identifies:

1. Actions that staff expects will reduce pathogens;
2. Parties responsible for taking these actions;
3. Regulatory mechanisms by which the Regional Water Board will ensure that these actions are taken; and
4. A timeline for completion of actions.

9.1 WASTE DISCHARGE PROHIBITIONS

Discharges of fecal material from humans or from domestic animals to waters of the state are controllable water quality factors that shall conform to the bacteria water quality objective. Controllable water quality factors are those actions, conditions, or circumstances resulting from man's activities that may influence the quality of waters of the state and that may be reasonably controlled.

In accordance with Water Code section 13243 and in order to achieve the bacteria water quality objective, to protect present and future beneficial uses of water, to protect public health, and to prevent nuisance, this TMDL sets forth the following discharge prohibition:

> *Discharges of waste containing fecal waste material from humans or domestic animals to waters of the state within the Russian River Watershed that cause or contribute to an exceedance of the bacteria water quality objectives not authorized by waste discharge requirements or other order or action of the Regional or State Water Board are prohibited.*

Examples of domestic animals include, but are not limited to, cows, horses, cattle, goats, sheep, dogs, cats, or any other animal(s) in the care of any person(s). Exceptions to the prohibition include discharges authorized in accordance with waste discharge requirements or other provisions of the Water Code, Division 7, as amended. Compliance with this Waste Discharge Prohibition implies compliance with the wasteload and load allocations for this TMDL.

Sources of human fecal waste material identified in this TMDL project include:

- Discharges of municipal wastewater directly to surface waters;
- Discharges of untreated sewage from sanitary sewer systems;
- Discharges of wastewater from percolation ponds and through spray irrigation;

- Discharges of runoff from land application of municipal biosolids;
- Discharges of runoff from water recycling projects;
- Discharges from onsite wastewater treatment systems;
- Discharges from recreational water uses and users;
- Discharges from homeless encampments; and
- Discharges of storm water to municipal separate storm sewer system (MS4s) and from areas outside MS4 boundaries.

Sources of domestic animal and farm animal waste identified in this TMDL project include:

- Discharges of pet waste;
- Discharges from non-dairy livestock and farm animals; and
- Discharges of manure from dairy cows.

9.2 IMPLEMENTATION ACTIONS

The implementation actions included in this TMDL address pathogens from specific controllable pathogen sources, including humans and domesticated animals. Each probable source, its responsible parties, and its implementation actions are described in the following sections and summarized in Table 9.1.

9.2.1 MUNICIPAL WASTEWATER DISCHARGES TO SURFACE WATERS

There are four municipal wastewater treatment facilities in the Russian River Watershed that collect, treat, and discharge fully-treated effluent directly to the Russian River or its tributaries. These facilities are operated by:

- City of Ukiah
- City of Healdsburg
- City of Santa Rosa
- Occidental County Sanitation District

The waste discharges are regulated under existing NPDES permits that include effluent limitations and disinfection specifications to ensure treatment processes achieve effective and reliable pathogen reduction. Disinfection requirements in these permits are derived from standards for tertiary-treated recycled water contained in title 22 of the California Code of Regulations. The limitations are consistent with Basin Plan requirements for advanced treated wastewater for such discharges. When a disinfection system operates properly and attains the effluent limitations, direct discharges of treated wastewater to surface waters will also attain *E. coli* and enterococci bacteria wasteload allocations.

In order to ensure that direct discharges of treated wastewater from municipal wastewater treatment facilities to the Russian River and its tributaries maintain existing performance, and thus remain in compliance with Basin Plan standards, these permittees are required to attain the following effluent limitations:

1. The median concentration of total coliform bacteria shall not exceed 2.2 MPN/ 100 mL, using the daily bacteriological results of the last 7 days for which analyses have been completed;
2. The number of total coliform bacteria shall not exceed 23 MPN/ 100 mL in more than one daily result in any 30-day period; and
3. No daily total coliform result shall exceed 240 MPN/ 100 mL.

To demonstrate compliance with limitations, direct dischargers of treated wastewater shall conduct daily effluent monitoring at a location or locations where a representative sample of the effluent can be collected. Direct dischargers shall provide to the Regional Water Board monthly discharge monitoring reports and other reports, as necessary, to demonstrate compliance with effluent limitations and with the *E. coli* and enterococci bacteria wasteload allocations.

Table 9.1
Summary of Implementation Actions

Bacteria Source Category	Implementing Parties (Source)	Implementation Actions	Compliance Date(s)
Municipal Wastewater Discharges	City of Ukiah, City of Healdsburg, City of Santa Rosa, Occidental CSD	Municipal wastewater discharger shall comply with effluent limitations for fecal indicator bacteria and disinfection specifications in NPDES permit.	As specified in applicable NPDES permits
Wastewater Holding Pond Discharges to Surface Water	City of Ukiah, City of Healdsburg , Town of Windsor, City of Santa Rosa , Graton CSD, Forestville WD, Russian River CSD, Occidental CSD Other entities with storage pond discharges to surface water.	Storage pond dischargers shall submit demonstration that discharge does not contain human-source bacteria and pathogens, or submit a Bacterial Load Reduction Plan (BLRP) with time schedule of compliance with waste load allocations. The discharger shall comply with applicable NPDES permit requirements. The Regional Water Board shall update waste discharge requirements (WDRs) for those municipalities and special districts that do not demonstrate to the satisfaction of the Regional Water Board Executive Office that the holding pond effluent discharge does not contain human-source bacteria and pathogens. The WDRs shall include effluent limitations based on holding pond effluent sampling using the bacteriological results of holding pond effluent samples collected at least weekly for the calendar month for which analyses have been completed: 1. The geometric mean concentration of *E.coli* bacteria shall not exceed 100 MPN/ 100 mL, and 2. The Statistical Threshold Value (STV) for *E. coli* bacteria shall not exceed 320 MPN/ 100 mL. 3. The geometric mean concentration of *enterococci* bacteria shall not exceed 30 MPN/ 100 mL, and 4. The STV for *enterococci* bacteria shall not exceed 110 MPN/ 100 mL.	a) 18 months after the effective date of the TMDL to submit demonstration of compliance with WLAs b) Two years after the effective date of the TMDL to submit BLRP, and up to ten years after the effective date of the TMDL to comply with effluent limitations c) Four years after the effective date of the TMDL for Regional Water Board to update WDRs, if applicable

Table 9.1
Summary of Implementation Actions

Bacteria Source Category	Implementing Parties (Source)	Implementation Actions	Compliance Date(s)
Percolation Pond and Irrigation Discharges	Calpella CWD, Hopland PUD, City of Cloverdale, Geyserville CSD, Airport-Larkfield-Wikiup SZ, Russian River CSD, Occidental CSD Other publically and privately-owned wastewater treatment facilities in the Russian River Watershed that collect, treat, and dispose of or recycle treated effluent to land via percolation ponds or by irrigation	The Regional Water Board shall update waste discharge requirements for percolation pond and irrigation discharges to include effluent limitations in which: 1. The geometric mean concentration of total coliform bacteria shall not exceed 23 MPN/100 mL in any calendar month. 2. The geometric mean concentration of enterococci bacteria shall not exceed 30 MPN/100 mL, and 3. The STV for *enterococci* bacteria shall not exceed 110 MPN/ 100 mL. The frequency of effluent monitoring for bacteria established in waste discharge requirements is at the discretion of the Regional Water Board, but shall be sufficient to demonstrate compliance with effluent limitations. Waste discharge requirements shall provide justification for the frequency of monitoring. Justification shall be based on factors such as discharge flow, proximity of the discharge to surfaces waters or other site conditions, effluent variability, and other factors, as appropriate. The discharger shall comply with the applicable WDR.	a) As specified in applicable WDRs b) As soon as practicable for Regional Water Board to update WDRs
Sanitary Sewer Systems	City of Ukiah, Ukiah SD, Calpella CWD, Hopland PUD, City of Cloverdale, Geyserville CSD, City of Healdsburg , Town of Windsor, Airport-Larkfield-Wikiup SZ, City of Santa Rosa , South Park CSD, City of Cotati, City of Sebastopol, Sonoma State University, Graton CSD, Forestville WD, Russian River CSD, Occidental CSD Other public entities that own or operate sanitary sewer systems	Each municipality and district with a sanitary sewer system shall comply with State Water Resources Control Board Order No. 2006-0003-DWQ, Statewide General WDRs for Sanitary Sewer Systems, the revised Monitoring and Reporting Program Order No. WQ 2013-0058-EXEC, and subsequent revisions. Each municipality and district with a sanitary sewer system shall submit or update a Sanitary Sewer Management Plan (SSMP) that describes actions with time schedules that it takes or plans to take to further minimize sanitary sewer overflows, spills, and exfiltration from its sanitary sewer system. The Regional Water Board will require submission of the SSMP amendment under authority of section 13267 subdivision (b) of the California Water Code.	As specified in the applicable general WDR
Land Application of Treated	City of Santa Rosa	The discharger shall comply with State Water Resources	a) As specified in an applicable general WDR

Table 9.1
Summary of Implementation Actions

Bacteria Source Category	Implementing Parties (Source)	Implementation Actions	Compliance Date(s)
Municipal Sewage Sludge (Biosolids)	Other public entity applying biosolids as a soil amendment	Control Board Order No. 2004-0012-DWQ, General WDRs for the Discharge of Biosolids to Land, subsequent general orders, or individual waste discharge requirements. The discharger shall submit or update an Erosion Control Plan describing enhanced protections to prevent the movement of biosolids from the application area. The Regional Water Board will require submission of the Erosion Control Plan under authority of section 13267 subdivision (b) of the Water Code.	b) One year after the effective date of the TMDL to submit (or update) and implement the Erosion Control Plan
Recycled Water Irrigation Runoff	Entities permitted to beneficially reuse treated domestic wastewater through irrigation to land	Each entity that is permitted to beneficially reuse treated wastewater for landscape irrigation, agricultural irrigation, or other use allowable under California Code of Regulations, title 22, chapter 3, article 3, section 60303 through 60307 shall maintain compliance with water recycling requirements in State Water Resources Control Board Order WQ 2014-0090-DWQ, General WDRs for Recycled Water Use, subsequent general orders, individual waste discharge requirements, or Master Water Reclamation Permits. Each municipality and district that is permitted to beneficially reuse treated wastewater shall develop (or update), submit, and implement a Non-Storm Water BMP Plan. The Regional Water Board will require submission of the Non-Storm Water BMP Plan under authority of section 13267 subdivision (b) of the Water Code.	a) One year after the effective date of the TMDL to update and submit existing BMP Plan, or sooner if the entity to submit a Non-Storm Water BMP Plan in accordance with an existing Order. b) Two years after the effective date of the TMDL to develop and submit new BMP Plan, c) Final compliance within 5 years after the effective date of TMDL
Existing, New and Replacement Onsite Wastewater Treatment Systems ***(High Priority Areas)***	Owners of Onsite Wastewater Treatment Systems in High Priority Areas	Owners of Onsite Wastewater Treatment Systems in High Priority areas shall comply with the Advanced Protection Management Program established by this TMDL. For a complete description of the options and requirements of the Advanced Protection Management Program, see section 9.2.7.1.	For a complete description of compliance dates, see section 9.2.7.1.

Table 9.1
Summary of Implementation Actions

Bacteria Source Category	Implementing Parties (Source)	Implementation Actions	Compliance Date(s)
Existing, New and Replacement Onsite Wastewater Treatment Systems ***(Low Priority Areas)***	Owners of Onsite Wastewater Treatment Systems in High Priority Areas	Owners of Onsite Wastewater Treatment Systems in Low Priority areas shall comply with the Advanced Protection Management Program established by this TMDL. For a complete description of the options and requirements of the Advanced Protection Management Program, see section 9.2.7.2.	For a complete description of compliance dates, see section 9.2.7.2.
Existing, New and Replacement Onsite Wastewater Treatment Systems ***(Non-Priority Areas)***	Owners of Onsite Wastewater Treatment Systems in High Priority Areas	Owners of Onsite Wastewater Treatment Systems in Low Priority areas shall comply with the requirements of the Basin Plan's OWTS Policy.	Compliance schedule shall be consistent with an approved LAMP or the Basin Plan's OWTS Policy.
Large Onsite Wastewater Treatment Systems	Owners and operators of all OWTS with projected flow greater than 10,000 gpd or owners of all OWTS with project flow greater than set forth in an approved LAMP	Owners and operators of Large Onsite Wastewater Treatment Systems shall submit a Report of Waste Discharge (ROWD) to the Regional Water Board. The Regional Water Board shall issue WDRs or Waivers of WDRs for the OWTS. For Owners of OWTS located in the geographic area of an Advanced Protection Management Program, the Regional Water Board shall include requirements in the Waiver or WDR that the OWTS Owner comply with supplemental treatment components for pathogens in accordance with requirements in sections 10.10.2 through 10.15 of the Basin Plan's OWTS Policy. Supplemental treatment components shall ensure OWTS effluent does not exceed a 30-day average of 30 mg TSS/L, can achieve an effluent *E. coli* bacteria concentration of less than or equal to 100 MPN/100 mL, and can achieve an effluent enterococci bacteria concentration of less than or equal to 30 MPN/ 100 mL. As an alternative to installing supplemental treatment components for OWTS, owners of large OWTS in High Priority Areas can commit to connecting to a centralized wastewater collection and treatment system, in accordance with Option 2 in Section 9.2.7.1 for individual OWTS.	a) For OWTS with projected flow of over 10,000 gpd, one year from the effective date of the TMDL to submit a ROWD b) For OWTS with projected flow greater than set forth in an approved LAMP, six months after approval of a LAMP for the local agency with jurisdiction over the OWTS

Table 9.1
Summary of Implementation Actions

Bacteria Source Category	Implementing Parties (Source)	Implementation Actions	Compliance Date(s)
Other Onsite Wastewater Treatment Systems	OWTs not covered by the Conditional Waiver of the Basin Plan's OWTS Policy: Cesspools of any kind or size OWTS that utilize any form of effluent disposal on or above the ground surface, slopes greater than 30 percent without a slope stability report approved by a registered professional Decreased leaching area for International Association of Plumbing and Mechanical Officials (IAPMO) certified dispersal systems using a multiplier less than 0.70 OWTS utilizing supplemental treatment without requirements for periodic monitoring or inspections OWTS dedicated to receiving significant amounts of wastes dumped from RV holding tanks Separation of the bottom of dispersal system to groundwater less than two feet, except for seepage pits, which shall not be less than 10 feet Minimum horizontal setbacks less than specified in section 10.6.9 of the Basin Plan's OWTS Policy	Owners of OWTS with conditions described here shall submit Report of Waste Discharge (ROWD) to the Regional Water Board. The Regional Water Board shall issue WDRs or Waivers of WDRs for the OWTS.	a) ROWD shall be submitted as soon as possible, but no later than 5 years after the effective date of the TMDL. b) As specified in applicable WDRs
Recreational Water Use	Sonoma County, Mendocino County, other landowner of a recreational beach	The County or landowner shall submit BLRP to control sources of bacteria. The Regional Water Board will require submission of the BLRP under authority of section 13267 subdivision (b) of the Water Code.	Two years from the effective date of the TMDL to submit a BLRP
Homeless and Farmworker Encampments and Illegal Camping	Sonoma County, Mendocino County, Municipalities, Sonoma-Marin Area Rail Transit (SMART) Other owners of land with homeless or farmworker encampments	The entity shall submit BLRP to control sources of bacteria. The Regional Water Board will require submission of the BLRP under authority of section 13267 subdivision (b) of the Water Code.	Two years from the effective date of the TMDL to submit a BLRP

Table 9.1
Summary of Implementation Actions

Bacteria Source Category	Implementing Parties (Source)	Implementation Actions	Compliance Date(s)
Urban Runoff	Sonoma County, Sonoma County Water Agency, City of Cloverdale, City of Cotati, City of Healdsburg, City of Rohnert Park, City of Santa Rosa, City of Sebastopol, City of Ukiah, Town of Windsor, County of Mendocino	The public entity shall comply with the applicable MS4 Permit	As specified in the applicable NPDES Permit
		The public entity shall submit BLRP to control sources of bacteria. The Regional Water Board will require submission of the BLRP under authority of section 13267 subdivision (b) of the Water Code.	Two years from the effective date of the TMDL to submit a BLRP
California Department of Transportation (Caltrans) Storm Water	Caltrans	The public entity shall comply with General Storm Water Permit (NPDES Permit No. CAS000003)	As specified in the applicable NPDES Permit
Non-dairy Livestock and Farm Animal Waste	Owners and operators of animal facilities, inclusive of animal husbandry, livestock production, other similar agriculture operations, and commercial animal boarding facilities	Owners and operators of animal facilities shall implement BMPs to properly contain and dispose of waste, and mitigate for potential water quality impacts resulting from surface runoff of animal waste and submit a report of waste discharge, as applicable.	Two years from the effective date of the TMDL to establish BMPs
Dairies and CAFOs	Owners and Operators of Cow Dairies and CAFOs	Owners and Operators of Cow Dairies and CAFOs shall comply with requirements set forth in the Conditional Waiver of Waste Discharge Requirements, the general WDR, an individual WDR, or NPDES permit, as applicable. If an enrollee is required to have a Waste Management Plan (WMP) and Nutrient Management Plan (NMP) or a Water Quality Plan (WQP) as a condition of the order, the WQP and NMP shall be updated to address sources of bacteria.	a) As specified in the applicable WDRs or Waiver of WDRs b) For Enrollees under the Conditional Waiver, one year from the effective date of the TMDL to update and implement the Water Quality Plan to address sources of bacteria c) For Enrollees under the general WDR or Permittees under an individual WDR, one year from the effective date of the TMDL to update and implement the Waste Management Plan for production areas (WMP) and/or Nutrient Management Plan (NMP)for manure to land application areas, as appropriate, to address sources of bacteria

The Regional Water Board will include the above effluent limitations and requirements in applicable waste discharge requirements as soon as is practicable, but no later than at the time of the facility's next permit renewal.

9.2.2 WASTEWATER HOLDING POND DISCHARGES TO SURFACE WATERS

There are six municipal wastewater treatment facilities in the Russian River Watershed that collect, treat, dispose, or recycle municipal wastewater and discharge treated effluent from a wastewater holding pond to the Russian River or its tributaries. These facilities are operated by:

- City of Santa Rosa
- Forestville Water District
- Graton Community Services District
- Occidental County Sanitation District
- Russian River County Sanitation District
- Town of Windsor

Each entity authorized to discharge treated wastewater from wastewater holding ponds to the Russian River or its tributaries shall maintain compliance with the following effluent limitations (which equal the *E. coli* and enterococci bacteria wasteload allocations) using the bacteriological results of holding pond effluent samples collected at least weekly for the calendar month for which analyses have been completed:

1. The geometric mean concentration of *E.coli* bacteria shall not exceed 100 MPN/ 100 mL, and

2. The Statistical Threshold Value (STV) for *E. coli* bacteria shall not exceed 320 MPN/ 100 mL.

3. The geometric mean concentration of *enterococci* bacteria shall not exceed 30 MPN/ 100 mL, and

4. The STV for *enterococci* bacteria shall not exceed 110 MPN/ 100 mL.

Within 18 months of the effective date of this TMDL, each entity permitted to discharge treated wastewater from wastewater holding ponds to surface waters shall provide evidence that its discharge is in compliance with the *E. coli* and enterococci bacteria WLAs in this TMDL or prepare and submit to the Regional Water Board a Bacteria Load Reduction Plan (BLRP) (further described in Section 8.3). The BLRP shall provide a description and a time schedule up to ten years after the effective date of the TMDL for actions that will bring the entity into compliance with the *E. coli* and enterococci bacteria WLAs. Possible compliance actions could include any combination of the following:

- Upgrades to existing disinfection systems to a process more completely destructive of wastewater pathogens (e.g., ozone, heat sterilization, ultrafiltration);
- Initial or additional disinfection of holding pond effluent immediately prior to discharge; and
- Zero discharge through expansion of recycled water use or enlargement of wastewater holding ponds.

If studies or other evidence demonstrate to the satisfaction of the Regional Water Board Executive Officer that human-source bacteria and pathogens are effectively killed or removed from the waste stream and are not present in the holding pond discharge, the entity will be considered to be in compliance with the waste load allocations. Accordingly, NPDES permits renewed for these entities will not include effluent limitations for *E. coli* and enterococci bacteria for the discharge from the wastewater holding ponds. Monitoring requirements for wastewater holding pond effluent to document continued compliance with wasteload allocations may be established in the NPDES permit, at the discretion of the permit writer.

For each entity that does not demonstrate to the satisfaction of the Regional Water Board Executive Officer that the holding pond effluent discharge does not contain human-source bacteria and pathogens, the Regional Water Board will include the above effluent limitations and requirements in applicable waste discharge requirements within four years after the effective date of this TMDL. Following the inclusion of effluent limitations and requirements, affected entities shall conduct effluent monitoring for *E. coli* and enterococci bacteria at least weekly at a location or locations where a representative sample of the effluent can be collected. Affected entities shall provide to the Regional Water Board monthly discharge monitoring reports and other reports, as necessary, to demonstrate compliance with effluent limitations.

9.2.3 PERCOLATION PONDS AND DISPOSAL BY IRRIGATION

There are six municipal wastewater treatment facilities and seven privately-owned wastewater treatment facilities in the Russian River Watershed that collect, treat, and dispose of or recycle treated effluent to land via percolation ponds or by irrigation. These facilities are operated by:

- Bohemian Grove (private)
- Calpella County Water District (public)
- Camp Royaneh (private)
- City of Cloverdale (public)
- City of Ukiah (public)
- Geyserville County Sanitation Zone (public)
- Hopland County Water District (public)

- Mayacamas Golf Club (private)
- Rio Lindo Academy (private)
- Russian River County Sanitation District (public)
- Rodney Strong Vineyards (private)
- Salvation Army Lytton Springs Rehabilitation Facility (private)
- Vintner's Inn (private)

Each municipality, district, and private wastewater treatment facility permitted to discharge treated municipal or domestic wastewater to a percolation pond within the Russian River Watershed shall use a treatment process designed to meet the following effluent limitations:

1. The geometric mean concentration of total coliform bacteria shall not exceed 23 MPN/100 mL in any calendar month.

2. The geometric mean concentration of enterococci bacteria shall not exceed 30 MPN/100 mL, and

3. The STV for *enterococci* bacteria shall not exceed 110 MPN/ 100 mL.

The effluent limitation for total coliform bacteria is derived from standards for disinfected secondary-23 treated recycled water contained in California Code of Regulations, title 22, chapter 3, article 1, section 60301.225. Disinfection systems that are designed to consistently achieve this level of disinfection are effective in reducing most wastewater pathogens to non-detectable or very low levels. Use of an effluent disinfection system to meet this total coliform bacteria effluent limitation will ensure compliance with load allocations for *E. coli* bacteria in this TMDL. The effluent limitation for enterococci bacteria implements the load allocation in this TMDL.

For disposal of wastewater to land through irrigation disposal, attainment of bacteria load allocations is achieved through proper treatment plant design and siting and through compliance with waste discharge requirements that contain appropriate effluent limitations and discharge specifications derived to meet standards for secondary-23 treated recycled water in California Code of Regulations, title 22, chapter 3, article 1, section 60301.225, and other requirements that prevent the creation of runoff that could impact surface water.

To demonstrate compliance with these bacteria limitations, facilities shall conduct effluent monitoring at a location or locations where a representative sample of the effluent can be collected, and provide discharge monitoring reports to Regional Water Board staff. The frequency of effluent monitoring for bacteria established in waste discharge requirements is at the discretion of the Regional Water Board, but shall be sufficient to demonstrate compliance with effluent limitations. Waste discharge requirements shall provide justification for the frequency of monitoring. Justification shall be based on factors such as discharge flow, proximity of the discharge to surfaces waters or other site conditions, effluent variability, and other factors, as appropriate.

The Regional Water Board shall include the above effluent limitations and requirements in applicable waste discharge requirements as soon as is practicable.

9.2.4 SANITARY SEWER SYSTEMS

There are eighteen sanitary sewer systems in the Russian River Watershed that collect and convey domestic wastewater to wastewater treatment facilities for treatment, and disposal or recycling. These facilities are operated by:

- Airport/Larkfield/Wikiup Sanitation Zone
- Calpella County Water District
- City of Cloverdale
- City of Cotati
- City of Healdsburg
- City of Rohnert Park
- City of Santa Rosa
- City of Sebastopol
- City of Ukiah
- Forestville Water District
- Geyserville County Sanitation Zone
- Graton Community Services District
- Hopland County Water District
- Occidental County Sanitation District
- Russian River County Sanitation District
- Sonoma State University
- South Park County Sanitation District
- Town of Windsor
- Ukiah Valley Sanitation District

In order to comply with this TMDL, each municipality and district shall (1) maintain compliance with General Waste Discharge Requirements for Sanitary Sewer System, Water Quality Order No. 2006-0003-DWQ (General Order) and all amendments and subsequent updates to the General Order.

In addition, within one year of the effective date of this TMDL, the municipality or district shall revise its approved Sanitary Sewer Management Plan (SSMP) to describe actions that it takes or plans to take to further minimize sanitary sewer overflows, spills, and exfiltration from its sanitary sewer system. Possible actions might include:

- Increasing the frequency and method of surveillance of sanitary sewer pipes, pump stations, siphons, and other sewer infrastructure that are located where overflows, spills, and exfiltration may adversely impact the Russian River or its tributaries;
- Accelerating schedules for pipeline rehabilitation and/or replacement;
- Revising sewer design standards to specify construction materials and methods that will ensure a water-tight sanitary sewer system for new and replacement sewer components in areas adjacent to the Russian River and its tributaries;
- Establishing local ordinances to require property owners to inspect their private sewer lateral upon property transfer, in response to chronic sanitary sewer overflows (SSOs), or after significant changes in property use; and
- Developing programs to enable and help finance ratepayers to voluntarily inspect and repair deteriorating private service laterals.

The Regional Water Board will require submission of the SSMP amendment under authority of section 13267 subdivision (b) of the California Water Code.

9.2.5 LAND APPLICATION OF TREATED MUNICIPAL SEWAGE SLUDGE (BIOSOLIDS)

Currently, the City of Santa Rosa is the only public entity permitted for the land application of biosolids as a soil amendment in the Russian River Watershed. In order to comply with this TMDL, the City of Santa Rosa shall maintain coverage for its biosolids land application projects under General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities, Water Quality Order No. 2004-12-DWQ (General Order), and all amendments and subsequent updates to the General Order, or equivalent individual waste discharge requirements.

In addition, within one year of the effective date of this TMDL, the City of Santa Rosa shall prepare and submit an Erosion Control Plan that describes actions and time schedules for enhanced protections to prevent the movement of biosolids from the application area. Enhanced protections might include:

- Increasing minimum allowable setbacks;
- Installing vegetation buffer strips between the application area and gullies, washes, and other areas that are vulnerable to erosion and washout; and
- Decreasing the pathogen concentration of land-applied biosolids.

The Regional Water Board will require submission of the Erosion Control Plan under authority of section 13267 subdivision (b) of the Water Code. Applicants seeking permit coverage for future projects involving the land application of municipal biosolids shall be required to prepare and submit an Erosion Control Plan, as described above, with the Notice of Intent.

9.2.6 RECYCLED WATER IRRIGATION RUNOFF

There are six municipal wastewater treatment facilities and districts responsible for water recycling projects in the Russian River Watershed that recycle treated effluent through spray irrigation. These facilities are operated by:

- Airport/Larkfield/Wikiup Sanitation Zone
- City of Cotati
- City of Healdsburg
- City of Rohnert Park
- City of Santa Rosa
- City of Sebastopol
- City of Ukiah
- Forestville Water District
- Graton Community Services District
- Occidental County Sanitation District.
- Russian River County Sanitation District, and
- Sonoma State University
- Town of Windsor

Each municipality and district or other entity that is permitted to beneficially reuse treated wastewater for landscape irrigation, agricultural irrigation, or other use allowable under California Code of Regulations, title 22, chapter 3, article 3, section 60303 through 60307 shall maintain compliance with water recycling requirements in State Water Resources Control Board Order WQ 2014-0090-DWQ, General Waste Discharge Requirements for Recycled Water Use, subsequent general orders, individual waste discharge requirements, or Master Water Reclamation Permits.

BMPs to prevent and/or minimize overspray, spills, and incidental runoff shall be described in a Non-Storm Water Best Management Practices (BMP) Plan, or equivalent plan, approved by the Regional Water Board Executive Officer. For Non-Storm Water BMP Plans approved by the Executive officer prior to the effective date of this TMDL, the implementing party shall update and submit to the Regional Water Board Executive Officer for approval an updated BMP Plan within one year of the effective date of this TMDL. The updated Non-Storm Water BMP Plan shall describe existing and/or planned actions to be undertaken to comply with *E. coli* and enterococci bacteria WLAs. Any implementing party without an approved Non-Storm Water BMP Plan by the effective date of the TMDL, shall submit to the Regional Water Board a Non-Storm Water BMP Plan that provides a description and a time schedule for actions that will bring the municipality or other entity into compliance with the *E. coli* and enterococci bacteria WLAs. The Non-Storm Water BMP Plan shall describe actions that prevent recycled water spills and incidental runoff from reuse areas adjacent to the Russian River and its tributaries. All new and updated Non-

Storm Water BMP Plans shall be fully implemented within 5 years of the effective date of the TMDL.

Possible actions in the Non-Storm Water BMP Plan might include:

- Evaluating and, when necessary, improving BMPs to prevent overspray, spills, and incidental runoff;
- Increasing setbacks from recycled water points of use to waterbodies, curbs, pavement and storm water inlets; and
- Improving compliance with recycled water user requirements through increased public outreach and, when necessary, through progressive enforcement.

The Regional Water Board will require the submission of a Non-Storm Water BMP Plan under authority of section 13267 subdivision (b) of the Water Code.

9.2.7 INDIVIDUAL ONSITE WASTEWATER TREATMENT SYSTEMS

Based on evidence of exceedances of the bacteria objective and the presence of human-source pathogenic indicator bacteria in the tributaries and in association with areas with a high density of onsite wastewater treatment systems (OWTS), this TMDL prescribes a risk-based management approach for the regulation of individual OWTS in the Russian River Watershed. This management approach mandates special requirements for those OWTS whose operation is likely to pose the greatest threat to public health and water quality.

To most efficiently implement this risk-based approach, areas within the Russian River Watershed that rely primarily on OWTS for wastewater treatment and disposal are identified and prioritized for application of special provisions based on the threat to water quality from OWTS discharges. Priority ranking consists of two threat ranks: High Priority and Low Priority. In accordance with the Basin Plan's On-site Wastewater System Requirements (Basin Plan OWTS Policy), the geographic area of the Advanced Protection Management Program (APMP) includes the High Priority and Low Priority Areas described below. Areas within the Russian River Watershed that have not been designated as High or Low Priority by the Regional Water Board are not covered by the APMP. Owners of existing, new and replacement OWTS not covered under the APMP must still comply with requirements of the Basin Plan's OWTS Policy.

Based on the TMDL assessment by Regional Water Board staff, High and Low Priority Areas are identified below. The Regional Water Board, in consultation with the local agency, will further define and rank communities and other areas based on the threat to water quality from OWTS within these areas as new data become available.

High Priority Areas include:

- Areas with a high density of OWTS in the lower Russian River Watershed, including the communities of Jenner, Cazadero, Monte Rio, Camp Meeker, Guerneville, Rio Nido, Summer Home Park, Hacienda, Mirabel, and in the Middle Russian River Watershed, including Fitch Mountain near Healdsburg.

Low Priority Areas include:

- Areas with a high density of OWTS in the middle and upper Russian River Watershed, including Oakmont in East Santa Rosa, North Cloverdale, Talmage, and Redwood Valley;
- Areas where OWTS are within 600 linear feet in the horizontal (map) direction of the mainstem Russian River and the following tributaries of the Russian River in the middle and upper Russian River Watershed: Austin Creek, Big Sulphur Creek, Little Sulphur Creek, Commisky Creek, Dry Creek, Dutch Bill Creek, Feliz Creek, Fife Creek, Forsythe Creek, Franz Creek, Green Valley Creek, Laguna de Santa Rosa, Maacama Creek, Mark West Creek, Mill Creek, Pieta Creek, East Fork Russian River, Santa Rosa Creek, Sausal Creek, and York Creek.

9.2.7.1 REQUIREMENTS FOR ALL OWTS IN HIGH PRIORITY AREAS

To comply with the Section 8.1 of this TMDL, which prohibits the discharges of fecal waste material from humans to waters of the state, all existing, new, and replacement OWTS in High Priority Areas in the Russian River Watershed shall meet one of the following options:

Option 1: OWTS Meets Performance Standards for Pathogens

To ensure that any OWTS adequately disinfects domestic wastewater discharges, owners of OWTS shall employ supplemental treatment components for their OWTS. OWTS operating on the effective date of the TMDL shall meet this requirement within three years after the effective date of the TMDL or subsequently being identified as a High Priority Area by the Regional Water Board or the local agency. OWTS using supplemental treatment components shall comply with following requirements:

1. Supplemental treatment components shall ensure effluent does not exceed a 30-day average of 30 mg/L of TSS and can achieve an effluent *E. coli* bacteria concentration of less than or equal to 100 MPN/100 mL and an effluent enterococci bacteria concentration of less than or equal to 30 MPN/ 100 mL.
2. The minimum soil depth and the minimum depth to the anticipated highest level of groundwater below the bottom of the effluent dispersal system shall not be less than three feet. All dispersal systems shall have at least twelve inches of soil cover.
3. Supplemental treatment components shall be designed to meet the applicable performance requirements above and shall be stamped or approved by a Qualified Professional, as defined in Section 1.0 of the Basin Plan's OWTS Policy.

4. Prior to the installation of any proprietary treatment OWTS installed to comply with the performance requirements above, all such treatment components shall be tested by an independent third party testing laboratory.
5. OWTS monitoring to demonstrate continuous compliance with the performance requirements above shall be in accordance with the operation and maintenance manual for the OWTS or more frequently as required by the local agency or Regional Water Board.
6. OWTS shall be equipped with a visual or audible alarm as well as a telemetric alarm that alerts the owner and service provider in the event of system malfunction. Where telemetry is not possible, the owner or owner's agent shall inspect the system at least monthly while the system is in use as directed and instructed by a service provider and notify the service provider not less than quarterly of the observed operating parameters of the OWTS. As defined in the Basin Plan's OWTS Policy, a service provider means a person who is capable of operating, monitoring, and maintaining an OWTS in accordance with the Basin Plan's OWTS Policy.
7. OWTS designed to meet the disinfection requirements shall be inspected for proper operation quarterly while the system is in use by a service provider unless a telemetric monitoring system is capable of continuously assessing the operation of the disinfection system. Testing of the effluent from supplemental treatment components that perform disinfection shall be sampled at a point in the system after the treatment components and prior to the dispersal system and shall be conducted quarterly based on analysis of *E. coli* and enterococci bacteria with a minimum detection limit of 2.2 MPN. All effluent samples must include the geographic coordinates of the sample's location. Effluent samples shall be taken by a service provider and analyzed by a laboratory certified by the State Water Resources Control Board Division of Drinking Water.
8. Reporting of compliance with performance requirements and other pertinent information regarding the operation and maintenance of the OWTS shall be provided to the local agency or the Regional Water Board, as required.
9. New and replacement OWTS shall also comply with local agency requirements for new and replacement OWTS in a Local Agency Management Program (LAMP), or comply with Tier 1 requirements in the Basin Plan's OWTS Policy, as applicable.

Option 2: Connection to a Centralized Wastewater Collection and Treatment System

An owner of an OWTS will be considered to be in compliance with the TMDL if the owners (1) commit by way of a legal document within 4 years after the effective date of the TMDL or subsequently being identified as a High Priority Area by the Regional Water Board or the local agency to connect to the sanitary sewer system of a permitted centralized wastewater collection and treatment system; and (2) the specified date for the connection to the centralized wastewater collection and treatment system does not extend beyond 10 years after the effective date of the TMDL.

Option 3: Permitting of the OWTS under a Local Agency Management Program (LAMP)

In an approved LAMP, a local agency may provide alternative methods to comply with the Fecal Waste Discharge Prohibition to owners of existing, new, and replacement OWTS. To account for local conditions and community preferences, the LAMP could include standards and requirements that differ from requirements in Option 1. However, in order to qualify for use as an alternative means of compliance with this TMDL, the approved LAMP must include the following elements, at a minimum:

1. Minimum standards for existing OWTS (e.g., site requirements, supplemental treatment requirements, etc.) specific to the High Priority Area;
2. A program to review existing, new and replacement OWTS to ensure that they are correctly sited, designed, installed, and operated and maintained;
3. A plan for development of community-specific management plans;
4. A policy governing the repair or replacement of OWTS that ensures that the OWTS does not threaten public health or water quality;
5. Water quality monitoring and reporting; and
6. Time schedule to complete LAMP elements.

In addition, OWTS in High Priority Areas must be inspected and evaluated by a qualified professional to assess their performance. OWTS owners in High Priority Areas are required to obtain a third-party service provider to ensure proper operation and ongoing maintenance of OWTS through inspections performed at least annually.

Local agencies are required to submit their LAMPs for approval to the Regional Water Board no later than May 13, 2016, in accordance with Basin Plan's OWTS Policy. Regional Water Board staff is currently working with staff from Sonoma County and Mendocino County on the development of their LAMPs and anticipate the possibility of revising the LAMPs after the effective date of the TMDL to incorporate requirements and local programs designed to comply with the Russian River TMDL Action Plan.

9.2.7.2 REQUIREMENTS FOR ALL OWTS IN LOW PRIORITY AREAS

All existing OWTS in Low Priority Areas in the Russian River Watershed presumptively covered under the Conditional Waiver of Waste Discharge Requirements established in the Basin Plan's OWTS Policy shall be inspected within three years of the effective date of the TMDL to ascertain whether the OWTS is functioning properly to the extent that the OWTS does not require major repair, as defined in Section 1.0 of the Basin Plan's OWTS Policy, or is not affecting, or will not affect groundwater or surface water to a degree that makes it unfit for drinking or other uses, or is not causing a human health or other public nuisance condition. The minimum requirements for an inspection to satisfy this requirement are listed in section 8.2.7.3, below and a qualified professional's report shall be submitted to the Regional Water Board.

For any existing OWTS that is found as a result of an inspection or report by a qualified professional to be not functioning properly to the extent that the OWTS requires major repair, or is affecting, or will affect groundwater or surface water to a degree that makes it unfit for drinking or other uses, or is causing a human health or other public nuisance condition, the owner of the OWTS shall be required to take corrective action in accordance with the Basin Plan's OWTS Policy. In addition, once corrective actions are completed, the owner of the existing OWTS shall obtain a service provider to ensure proper operation and ongoing maintenance of the OWTS system through annual inspections, at least initially, and longer intervals, as appropriate.

For any existing OWTS found as a result of an inspection or report by a qualified professional to be functioning properly, not requiring major repair, not causing human health or nuisance conditions, and not affecting groundwater or surface water, shall be inspected at least once every five years thereafter, in accordance with section 8.2.7.3, below.

Owners of new and replacement OWTS in Low Priority Areas shall comply with local agency requirements for new and replacement OWTS in a LAMP, or comply with Tier 1 requirements in the Basin Plan's OWTS Policy, as applicable. Owners of new OWTS in Low Priority Areas are required to obtain a third-party service provider within six months after commencing use of the OWTS to ensure proper operation and ongoing maintenance of OWTS. New OWTS shall be inspected at least every five years, in accordance with section 8.2.7.3, below. Replacement OWTS in Low Priority Areas are required to obtain a third-party service provider prior to commencement of operation of the replacement OWTS to ensure proper operation and ongoing maintenance of OWTS through annual inspections, at least initially, and longer intervals, as appropriate.

9.2.7.3 MINIMUM REQUIREMENTS FOR OWTS INSPECTIONS

Where inspections of OWTS are required, owners of OWTS shall submit a qualified professional's report to the Regional Water Board (or County if applicable) that includes a determination of whether the OWTS is functioning properly and as designed or requires corrective action pursuant to Tier 4 of the Basin Plan OWTS Policy. The report shall include, but is not limited to, the following:

1. A general description of system components, their physical layout, and horizontal setback distances from property lines, buildings, wells, and surface waters.
2. A description of the type of wastewater discharged to the OWTS such as domestic, commercial, or industrial and classification of it as domestic wastewater or high-strength waste.
3. A determination of the systems design flow and the volume of wastewater discharged daily derived from water use, either estimated or actual if metered.
4. A description of the septic tank, including age, size, material of construction, internal and external condition, water level, scum layer thickness, depth of solids, and the results of a one-hour hydrostatic test.

5. A description of the distribution box, dosing siphon, or distribution pump, and if flow is being equally distributed throughout the dispersal system, as well as any evidence of solids carryover, clear water infiltration, or evidence of system backup.
6. A description of the dispersal system including signs of hydraulic failure, condition of surface vegetation over the dispersal system, level of ponding above the infiltrative surface within the dispersal system, other possible sources of hydraulic loading to the dispersal area, and depth of the seasonally high groundwater level.
7. A determination of whether the OWTS is discharging to the ground's surface.
8. A determination of the OWTS dispersal system's separation from its deepest most infiltrative surface to the highest seasonal groundwater level or fractured bedrock.

9.2.7.4 GENERAL RESTRICTIONS FOR ALL OWTS IN THE HIGH PRIORITY AND LOW PRIORITY AREAS

For new, replacement, and existing OWTS in High Priority and Low Priority Areas, the following are not authorized for OWTS in the Russian River Watershed, but may be authorized by a separate Regional Water Board order:

1. Cesspools of any kind or size.
2. OWTS receiving a projected flow over 10,000 gallons per day.
3. OWTS that utilize any form of effluent disposal on or above the ground surface.
4. Slopes greater than 30 percent without a slope stability report approved by a registered professional.
5. Decreased leaching area for International Association of Plumbing and Mechanical Officials (IAPMO) certified dispersal systems using a multiplier less than 0.70.
6. OWTS utilizing supplemental treatment without requirements for periodic monitoring or inspections.
7. OWTS dedicated to receiving significant amounts of wastes dumped from RV holding tanks.
8. Separation of the bottom of dispersal system to groundwater less than two feet, except for seepage pits, which shall not be less than 10 feet.
9. Minimum horizontal setbacks less than specified in section 10.6.9 of the OWTS Policy.

9.2.8 LARGE ONSITE WASTEWATER TREATMENT SYSTEMS

For the purpose of this TMDL, a large OWTS means any OWTS with a projected flow greater than 10,000 gpd or any OWTS with projected flow greater than that specified in an approved LAMP. Owners of large OWTS in the Russian River Watershed not regulated by WDRs or a Waiver of WDRs on the effective date of this TMDL shall notify the Regional Water Board by submitting a report of waste discharge containing information about their OWTS. Based on the report of waste discharge, the Regional Water Board may issue WDRs or Waivers of WDRs for the OWTS. Owners of OWTS with a projected flow greater than 10,000 gpd shall submit a report of waste discharge to the Regional Water Board within one year of the effective date of this TMDL. Owners of OWTS not meeting conditions and requirements in a LAMP approved for the local agency with jurisdiction over the OWTS shall submit a report of waste discharge to the Regional Water Board within six months after the approval of the LAMP.

OWTS subject to this subsection that are identified in this TMDL as being located in High Priority Areas shall be required in a WDR or Waiver of WDR to comply with supplemental treatment components for pathogens in accordance with requirements in sections 10.10.2 through 10.15 of the Basin Plan's OWTS Policy for impaired areas. Supplemental treatment components shall ensure OWTS effluent does not exceed a 30-day average of 30 mg TSS/L, can achieve an effluent *E. coli* bacteria concentration of less than or equal to 100 MPN/100 mL, and can achieve an effluent enterococci bacteria concentration of less than or equal to 30 MPN/ 100 mL. As an alternative to installing supplemental treatment components for OWTS, owners of large OWTS in High Priority Areas can commit to connecting to a centralized wastewater collection and treatment system, in accordance with Option 2 in Section 8.2.7 for individual OWTS. In Low Priority Areas, appropriate waste discharge requirements will be prescribed by the Regional Water Board.

For large OWTS permitted, constructed, or operating prior to the effective date of this TMDL and regulated by existing waste discharge requirements, the Regional Water Board will include in the waste discharge requirements, as soon as is practicable, effluent limitations and other requirements to demonstrate compliance with the above discharge specifications. For permitted large OWTS, the Regional Water Board shall require the submission of the report of waste discharge under authority of section 13260 of the Water Code.

For large OWTS constructed after the effective date of this TMDL, effluent limitations and other requirements shall be established in waste discharge requirements as the permits are adopted.

9.2.9 RECREATIONAL WATER USE

Within two years of the effective date of this TMDL, Sonoma County, Mendocino County, and other landowners of recreational beaches shall prepare and submit a BLRP that describes actions to reduce bacteria loading associated with activities at recreational beaches and other known swimming areas within their jurisdiction to attain load allocations. Regional Water Board staff will review the BLRP and determine the appropriate program actions to regulate the implementation actions proposed in the BLRP. Potential implementation actions could include:

- Installing temporary or permanent restroom facilities, including diaper changing stations, near the recreation use areas and signage to effectively direct recreators to restroom facilities;
- Establishing interagency agreements with local sanitation districts to provide maintenance and waste disposal for temporary restroom facilities;
- Developing and distributing educational and outreach materials (fliers, brochures) to inform river recreators about proper waste disposal and sanitation at beaches and access points along the Russian River and tributaries;
- Conducting outreach to private recreational beach operators and commercial river outfitters to improve beach housekeeping and provide adequate sanitation facilities for customers;
- Publicizing locations of public restroom facilities on the county website and at recreational outfitters' headquarters;
- Improving restroom facilities at popular private beaches; and
- Limiting availability of parking along county roads near beach areas where waste collection is difficult.

9.2.10 HOMELESS AND FARMWORKER ENCAMPMENTS AND ILLEGAL CAMPING

Within two years of the effective date of this TMDL, Sonoma County, Mendocino County, municipalities, and other owners of land with homeless and farmworker encampments within the Russian River Watershed shall prepare and submit a BLRP that describes actions to: (1) reduce noncompliance with existing ordinances pertaining to illegal camping and farmworker housing; and (2) provide secure waste disposal facilities for homeless persons currently residing along watercourses and other areas within the public space. The BLRP must include an implementation schedule that ensures attainment of load allocations in the shortest time practicable, milestones to achieve compliance, a commitment to provide periodic status reports to the Regional Water Board to monitor progress toward completing the BLRP and compliance milestones, and a monitoring plan through which compliance with load allocations can be assessed. Regional Water Board staff will review the BLRP and determine the appropriate program actions to regulate the implementation actions proposed in the BLRP.

Implementation actions might include:

- Providing or improving options for shelters, transitional housing, affordable housing, and other homeless services;
- Conducting public outreach to owners of private property in the Russian River Watershed to inform and assist them on how best to prevent illegal camping and trespassing on their property, including how to report illegal use to local law enforcement;

- Establishing a program, including a hotline, for reporting homeless encampments and facilitating camp cleanup activities;
- Installing physical barriers to prevent illegal camping and habitation under bridges and overpasses; and
- Initiating and participating in pilot programs that provide public restroom facilities along public trails and upgraded restroom facilities at public parks.

Options to reduce water quality impacts of homeless and farmworker encampments can also be combined with efforts to reduce homelessness. Sonoma County, Mendocino County, and municipalities are encouraged to fully fund and implement goals, objectives, and policies contained in their general plans for homeless and farmworker populations. More affordable, available housing will result in fewer residents seeking shelter along waterways, away from adequate sanitation facilities.

Where suitable housing for homeless persons and farmworkers exists or is planned, and the housing unit is served by an individual septic system, community septic system, or other approved waste treatment and disposal system, the design, installation, and operation of the system shall comply with this TMDL Action Plan and the LAMP for the local agency with jurisdiction over individual OWTS.

9.2.11 URBAN RUNOFF

Within the Russian River Watershed's urban boundaries, storm water runoff and non-storm water runoff is regulated under a Phase I Municipal Separate Storm Sewer Systems (MS4) Permit. The current Phase I MS4 Permit, Order No. R1-2009-0050 (NPDES Permit No. CA0025054) became effective on October 1, 2009, and continues in force until a new permit is issued. Small MS4s within the watershed are enrolled under Water Quality Order No. 2013-0001-DWQ, National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000004, Waste Discharge Requirements (WDRs) for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (Phase II MS4 General Permit).

Permittees currently named under the Phase I MS4 Permit are:

- City of Santa Rosa
- County of Sonoma
- Sonoma County Water Agency

Small MS4s in the Russian River Watershed currently enrolled under the Phase II MS4 General Permit are:

- City of Cloverdale
- City of Cotati.
- City of Healdsburg

- County of Sonoma
- Sonoma County Water Agency
- Sonoma State University
- Town of Windsor

In order to comply with this TMDL, discharges of urban storm water from MS4s in the Russian River Watershed shall attain the *E. coli*, and enterococci bacteria waste load allocations.

Upon renewal of the Phase I MS4 permit or as soon as is practicable, the Regional Water Board will establish permit requirements for MS4s to comply with wasteload allocations. In addition, MS4 permittees will be required to develop and implement additional best management practices to reduce the discharge of pathogens from MS4s to surface waters from illicit discharges, sanitary sewer overflows, and improper disposal of pet waste. To reduce pet waste from entering surface waters, possible action include:

- Improving or establishing a pet waste program that could include more widespread availability of pet waste collections systems and a higher profile outreach program to educate the public about proper disposal of pet waste and the environmental consequences of improper disposal; and
- Partnering with local businesses and organizations to sponsor the installation, operation, and maintenance of pet waste collection systems.

For Phase II MS4 permittees, TMDL-specific permit requirements shall be submitted to the State Water Board for inclusion in Attachment G of the Phase II MS4 General Order, as soon as practicable.

9.2.12 CALTRANS STORM WATER RUNOFF

The California Department of Transportation (Caltrans) is regulated under General Storm Water Permit (NPDES Permit No. CAS000003), Waste Discharge Requirements Order No. 2012-0011-DWQ and Order 2014-0077-DWQ, which is an amendment to include TMDL-specific permit implementation requirements. The statewide permit regulates storm water and non-storm water discharges from the Department's properties and facilities, and discharges associated with operation and maintenance of the state highway system.

In order to comply with this TMDL, storm water and non-storm water discharges from Caltrans' facilities and properties in the Russian River Watershed shall attain the waste load allocations identified in Table 8.1. Upon renewal of the statewide storm water permit or as soon as is practicable, Regional Water Board staff will work with the State Water Board to include the Russian River Pathogen Indicator Bacteria TMDL in the TMDL requirements of the permit to ensure compliance with *E. coli* and enterococci bacteria wasteload allocations. Permit renewal is likely in 2017 or 2018.

Implementation actions might include:

- Managing irrigation to ensure overwatering and runoff does not occur;
- Identifying and fixing broken sprinklers and irrigation pipes;
- Increasing infiltration by improving soil structure and texture;
- Adding structural management practices such as biofiltration strips, biofiltration swales, bioretention and biodetention basins;
- Diverting storm water runoff to bioretention/biodetention/infiltration basins;
- Street sweeping;
- Cleaning up illegal dumping;
- Limiting or excluding access for camping under bridges and in the right-of-way; and
- Developing and implementing a program, in collaboration with local jurisdictions, to report, respond to, and remove homeless encampments.

9.2.13 NON-DAIRY LIVESTOCK AND FARM ANIMALS

Owners and operators of animal facilities, inclusive of animal husbandry, livestock production, other similar agriculture operations, and commercial animal boarding facilities, shall implement best management practices to properly contain and dispose of waste, and mitigate for potential water quality impacts resulting from surface runoff of animal waste. Possible actions may include:

- Regular cleanup of manure and soiled bedding in animal habitation areas;
- Use of impermeable surfaces for storage of manure;
- Use of onsite composting to stabilize and reuse manure;
- Siting of manure storage areas away from water courses and off slopes;

- Reduction of storm water contacting manure storage areas, paddocks, and kennel areas;
- Use of vegetated buffers to encourage uptake of pollutants; and
- Limiting of animals' access to waterways.

The requirement of owners and operators of animal facilities to submit a report of waste discharge for discharges from these operations is waived for animal facilities that implement these or similar best management practices that achieve the same purpose, which is to protect water quality and public health. Owners and operators of animal facilities found to be in violation of the prohibition may be subject to enforcement action for the unpermitted discharge, and may be required to submit a report of waste discharge for the possible establishment of waste discharges requirements for the discharge.

9.2.14 DAIRIES & CAFOS

Each cow dairy and Confined Animal Feeding Operation (CAFO) in the Russian River Watershed is required to maintain compliance with requirements set forth in the Conditional Waiver of Waste Discharge Requirements, the general WDR, an individual WDR, or NPDES permit, as applicable.

Within two years of the effective date of this TMDL, in order to prevent discharges of animal waste to surface water, each enrollee under the Conditional Waiver of Waste Discharge Requirements shall update its Water Quality Plan (WQP) to address sources of bacteria. Each enrollee under the general WDR and each permittee under an individual WDR shall update their Waste Management Plan and Nutrient Management Plan (NMP), as appropriate, to address sources of bacteria. The updated actions to be taken by the enrollee or permittee shall be actions that are beyond what is currently required under the respective permit.

At a minimum, the WQP and NMP shall be updated to include:

- Actions, such as riparian fencing, that prevent animal access to water courses and provide a vegetated buffer to reduce manure runoff;
- A surface water monitoring plan that includes routine monitoring for pathogen indicator bacteria to demonstrate attainment of WLAs or LAs. Coordination between dairies and CAFOs, including but not limited to group monitoring, is encouraged; and
- An implementation schedule, with a commencement date not exceeding two years from the effective date of this TMDL.

The Regional Water Board will incorporate the requirement to address sources of bacteria into renewed Conditional Waiver of Waste Discharge Requirements, Waste Discharge Requirements, or NPDES Permit when these orders come up for renewal, and into new dairy WDRs as they are proposed and adopted. WLAs for CAFOs will be incorporated into the NPDES permit as effluent limitations.

9.3 BACTERIA LOAD REDUCTION PLAN

The goal of the BLRP is to describe and ensure effective implementation of actions that will reduce pathogens and indicator bacteria to attain the WLAs and LAs in the Russian River Watershed. The BLRP should be designed to identify, eliminate, reduce and clean up existing sources to the maximum extent practicable, prevent and control new sources, monitor, and implement additional actions as necessary.

The BLRPs can be developed cooperatively with other implementing parties or individually. An implementing party that is required to submit BLRPs for more than one source type may combine the individual BLRPs into one master document.

9.3.1 TIME SCHEDULE FOR PLAN DEVELOPMENT AND REVIEW

The following is the development and review process for a BLRP:

1. The implementing party or parties develops a draft BLRP.
2. The implementing party or parties submits its BLRP to the Regional Water Board in accordance with Table 9.1. Additional time to submit a BLRP may be granted by the Regional Water Board's Executive Officer upon the request of the implementing party or parties if necessary due to the complexity or level of public involvement in the BLRP.
3. Regional Water Board staff reviews the BLRP.
4. Within 6 months of the submittal of a complete BLRP, Regional Water Board staff will publicly notice a Memorandum of Recommended BLRP Acceptance for 21 days.

9.3.2 PLAN ORGANIZATION

The BLRP shall contain the following elements in order to be deemed complete and accepted. Should an element not apply, the implementing party or parties should provide a brief explanation of its inapplicability.

1. Party Information and Legal Authority
   - **a.** The BLRP shall include the name of the implementing party or parties.
   - **b.** For a municipality, state, federal, or other public agency, the BLRP shall include the name of the duly authorized representative(s). A duly authorized representative is either a principal executive officer or ranking elected official, or a duly authorized representative of that person. A duly authorized representative is also a person who has responsibility for the overall operation of the subject facility or activity.

   c. The BLRP shall include a map of the implementing party's or parties' jurisdictional boundary along with the receiving waters and sub-watershed boundaries that overlap the jurisdictional boundary to facilitate planning, assessment, and collaborative decision-making.

   d. The BLRP shall include a demonstration that the implementing party or parties or duly authorized representative(s) possess the legal authority to implement the actions contained in the BLRP, such as through ordinances, service agreements, or other legally binding procedures.

2. Sources

   a. The BLRP shall include the sources of pathogens and indicator bacteria potentially contributing to exceedances of the WLAs or LAs within the jurisdiction of the responsible party or parties.

   b. The sources of potential sources of fecal waste shall be identified on a map.

   c. The BLRP shall describe how sources are determined and characterized.

3. Description of Actions

   a. The BLRP shall include a description of specific pollution prevention actions (e.g., water conservation and waste minimization), management measures, or treatment facilities that are being implemented or will be implemented to reduce the concentration of pathogens and indicator bacteria from identified sources.

   b. The locations of the specific management measures shall be identified on a map if appropriate. For example, it is appropriate to map new restroom facilities, but not appropriate to map public outreach efforts.

   c. The BLRP shall include scientific and technical documentation used to conclude that the actions, once fully implemented, are expected to achieve compliance with the WLAs and LAs.

   d. If the BLRP is a cooperative document among multiple implementing parties, the BLRP shall indicate which party is responsible for each of the actions.

4. Schedule

   a. The BLRP shall include a schedule for implementing the actions within the shortest time practicable.

5. Monitoring, Reporting, and Adaptive Management

   a. The BLRP shall describe the frequency of periodic status reports, which shall be submitted to Regional Water Board staff. Reports shall include the status of the actions taken and to be taken, and any other necessary content.

   b. The BLRP shall describe how, when, and where the effectiveness of actions will be monitored and assessed. The BLRP shall describe the frequency of effectiveness monitoring reports and assessments, which shall be submitted to Regional Water

Board staff. The purpose of effectiveness monitoring is to understand if actions are improving pathogen and indicator bacteria concentrations (or loads) in the Russian River and its tributaries.

c. All water quality data collected to satisfy the BLRP shall be collected in accordance with a Quality Assurance and Project Plan developed per Guidance for Quality Assurance Project Plans EPA QA/G-5. Publication No. EPA/240/R-02/09 (U.S. EPA 2002c). Additionally, such data shall be uploaded by the implementing party or parties into the California Environmental Data Exchange Network.

d. The BLRP shall describe how the BLRP will be updated based on monitoring and performance assessments. It is expected that, in some cases, additional actions will be required if data from effectiveness monitoring shows exceedances of allocations. It is expected that the BLRP will be assessed and revised at least every 5 years.

CHAPTER 10
MONITORING

Monitoring provides data and information that allows for assessment and adaptive management. By monitoring discharges and receiving waters, it is possible to evaluate the progress toward completion of implementation actions. By identifying the actions that work best, monitoring data enables more efficient distribution of funds and resources and subsequent improvements in BLRPs and permit requirements. By assessing implementation actions and instream data, it is possible to evaluate the progress toward attainment of the TMDLs/loading capacities. And finally, monitoring data provides the feedback that indicates if modifications of the TMDL targets and water quality standards are necessary.

This chapter describes TMDL requirements and implementing parties for monitoring, assessment, and adaptive management, while also providing an umbrella stewardship approach for cooperation and collaboration in the Russian River Watershed.

10.1 STEWARDSHIP & THE RUSSIAN RIVER WATERSHED MONITORING PROGRAM

There are many opportunities for cooperation and collaboration in regards to monitoring in the Russian River Watershed. Residents, recreators, cities, counties, state agencies, federal agencies, and other stakeholders have a vested interest and/or specific TMDL requirements to address sources of pathogens and indicator bacteria and monitor the effect of those actions. By forming a monitoring coalition to identify problems, develop and implement solutions, coordinate monitoring, evaluate progress, and make adjustments, more progress toward a healthy watershed can be made with less cost. These elements are keys to the concept of watershed stewardship.

Regional Water Board staff will work to form a Russian River Watershed monitoring coalition to help coordinate and conduct required monitoring. The watershed-wide monitoring program will be modeled on the Klamath Basin Monitoring Program and San Francisco Bay Regional Water Board's Regional Monitoring Program. It will likely include:

- Coordinating instream sampling efforts to reduce duplication of efforts and costs
- Coordinating sampling methods, protocols, and Quality Assurance/Quality Control requirements so data from multiple entities are comparable
- Compiling and sharing data with possible upload of data to the California Environmental Data Exchange Network
- Assessing and interpreting data to inform load reduction actions
- Reporting and sharing data and information with stakeholders and the public

- Conducting regular meetings to share and discuss implementation activities, data results, research, and other information critical to water quality and the health of the Russian River Watershed

10.2 MONITORING & REPORTING OF IMPLEMENTATION ACTIONS

As described in Chapter 8, dischargers and parties responsible for sources of pathogens and indicator bacteria are required to develop and implement a BLRP. The BLRP includes requirements to report the status of individual implementation actions to the Regional Water Board. Dischargers and implementing parties are also required to monitor, assess, and report on the effectiveness of their implementation actions required under a BLRP. The purpose is to understand if actions are improving pathogen and indicator bacteria concentrations (and loads) in the Russian River and tributaries. Regional Water Board staff will evaluate this information on an implementing-party-by-implementing-party basis to ensure implementation actions are executed as planned and on schedule, and are being maintained and working as expected. If this is not the case, staff will work with implementing parties to revise the BLRP and use alternative implementation actions.

Regional Water Board staff will compile the above information, assess progress and effectiveness on a watershed or sub-watershed scale, and provide a report on a regular basis, likely every five years. The report may be accomplished through an informational presentation to the Regional Water Board or as part of a larger stewardship report.

10.3 MONITORING & REPORTING OF TMDL ATTAINMENT

The Sonoma County Department of Health Services, Environmental Health and Safety Section currently conducts this monitoring at several of the beaches listed in Table 10.1. In past years, the Regional Water Board has provided funding and staffing. There may be future opportunities for the Regional Water Board and other stakeholders to partner with the counties to ensure this monitoring is funded and executed. Additionally, this monitoring effort may be used to satisfy effectiveness monitoring requirements in the counties' BLRPs.

In order to assess changes in in-stream conditions and attainment of the TMDLs/loading capacities, indicator bacteria data should be collected in mainstem Russian River and tributary sites. The County of Sonoma, the County of Mendocino, City of Healdsburg, City of Sebastopol, and the City of Santa Rosa should participate in a the Russian River Watershed Regional Monitoring Program. It is recommended that water sample for *E. coli* and enterococci bacteria concentrations be collected at the mainstem Russian River beaches listed in Table 10.1 and shown in Figure 10.1 be at least weekly from May 15 through September 30. All water quality data collected should be collected in accordance with a Quality Assurance and Project Plan developed per U.S. EPA (2002c). Additionally, such data shall be uploaded by the coalition or individual into the California Environmental Data Exchange Network.

Table 10.1
TMDL Attainment Monitoring Locations

Hydrologic Subarea	Russian River Watershed Beach	Location
Coyote Valley	Russian River at Mill Creek Park	Potter Valley
Forsythe Creek	Russian River at Mariposa Swimming Hole	Redwood Valley
Geyserville	Russian River at Cloverdale River Park	Cloverdale
Guerneville	Russian River at Veteran Memorial Beach	Healdsburg
	Russian River at Riverfront Park	Windsor
	Russian River at Steelhead Beach	Forestville
	Russian River at River Access Beach	Forestville
	Russian River at Sunset Beach	Forestville
	Russian River at Johnson's Beach	Guerneville
	Russian River at Monte Rio Beach	Monte Rio
	Green Valley Creek at Martinelli Road and River Road	Forestville
Laguna	Laguna de Santa Rosa at Sebastopol Community Park	Sebastopol
Santa Rosa	Matanzas Creek at Doyle Park and Bethards Drive	Santa Rosa
	Santa Rosa Creek at Highway 12	Santa Rosa
	Santa Rosa Creek at Railroad Street	Santa Rosa
Ukiah	Russian River at Vichy Springs Park	Ukiah
	Russian River at Mill Creek Park	Ukiah
Warm Springs	Foss Creek at Matheson Street	Healdsburg

Figure 10.1: TMDL Attainment Monitoring Locations

10.3.1 IDENTIFICATION OF BACTERIA SOURCES

Since both *E. coli* and enterococci bacteria can originate from natural sources, the human and domestic animal sources causing exceedance of the concentration-based TMDLs should also be investigated in the BLRPs and Russian River Watershed Regional Monitoring Program. There are numerous laboratory analyses that can confirm the presence of waste from human or domestic animals (Griffith et al. 2013).

Bacteroides bacteria

Because of the short life span, *Bacteroides* bacteria concentrations are often used to indicate recent fecal contamination of surface waters. *Bacteroides* bacteria are a suitable indicator of a waterbody's bacteriological quality since the bacteria come from the gastrointestinal systems of animals, they degrade rapidly outside of the body, and technology is available to trace the bacteria back to specific types of animals, including humans and domestic animals. Host-specific *Bacteroides* bacteria can be used to help assess the natural background of pathogenic indicator bacteria in minimally disturbed waterbodies. Current recommended genetic markers and protocols for *Bacteroides* bacteria analysis are described by Griffith et al. (2013). Additional markers may also be appropriate in the future as technology advances to improve assay sensitivity and performance.

Bacteriophages

Measurement of *Bacteroides* bacteriophages may provide additional information on animal hosts. *Bacteroides* bacteria are rapidly inactivated by environmental oxygen levels, but *Bacteroides* bacteriophages are resistant to degradation. One group of phages that specifically uses *B. fragilis* strain HSP40 as host is found only in human feces and not in feces of other animals.

Viruses

Several methods detect viruses excreted in feces and/or urine with high specificity to human waste and almost no cross-reactivity with other sources. Among the virus methods, markers for DNA viruses, such as human adenovirus and human polyomavirus, are among the more sensitive and robust. These viruses are fairly widespread among humans, and a sizable portion of the population sheds polyomaviruses passively. In addition, the DNA genomes of these viruses are less labile than those of common human enteric viruses with RNA genomes, which may make them more resistant to environmental degradation and therefore easier to detect.

Chemical Source Tracking

Chemicals found in wastewater might be useful for independently confirming human waste in ambient surface waters. Measurement of chemicals that could include optical brighteners used in laundry detergents, caffeine, fecal sterols (metabolic byproducts of human digestion processes), and metabolite of nicotine (cotinine) excreted by tobacco users.

10.3.2 REPORTING AND ASSESSMENT

The assessment of *E. coli* and enterococci concentrations and TMDL target attainment in tributary streams and creeks shall be assessed by Regional Water Board staff by compiling available instream data. Available data may include effectiveness monitoring data submitted by the monitoring coalition or by individual implementing parties under their BLRPs, data collected by other watershed stakeholders, and data collected by the Surface Water Ambient Monitoring Program and other Regional Water Board efforts. These data could be shared and coordinated via a cooperative Russian River Watershed monitoring coalition.

Regional Water Board staff will assess progress toward attainment of the TMDLs/loading capacities on a watershed or sub-watershed scale, and provide a report on a regular basis, likely every five years. The report may be accomplished through an informational presentation to the Regional Water Board or as part of a larger stewardship report.

10.4 POST TMDL-ATTAINMENT OR NON-ATTAINMENT PROCEDURES

When reaches of the Russian River and/or its tributaries attain the TMDLs/loading capacities, it is assumed that wasteload and load allocations are attained in the watersheds, and the following procedures shall take place in those reaches. Should instream data again identify impairment after TMDL attainment, these procedures shall not apply.

1. Effluent limitations and other pertinent discharge requirements established in WDRs and conditional waivers of WDRs will remain in place.
2. Implementation actions already in place shall be maintained by the implementing party or parties.
3. Implementation actions that are described in a BLRP but have not yet been put into place shall not be required.
4. Status reports for TMDL implementation actions shall no longer be required.
5. Effectiveness monitoring shall continue to ensure water quality does not degrade, although the monitoring and reporting frequency can be reduced if approved by the Executive Officer.

CHAPTER 11
CEQA SUBSTITUTE ENVIRONMENTAL ANALYSIS

Staff from the Regional Water Board has developed a proposed amendment to the Basin Plan that would incorporate the *Action Plan for the Russian River Watershed Pathogen Indicator Bacteria TMDL* (Action Plan) into the Basin Plan. The proposed Action Plan consists of a description of the TMDL pathogen indicator bacteria-related load allocations, numeric targets, and implementation actions necessary to comply with the TMDL. The proposed Action Plan also includes the following prohibition:

> *Discharges of waste containing fecal waste material from humans or domestic animals to waters of the state within the Russian River Watershed that cause or contribute to an exceedance of the bacteria water quality objectives not authorized by waste discharge requirements or other order or action of the Regional or State Water Board are prohibited.*

The proposed Action Plan is necessary to comply with existing federal and State laws, regulations, plans and policies.

The Regional Water Board is the lead agency for evaluating the environmental impacts of a Basin Plan amendment pursuant to the California Environmental Quality Act (CEQA). Although subject to CEQA, the Regional Water Board basin planning process is certified by the Secretary for Natural Resources as “functionally equivalent” to CEQA, and therefore exempt from the requirement for preparation of an environmental impact report or negative declaration and initial study[13]. The State Water Board CEQA Implementation Regulations for Certified Regulatory Programs[14] require the development of Substitute Environmental Documentation (SED) which shall include, at a minimum, all of the following:

1. Provide a brief description of the proposed project (Chapter 11.1; Details described in Chapters 1-10).
2. Identify any significant or potentially significant adverse environmental impacts of the proposed project. (Chapter 11.4)
3. Provide a discussion of the reasonably foreseeable alternatives to the proposed project. (Chapter 11.2)
4. Provide an analysis of mitigation measures needed to avoid or minimize any significant adverse environmental impacts of the proposed project. (Chapter 11.4)

[13] Cal. Code Regs., tit. 14, § 15251(g); Cal. Code Regs., tit. 23, § 3777.
[14] Cal. Code Regs., tit. 23, § 3777.

5. Provide an analysis of the reasonable foreseeable methods of compliance. (Chapters 9 and 11.4)

The SED shall contain an environmental analysis of reasonably foreseeable methods of compliance (compliance measures) for the project that include the following components:[15]

1. An analysis of the environmental impacts from the reasonably foreseeable methods of compliance. The reasonably foreseeable methods of compliance (hereinafter compliance measures) are the potential actions that responsible parties may employ to comply with the TMDL load allocations, numeric targets and the implementation measures in the proposed Action Plan. (Chapter 11.4)
2. An analysis of the reasonably foreseeable feasible mitigation measures relating to the identified environmental impacts of the compliance measures. (Chapter 11.4)
3. An analysis of reasonably foreseeable alternative means of compliance with the rule or regulation, which would avoid or eliminate any identified impacts. (Chapter 11.2)

The SED must take into account a reasonable range of:[16]

1. Environmental, economic, and technical factors. (Chapters 1-12)
2. Population and geographic areas. (Chapters 1 & 2 &11)
3. Specific sites (Chapters 9 & 11)

While the regulations require consideration of a "reasonable range" of the factors listed above, an examination of every site is not required.[17] The statute specifically states that the agency shall not conduct a "project-level analysis[18]." Rather, in most circumstances, the site-specific analysis will be performed by the responsible party or the agency with jurisdiction when an activity is conducted in conformance with the Basin Plan amendments.

Notably, the Regional Water Board is prohibited from specifying the manner of compliance with its regulations[19], and accordingly, the actual environmental impacts will necessarily depend upon the compliance strategy selected by the responsible party.

[15] Cal. Code Regs., tit. 23 § 3777(b)(4); Cal. Code Regs., tit. 14 § 15187(c); Cal. Pub. Resources Code, § 21159 (c).
[16] Cal. Code Regs., tit. 23 § 3777(c); Cal. Code Regs., tit. 14 § 15187(d); Cal. Pub. Resources Code, § 21159 (c).
[17] Cal. Code Regs., tit. 23 § 3777(c);
[18] Public Resources Code § 21159(d)[19] Cal. Water Code § 13360
[19] Cal. Water Code § 13360

The *Staff Report for the Action Plan for the Russian River Watershed Pathogen Indicator Bacteria TMDL* (Staff Report), which includes the CEQA checklist, along with the Action Plan, public comments and responses to comments, and the resolution approving the Action Plan, fulfill the requirements of California Code of Regulations, title 23, section 3777, and the Regional Water Board's substantive CEQA obligations.

Any potential environmental impacts associated with implementation of the Action Plan depend upon the specific compliance projects selected by the responsible parties, many of whom are public agencies subject to their own CEQA obligations[20]. Consistent with CEQA, the SED does not engage in speculation or conjecture but rather considers the reasonably foreseeable feasible mitigation measures, and the reasonably foreseeable methods of compliance, which would avoid, or minimize the identified impacts.

The Regional Water Board recognizes that there may be project-level impacts that the local public agencies may determine cannot be avoided or minimized to have less than significant adverse impacts. To the extent there are unavoidable adverse environmental effects, the necessity of implementing the federally required TMDL via the Action Plan and removing the water quality impairment from the Russian River Watershed (an action required to achieve the national policy of the Clean Water Act) outweigh the unavoidable adverse environmental effects.

11.1 SUMMARY OF PROPOSED ACTION PLAN

The proposed Action Plan is described in detail in chapters 1-10 of this staff report. In summary, the Action Plan is proposed to include the following elements.

1. An analysis of the sources of pathogenic contamination within the Russian River Watershed.
2. The Total Maximum Daily Load (TMDL) of pathogenic waste that can be discharged to the Russian River Watershed and still attain water quality objectives.
3. Waste load and load allocations for pathogenic waste applicable to all controllable factors identified within the Russian River Watershed.
4. A new Waste Discharge Prohibition specific to unauthorized discharges to the Russian River Watershed.
5. Requirement of responsible parties to develop:
    a. *Bacteria Load Reduction Plan* for wastewater holding ponds discharging to surface water, recreational uses, homeless and farmworker encampments, and Caltrans;
    b. *Sanitary Sewer Management Plan*;
    c. *Erosion Control Plan* for land disposal of biosolids;

[20] Public Resources Code § 21159.2

   - **d.** *Non-Storm Water BMP Plan* for recycled water projects;
   - **e.** *Water Quality Management Plan, Waste Management Plan, or Nutrient Management Plan* for dairies;
   - **f.** *Report of Waste Discharge* or *Bacteria Load Reduction Plan* for large private OWTS, OWTS not meeting conditions of the Conditional Waiver of Waste Discharge Requirements, and perhaps municipal storm water.

6. A discussion of permitting, implementation of the prohibition, and enforcement.
7. A discussion of monitoring and adaptive management.

11.2 ALTERNATIVES ANALYSIS

Regional Water Board staff has identified two approaches (or alternatives) to address the pathogen indicator bacteria impairment in the Russian River Watershed. The following sections discuss the two alternatives: 1) Adoption of the Action Plan (i.e., adoption of the proposed Basin Plan amendment), and 2) No Action.

11.2.1 ALTERNATIVE 1 - ADOPTION OF THE ACTION PLAN (PREFERRED ALTERNATIVE)

The Preferred Alternative is adoption of the Action Plan, including establishment of the human and domestic animal waste discharge prohibition for the Russian River Watershed. The Action Plan includes the source assessment, waste load allocations and load allocations for each of the identified sources, and an implementation program describing the actions likely necessary to achieve the TMDL allocations and numeric targets. Regional Water Board staff will conduct reviews to evaluate the success of implementation actions aimed at reducing loading to achieve the allocations. A coordinated monitoring program will be required to provide data and information about whether the implementation actions are working and if the TMDL is being achieved. The Action Plan requirements will be implemented through updates to existing permits and through existing Regional Water Board authorities. Staff have determined that this alternative is the most likely to result in attainment of water quality standards in a reasonable period of time and that most of the impacts resulting from this action are generally less than significant or can be mitigated. Therefore, this is the preferred alternative.

11.2.2 ALTERNATIVE 2 - NO ACTION

Under the No Action alternative, no amendment to the Basin Plan would occur (no Action Plan adopted) and staff would continue to implement existing Regional and State Water Board programs and permits. The Regional Water Board would not require specific load reductions from each source and the proposed prohibition would not be enacted.

Under the No Action alternative, the Regional Water Board would not adopt a TMDL for the Russian River Watershed. Under this scenario, all existing OWTS in the Russian River Watershed would continue to comply with the Basin Plan requirements for onsite wastewater treatment systems (OWTS). If the Regional Water Board does not adopt a TMDL within two years of the TMDL completion date specified in Attachment 2 of the statewide OWTS Policy (i.e., by the end of 2018), coverage under the OWTS Policy's conditional waiver of WDRs will expire for any OWTS that has any part of its dispersal system within 600 feet of the water bodies listed in Attachment 2 for pathogens. These reaches include:

- Lower Russian HA, Guerneville HAS, mainstem Russian River from Fife Creek to Dutch Bill Creek
- Lower Russian HA, Guerneville HAS, Green Valley Creek Watershed
- Middle Russian River HA, Geyserville HAS, mainstem Russian River at Healdsburg memorial beach and unnamed tributary at Fitch mountain
- Middle Russian River HA, Mainstem Laguna de Santa Rosa
- Middle Russian River HA, Mainstem Santa Rosa Creek

Beginning in 2019, for all existing OWTS within these geographic areas, the Regional Water Board would have to issue WDRs, waivers of WDRs, or require corrective action to comply to meet siting, design, or operational standards that would be protective of bacteria water quality objectives. New and replacement OWTS within 600 feet of the water bodies listed in Attachment 2 would have to meet applicable specific Tier 3 requirements of Basin Plan OWTS Policy adopted by the Regional Water Board on June 19, 2014, or other special provisions established for these water bodies.

Additionally, opportunities for owners of OWTS to obtain public funding assistance for required upgrades their OWTS may be reduced because standards federal and state implementation grants and other funding sources are typically only available for projects located in watersheds that have an approved TMDL Action Plan or some other effective watershed-scale management plan in place.

It should be noted that environmental impacts associated with the no project alternative are likely to be the same as the preferred project alternative, as the preferred alternative essentially requires actions to be implemented through updates to existing permits and under the Regional Water Boards existing authorities. Therefore, this no action alternative will likely result in some improvement in water quality, but it does not provide a framework for watershed-wide implementation and monitoring efforts, a timeline by which implementation must occur, and reasonable assurance that water quality objectives will be attained within the shortest, reasonable period of time.

11.3 REASONABLY FORESEEABLE MEANS OF COMPLIANCE

The following sections present an analysis of the potential environmental impacts associated with the reasonably foreseeable methods of compliance with the Action Plan (preferred alternative). Public input was solicited to help Regional Water Board staff identify reasonably foreseeable compliance measures, and many of the measures listed below were identified by members of the public and agency staff during the CEQA scoping process. The current impairment created by elevated pathogen indicator bacteria densities are detrimental to the environment and exceed of water quality objectives. The Action Plan provides a program for addressing the adverse impacts of non-compliance with water quality objectives through a progressive reduction in the loading of pathogen indicator bacteria to the Russian River Watershed and a schedule that is reasonable and as short as practicable.

The compliance measures and pollution controls necessary to comply with the Action Plan will depend on a number of site-specific conditions and factors. The following examples are not meant to be exhaustive of the suitable suite of compliance measures, but rather provide a reasonable range of measures that may be implemented. Many of the compliance measures listed below are often interchangeable as mitigation measures for potentially adverse environmental impacts associated with specific project activities. Additionally, though not listed below, public commenters encouraged the use of Low Impact Development (LID), including the construction of smaller homes, as possible mitigation measures.

11.3.1 NON-STRUCTURAL CONTROLS

Non-structural controls are typically aimed at controlling sources of a pollutant and do not involve construction or other earth moving/landscape manipulations. Non-structural controls are those activities that are primarily planning or outreach in nature. Most of the non-structural controls identified are unlikely to have an environmental impact because they are not physical in nature; however, where they were found to have less than significant impacts or where they could be mitigated to less than significant, they are discussed in Section 10.3. No potentially significant impacts on the environment were identified for these controls. Some of the possible non-structural controls that could be implemented as a method of compliance include:

- Education and Outreach: Conduct education and outreach about proper maintenance and upkeep for OWTS, water conservation, recycled water and graywater use, preventing illegal camping along waterbodies, proper human and domestic animal waste disposal and sanitation, and the effects of improper pet waste disposal. Publicize the locations of restrooms found at recreational beaches along the mainstem Russian River.

- Inspection and Maintenance: Require preventative maintenance and upkeep of OWTS. Inspect and perform routine maintenance of sewer laterals. Perform inspections and routine maintenance of sanitary sewer infrastructure and existing public restroom facilities at beaches along the Russian River. Perform regular beach clean-up to dispose of waste left on beaches. Manage irrigation to ensure that overwatering and runoff do not occur.

- Municipal Wastewater Program Establishment, Evaluation, and Enforcement: Revise design standards for new and replacement sewer systems to add enhanced protection against overflows and exfiltration. Establish procedures and standards for the use of off-site easements, which include proper appropriate conditions, covenants, and deed restrictions, to facilitate OWTS serving multiple dwellings. Establish a local ordinance to require property owners to inspect their private sewer lateral upon property transfer, in response to chronic sanitary sewer overflows, or after change in property use. Establish a program and funding assistance to homeowners to promote voluntary inspections and repairs of private laterals. Develop an OWTS management program. Provide and/or improve options for shelters and transitional housing or other homeless services. Establish a hotline for reporting homeless/illegal encampments and facilitate their removal along stream corridors. Evaluate and if necessary improve management practices to prevent recycled water overspray, spills, and runoff. Implement programs to discourage or prevent illegal dumping. Explore expanding recycled water use to prevent discharge into surface waters. Enforce permit requirements, including water recycling requirements.

- Manure Management Plan: Require Best Management Practices (BMPs) for manure handling through the development of Manure Management Plans. BMPs for manure handling could include regular cleanup of manure and soiled bedding in animal habitation areas, locating manure storage areas away from water courses and off slopes (i.e., prevent storm water discharge), practicing onsite composting and reuse of manure, and storing manure on impermeable surfaces (i.e., prevent groundwater discharge).

- Limitation of Access to Waterbodies Without Restroom Facilities: Limit public access to locations on the Russian River with limited or no public restroom - facilities by restricting street parking near beaches and boat launching locations.

11.3.2 STRUCTURAL CONTROLS

Structural controls for non-point sources divert, store, treat, and/or infiltrate storm water so as to prevent the discharge of waste material to the river as a result of runoff. Structural controls for point sources can be implemented to treat waste before discharge and/or prevent the direct discharge of waste into a waterbody. Structural controls can involve activities that create potentially significant environmental impacts. Structural controls that were found to have impacts, both potentially significant and less than significant, are discussed in Section 10.3.

- Straw Waddles: Use straw waddles inoculated with mushrooms (i.e. mycofiltration) to filter bacteria from runoff.

- Buffer Strips, Vegetated Swales, and Bioretention: Construct and maintain vegetative buffers along roadsides and next to waterbodies to slow runoff velocity, increase filtration of pollutants, and increase storm water infiltration. Construct and maintain bioretention BMPs to provide onsite removal of pollutants from storm water runoff through landscaping features.

- Green Roofs and Rain Gardens: Replace existing roofs and gardens with "green" infrastructure such as green roofs and rain gardens to prevent or reduce clean storm water from coming into contact with fecal wastes.

- Exclusion: Construct fencing, hedgerows, livestock trails, and walkways to exclude animals from streams and riparian areas to prevent direct deposition of feces into surface waters. Construct fencing, shrubs, or other barriers to prevent camping & habitation under bridges and overpasses.

- Waste Storage and Disposal: Install pet waste collection systems, which provide plastic bags to be used in the collection of domestic pet waste, throughout the watershed. Provide garbage cans, recycling bins, and diaper changing stations at public beaches.

- Municipal Composting of Biosolids: Ensure the elimination of pathogens from biosolids by upgrading treatment through the use of composting.

- Waterless Waste Treatment: Utilize waterless technology such as composting and incinerating toilets.

- Restroom Facilities: Provide and/or upgrade permanent or temporary restroom facilities at recreation beaches and at locations frequented by homeless and transient people.

- Sewer Lateral Replacement: Fix or replace private sewer laterals that have inflow and infiltration issues.

- Increase Wastewater Storage Capacity: Enlarge wastewater holding ponds to prevent discharge to the Russian River and its tributaries.

- Wastewater Treatment Plant Expansion and/or New Treatment Plant Construction: Expand or construct wastewater treatment plants to allow for new connections.

- Connect OWTS to a Centralized Wastewater Treatment Plant or Decentralized Community System: Connect individual wastewater treatment and disposal systems to a centralized treatment plant or decentralized community wastewater treatment system and discontinue use of individual OWTS.

- Treatment Plant Wastewater Disinfection: Upgrade treatment plant wastewater disinfection systems and disinfect holding pond effluent through the use of ozone, heat sterilization or ultrafiltration.

- OWTS Supplemental Treatment: Utilize supplemental treatment such as ultraviolet (UV) light disinfection or chlorine to ensure adequate treatment of effluent from OWTS.
- MS4 Sand Filters: Install and maintain sand filters, which are effective for pollutant removal from storm water. Sand filters may be a good option in densely developed urban areas with little pervious surface since the filters occupy minimal space.

- Replacement and/or Improvement of OWTS: Replace/upgrade leaking and poorly sited OWTS with OWTS that are correctly designed, sited, constructed, installed, operated and maintained.

11.4 ENVIRONMENTAL CHECKLIST

As stated previously, the environmental analysis must include an evaluation of the reasonably foreseeable environmental impacts of the methods of compliance and the reasonably foreseeable mitigation measures relating to those impacts. This section, consisting of the CEQA checklist and answers to the questions in the checklist, discusses the reasonably foreseeable compliance measures and alternatives and mitigation measures of those compliance methods.

In formulating the checklist answers, the impacts of implementing the non-structural and structural controls were evaluated. At this time, the exact compliance measures that might be implemented to comply with the Action Plan are unknown, and therefore this analysis considers a range of non-structural and structural measures that might be used. When specific measures are selected for implementation, a project-level/site-specific CEQA analysis will be performed by the responsible party, as necessary.

This evaluation considers whether the construction or implementation of the reasonably foreseeable compliance measures has the potential to cause a substantial, adverse change in any of the physical conditions within the area affected by the project. In addition, the evaluation considers environmental effects in proportion to their severity and probability of occurrence. In this analysis, the level of significance is based on the existing conditions of both the physical environment and regulatory baseline requirements. A significant effect on the environment is defined in regulation as "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment. An economic or social change related to a physical change may be considered in determining whether the physical change is significant[21]."

Potential reasonably foreseeable impacts of the reasonably foreseeable compliance measures were evaluated with respect to each of the factors on the checklist. Additionally, mandatory findings of significance regarding short-term, long-term, cumulative and substantial impacts were evaluated. In this analysis, the level of significance was based on baseline conditions (i.e., current conditions). Based on this review, it has been concluded that there may be some potentially significant impacts associated with some of the reasonably foreseeable methods of compliance with the Action Plan. Reasonably foreseeable structural and non-structural controls that were found to have impacts, both potentially significant and less than significant, or require mitigation are discussed in detail below.

Table 11.1
Environmental Checklist

	Potentially Significant Impact	Less Than Significant With Mitigation	Less Than Significant Impact	No Impact
I. AESTHETICS -- Would the project:				
a) Have a substantial adverse effect on a scenic vista?			✓	
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?		✓		
c) Substantially degrade the existing visual character or quality of the site and its surroundings?		✓		
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?		✓		

[21] 14 CCR section 15382

Table 11.1
Environmental Checklist

	Potentially Significant Impact	Less Than Significant With Mitigation	Less Than Significant Impact	No Impact
II. AGRICULTURE AND FOREST RESOURCES: In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and forest carbon measurement methodology				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	✓			
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	✓			
c) Conflict with existing zoning for, or cause rezoning or, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?				✓
d) Result in the loss of forest land or conversion of forest land to non-forest use?				✓
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	✓			
III. AIR QUALITY: Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. -- Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?				✓
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?			✓	

Table 11.1 Environmental Checklist				
	Potentially Significant Impact	Less Than Significant With Mitigation	Less Than Significant Impact	No Impact
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?				✓
d) Expose sensitive receptors to substantial pollutant concentrations?				✓
e) Create objectionable odors affecting a substantial number of people?		✓		
IV. BIOLOGICAL RESOURCES -- Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		✓		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Wildlife or US Fish and Wildlife Service?		✓		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?		✓		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?		✓		
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?		✓		
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?		✓		

V. CULTURAL RESOURCES -- Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?		✓		
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?		✓		
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?		✓		
d) Disturb any human remains, including those interred outside of formal cemeteries?		✓		
VI. GEOLOGY AND SOILS -- Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist- Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.		✓		
ii) Strong seismic ground shaking?		✓		
iii) Seismic-related ground failure, including liquefaction?		✓		
iv) Landslides?		✓		
b) Result in substantial soil erosion or the loss of topsoil?		✓		
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?		✓		
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?		✓		
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste- water disposal systems where sewers are not available for the disposal of waste water?		✓		
VII. GREENHOUSE GAS EMISSIONS -- Would the project:				
a) Generate Greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?		✓		
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?				✓

VII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?		✓		
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?		✓		
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?		✓		
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?		✓		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?		✓		
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?		✓		
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				✓
h) Expose people or structures to a significant risk of loss injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?				✓
VIII. HYDROLOGY AND WATER QUALITY -- Would the project:				
a) Violate any water quality standards or waste discharge requirements?		✓		
b) Substantially deplete ground water supplies or interfere substantially with ground water recharge such that there would be a net deficit in aquifer volume or a lowering of the local ground water table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?				✓
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?		✓		

d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?		✓		
e) Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?		✓		
f) Otherwise substantially degrade water quality?		✓		
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				✓
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?		✓		
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?				✓
j) Inundation by seiche, tsunami, or mudflow?				✓
IX. LAND USE AND PLANNING -- Would the project:				
a) Physically divide an established community?				✓
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?				✓
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?				✓
X. MINERAL RESOURCES -- Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?				✓
b) Result in the loss of availability of a locally – important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				✓
XI. NOISE -- Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?		✓		
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?				✓

c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	✓			
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?		✓		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?				✓
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?				✓
XII. POPULATION AND HOUSING -- Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	✓			
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?		✓		
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				✓
XIII. PUBLIC SERVICES				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
Fire protection?				✓
Police protection?				✓
Schools?				✓
Parks?				✓
Other public facilities?				✓
XIV. RECREATION				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?			✓	

b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?				✓
XV. TRANSPORTATION/TRAFFIC -- Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?			✓	
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?				✓
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?				✓
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?				✓
e) Result in inadequate emergency access?				✓
f) Result in inadequate parking capacity?			✓	
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?			✓	
XVI. UTILITIES AND SERVICE SYSTEMS -- Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				✓
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	✓			
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?			✓	
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				✓
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	✓			

f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?				✓
g) Comply with federal, state, and local statute and regulations related to solid waste?				✓
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		✓		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	✓			
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	✓			

I. AESTHETICS -- Would the project:
(a) – Have a substantial adverse effect on a scenic vista?
Answer: Less than significant.

The creation of buffer strips and vegetated swales may include planting of trees and shrubs. The addition of these types of vegetation to the landscape is generally regarded as having positive aesthetic effects. In some cases the planting or retention of large woody vegetation could reduce visibility of an adjacent waterbody or of the surrounding landscape and therefore could alter the scenic vista. Although the creation of buffer strips and vegetated swales will modify the appearance of an area, the aesthetic effects are expected to be positive and will not likely result in a substantial adverse effect on the scenic vista and are considered less than significant.

(b) – Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?
(c) – Substantially degrade the existing visual character or quality of the site and its surroundings?
(d) – Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?
Answer: Less than significant with mitigation.

The changes to the visual character of a site due to the construction of wastewater treatment ponds and buildings associated with significantly expanded or new centralized or decentralized wastewater treatment facilities can be mitigated by building facility structures to house equipment and fences to provide a visual screen for equipment and materials used in the everyday operations of the facility. Planting vegetation such as native trees, grasses, and wildflowers can provide a vegetative screen and result in an aesthetic that more closely reflects the surrounding landscape. Strategic siting of the facility structures on the landscape can also allow for the structures to be placed in locations that will have the least possible effect on the existing visual character of the surrounding area and allow them to avoid damaging scenic resources. Additionally, where scenic resources are identified at a site along a scenic highway, the use of standard construction techniques and sediment and erosion control practices would require revegetation and would not result in permanent alteration to the vegetation of scenic resources. The potential glare that could result from the construction of new wastewater treatment and effluent storage ponds could be mitigated by proper siting and the planting of vegetation screens around the ponds.

The construction of new restroom facilities at public beaches or other locations throughout the watershed could result in adverse aesthetic affects to the visual quality of the surroundings; however this effect can be mitigated through strategic siting of the restroom facility in a location that minimizes the effect on the visual character of the surrounding site. Additionally, the planting of trees, shrubs, and native plants can be used to screen the restroom from view and result in an aesthetic that more closely reflects the surrounding landscape. For restrooms constructed in urban locations, the selection of materials used to construct the exterior of the restroom should reflect the aesthetic and character of the surrounding location, which will allow it to blend it better with neighboring structures.

Increasing wastewater storage capacity, adding supplemental treatment to OWTS, composting biosolids, and installing pet waste collection systems, and garbage and recycling cans would result in less than significant impacts to the visual character and quality of the site and its surroundings. The enlarging of wastewater holding ponds would result in minimal changes from the existing baseline and therefore will have a less than significant impact on the visual character surrounding site. The composting of biosolids and addition of supplemental treatment to OWTS would result in minimal changes to the visual landscape as they can be housed in existing structures and the mechanisms to house supplemental treatment could even be placed underground with a cover for access. Pet waste collection systems are small and can be painted to blend with the surrounding environment. The presence of garbage and recycling cans will not substantially degrade the surrounding area and is expected to improve the aesthetics of the surroundings by preventing trash from being deposited on the ground.

II. AGRICULTURE AND FOREST RESOURCES: --Would the project:
(a) – Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?
(b) – Conflict with existing zoning for agricultural use, or a Williamson Act contract?
(e) – Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to nonforest use?
Answer: Potentially significant.

The creation of riparian buffers and exclusion of animals from riparian zones could cause incidental loss of agricultural use. These losses would affect only a very narrow band of land on either side of a watercourse. Additionally, some agricultural areas that are mapped as prime, unique or important may already have riparian buffers or exclusion fencing in place. Although there are many factors that affect this determination, it can be assumed that agricultural lands with a potential to discharge waste that contains pathogenic microorganisms to waters of the state and that implement riparian protection actions or compliance measures to comply with the Action Plan could be taking land out of production. While avoidance and minimization measures can be used to lessen impacts, and experience suggests that some modified management of riparian zones is often appropriate, there is no mitigation for loss of land where that occurs. Therefore, this is a potentially significant and unavoidable impact.

(c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code

section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?
(d) Result in the loss of forest land or conversion of forest land to non-forest use?
Answer: No Impact.

None of the reasonably foreseeable structural or non-structural compliance measures will rezone or force the rezoning of Timberlands Production or result in the conversion of forested land to non-forested land. Therefore, there will be no impact on the classification or conversion of timberlands.

III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:
(a) – Conflict with or obstruct implementation of the applicable air quality plan?
(c) – Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is not attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?
(d) – Expose sensitive receptors to substantial pollutant concentrations?
Answer: No impact.

None of the structural or non-structural compliance measures would result in a violation of air quality plans, result in a cumulatively considerable increase in criteria pollutants, or expose sensitive receptors to substantial pollutant concentrations.

(b) – Violate any air quality standard or contribute substantially to an existing or projected air quality violation?
Answer: Less than significant impact.

Construction activities can generate dust and combustion exhaust emissions that will be emitted into the atmosphere from construction equipment associated with wastewater treatment plant expansion and/or construction, treatment plant wastewater disinfection system upgrades, connecting OWTS to a centralized or decentralized wastewater treatment plant, adding supplemental treatment to OWTS, replacing or upgrading existing OWTS, increasing wastewater storage capacity, construction of new restroom facilities, creation of sand filters for storm water, sewer lateral replacement, and creation of green roofs and rain gardens. Air pollutants will be emitted from construction worker commutes. However, because of the temporary nature of construction activities, the proposed project is not likely to result in construction-related emissions that will result in significant impacts or require mitigation for any of the regionally significant pollutants.

(e) – Create objectionable odors affecting a substantial number of people?
Answer: Less than significant with mitigation.

The repair and replacement of sewer laterals and upgrade, maintenance, and/or replacement of OWTS will decrease the potential for illicit discharges which would result in objectionable odors. Therefore, there would be no impact from those activities. The composting of biosolids can result in objectionable odors, however through the use of indoor composting or the thoughtful siting and design of composting locations odors can be minimized. Other mechanisms that could be considered to mitigate composting odors include use of aeration and biofiltration, mixing with coarse dry bulking agents, and placing an aerobic biofilter layer over the biosolids. Therefore, the application of mitigation measures will result in less than significant impacts to air quality.

IV. BIOLOGICAL RESOURCES -- Would the project:
(a) – Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?
(b) – Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Game or US Fish and Wildlife Service?
(c) – Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?
(d) – Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?
(e) – Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?
(f) – Conflict with the provision of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?
Answer: Less than significant impact with mitigation.

There are numerous aquatic and terrestrial Federal and State listed endangered and threatened animals which are known to be present in the Russian River Watershed. Such species could potentially be adversely impacted by measures implemented to comply with the proposed Action Plan, if only temporarily. The location of sensitive species and habitat must be assessed on a project by project basis. When installing structural compliance measures that involve substantial earth moving or riparian restoration activities that have the potential to affect candidate, sensitive, or special status species, project proponents are required to consult with federal, state and local agencies, including but not limited to, the county, CDFW, Regional Water Board, and USFWS. Project proponents must ensure project actions avoid, minimize and/or mitigate for impacts to rare, threatened or endangered species.

Actions to limit the input of pathogen indicator bacteria into water ways, such as riparian buffers, the use of straw waddles, and exclusion from riparian areas may conflict with the habitat requirements of certain flora or fauna and some could impede migration. Specific examples include non-native species out competing natives in constructed riparian buffers. Mitigation measures to reduce this potential impact include use of certified weed-free grass and project specific seed mixes to prevent the introduction of non-native or invasive species. Fencing can be selected that won't ensnare animals and migration corridors can be left to allow movement of fauna. Alternatively, rotational grazing practices and hotwire fences could be used where exclusionary fencing has the potential to affect wildlife and impede migration. The netting used in some straw waddles may ensnare small terrestrial fauna, and can be mitigated by the use of biodegradable, natural fiber netting. In most cases, impacts could be avoided by adjusting the timing and/or location of the actions to take into account candidate, sensitive, or special status species or their habitats. The process for designing, permitting, and implementing mitigation measures includes collaboration between Regional Water Board staff and CDFW and USFWS staff to reach agreement on the most appropriate approach to protecting sensitive beneficial uses.

Construction activities may have a potential impact upon species identified as a candidate, sensitive, or special status, may conflict with a local policies or ordinances protecting biological resources, may fill federally protected wetlands as defined by Section 404 of the Clean Water Act, and may conflict with the provisions of an adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan (NCCP) or other approved local, regional, or state habitat conservation plan. Construction has the potential to cause adverse effects in several ways: filling of federally protected wetlands, short-term habitat destruction during construction, permanent displacement of sensitive species due to new structures, and, "take" of endangered species. It is likely that when an entity is choosing possible locations for the construction of a new centralized or decentralized wastewater treatment plant, new restroom, new sewer lines, or significant expansion of a wastewater treatment plant they would give preference to sites that did not fill federally protected wetlands or adversely affect biological resources. If a site containing endangered or threatened species was selected for new construction, the entity would be required to consult with federal, state, and local agencies to mitigate potential impacts. If a site were selected that would result in the fill of federally protected wetlands, the responsible party would be required to obtain a Clean Water Act (CWA) Section 404 permit from the Army Corps of Engineers and a CWA Section 401 Water Quality Certification from the Regional Water Board. If a direct fill of a stream or wetland is absolutely necessary, then adequate compensatory mitigation in accordance with federal and state regulatory programs will be required to replace the loss of functions and values in compliance with the State's No Net Loss Policy[22].

During project level construction activities to implement compliance measures, both structural and non-structural mitigation measures can be implemented to avoid, minimize

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or mitigate potentially significant impacts to sensitive species. Once a project plan is prepared and construction areas are delineated, measures must be implemented prior to and during construction to avoid, minimize, and mitigate impacts to sensitive animals and their habitat, and vegetation communities such as wetlands. For example, wetlands within 100 feet of any ground disturbance and construction-related activities (including staging and access roads) would be clearly marked and/or fenced to avoid impacts from construction equipment and vehicles. If new or temporary access roads are required, grading would be conducted such that existing hydrology would be maintained. In addition, water pollution control measures such as erosion control, sediment control, and waste management would be implemented to avoid and minimize potential water quality impacts from polluted storm water runoff to streams, wetlands and riparian areas. Other potential mitigation measures could include only constructing during the time of year where the species are not present or are at less vulnerable life stages, or fencing off areas that contain sensitive species or their habitat so that they are not disturbed during construction.

Based on the information provided above and the variety of avoidance, minimization and mitigation measures available, the impacts to Biological Resources from compliance measures to address pathogen indicator bacteria impairment are less than significant with mitigation incorporated.

V. CULTURAL RESOURCES -- Would the project:
(a) – Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?
(b) – Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?
(c) – Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?
(d) – Disturb any human remains, including those interred outside of formal cemeteries?
Answer: Less than significant with mitigation.

For the majority of potential compliance measures, it is unlikely that their implementation will cause a substantial adverse change to cultural resources. Most of the reasonably foreseeable compliance measures will take place in areas that are already disturbed and are in highly urbanized areas, contain sewer laterals, septic systems, and/or other pipes. Implementation strategies that involve digging of a hole, such as for a fence post to contain livestock, may disturb previously unexcavated soil; however, the volume of soil excavated for post-holes is not significant and, therefore, does not pose a significant threat to cultural resources. Additionally, it is more probable that livestock owners will choose methods of compliance that are less costly than fencing a great length of ground, e.g. moving food and water sources away from riparian areas, which of course results in minimal excavation, if any. In the event cultural resources are discovered, implementation is not expected to have substantial adverse change in significance of the resources, destruction of unique cultural resources or sites with cultural value, or the disturbance of human remains.

Implementation of the Action Plan is not expected to have a substantial adverse change in significance of tribal cultural resources. The digging of new fence post holes is a small-scale operation and the fence post could be relocated if cultural resources are found.

In cases where the installation of compliance measures may involve large scale excavations or earth disturbing activities, such as centralized or decentralized wastewater treatment plant construction, restroom construction, placing new sewer lines, or expanding a wastewater treatment plant or pond, a cultural resources investigation should be conducted before any substantial disturbance. The cultural resources investigation will include, at a minimum, a records search for previously identified cultural resources, including sites, features, places, cultural landscapes, sacred places, and objects with cultural value pursuant to the California Register of Historical Resources or included in a local register of historical resources. Additionally, the lead agency will consider the impact of the project on tribal cultural resources and follow consultation requirements pursuant to Public Resources Code sections 21080.3.1, 21080.3.2, and 21082.3. Previously conducted cultural resources investigations of the project parcel and vicinity will also be identified and utilized.

All future actions must comply with the CEQA process and investigate, evaluate, and treat impacted significant cultural resources. A record search should be conducted that also includes contacting the appropriate information center of the California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation, and the relevant Regional Archaeological Information Center. In coordination with the information center or a qualified archaeologist, a determination regarding whether identified cultural resources will be affected by the proposed project must be made and if investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey may need to be conducted. The purpose of this investigation would be to identify resources before they are affected by a proposed project and avoid the impact. If resources are identified, site-specific implementation will minimize impacts. This can include actions such as avoidance through relocation, changes in design, site capping and protection through barriers, fencing, and covering of the cultural resources.

In addition, in the event that the ground disturbances uncover previously undiscovered or documented resources, California law protects Native American burials, skeletal remains, and associated grave goods regardless of the antiquity and provides for the sensitive treatment and disposition of those remains. (Health & Safety Code, Section 7050.5; Public Resource Code, Section 5097.9 et seq).

VI. GEOLOGY AND SOILS -- Would the project:

(a) – Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-

Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.
ii. Strong seismic ground shaking
iii. Seismic-related ground failure, including liquefaction?
iv. Landslides?
(b) – Result in substantial soil erosion or the loss of topsoil?
(c) – Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?
(d) – Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?
(e) – Have soils incapable of adequately supporting the use of septic tanks or alternative waste-water disposal systems where sewers are not available for the disposal of waste water?
Answer: Less than significant with mitigation.

It is possible that some soils in areas of the Russian River Watershed considered for the construction of new structures, including centralized or decentralized wastewater treatment facilities, community OWTS, and restrooms, could be unstable, be located on expansive soil, or result in ruptured faults, seismic ground shaking, liquefaction, or landslides if construction were to occur on certain sites. The first step in preventing this possibility is to properly site such construction so as to avoid these potential outcomes.

If it were determined that construction would take place on a site with areas of unstable or expansive soils or in areas with fault zones, seismic shaking, or where liquefaction could occur it would be up to the project proponents to offer mitigation measures to reduce the impact to less than significant. Mitigation measures could include abstaining from constructing in areas with unsuitable or unstable geology, minimizing the disturbance of the areas of concern, anchoring the soils, adding structural piles, building a thicker foundation, deepening the footings of the foundation, and ensuring proper drainage so that rain-induced landslides do not occur. A site-specific CEQA evaluation would need to be completed for the project to outline any potential environmental effects. Additionally, a site-specific work plan and health and safety plan would be developed by a licensed geologist or engineer prior to implementation of the project. Such plans ensure conditions are assessed and impacts appropriately avoided prior to initiation of the project. The site manager must also be made aware of potential risks and management measures associated with any structures, soil instability, expansive soils, or other features associated with the unique nature of the project setting, with specific attention to potential risks to life or property and appropriate protections.

Construction activities may result in soil erosion of disturbed topsoil. Implementation of compliance measures such as expansion of restroom facilities, construction of centralized or decentralized wastewater treatment systems, green roofing, or wastewater storage ponds will result in temporary ground disturbances. These activities could result in erosion and sedimentation. However, construction related erosion impacts will be temporary and should cease with the cessation of construction activities. Standard best management practices (BMPs) to address erosion, sediment, and pollution prevention should be used during small and large scale construction activities to mitigate potential erosion issues. Facility pollution prevention plans should be developed to ensure that the correct BMPs are selected for the construction of wastewater treatment facilities, wastewater storage ponds, and of other treatment measures. For example, excavated soil should be covered or seeded prior to precipitation and replanted as soon as practicable to avoid contaminating storm water runoff and to prevent soil erosion. For construction activities that are greater than one acre, enrollment under the National Pollutant Discharge Elimination System (NPDES) construction storm water general permit will be necessary and the development of a storm water pollution prevention plan (SWPPP) required.

The proper implementation of mitigation measures, including those discussed above, will result in a less than significant impact to soil stability and erosion.

VII. GREENHOUSE GAS EMISSIONS -- Would the project:
(a) Generate Greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?
Answer: Less than significant with mitigation.

Implementation of compliance measures at the project level could result in a temporary increase in greenhouse gases related to exhaust from equipment and vehicles used during construction activities. However, these emissions will be limited to a finite period of time and would result in less than significant impacts overall.

Greenhouse gases may be generated from wastewater treatment plant alterations or new construction, installation of new sewer lines, replacement of OWTS, and improvements, repair, and maintenance of OWTS, sewer laterals, and wastewater treatment facilities, as compared to the current baseline.

The daily operations of a new centralized or decentralized wastewater treatment plant, or significantly expanded plant, could result in increased greenhouse gas emissions as a result of greater power needs at the plant itself, as well as at lift stations to move a larger volume of waste. Possible mitigation measures include the use of ecofriendly power, including wind and solar power, and implementation of water and power conservation measures. Impacts associated with individual projects implemented to comply with the Action Plan will be evaluated for their potential to increase greenhouse gases by the parties responsible for implementing the compliance measures and appropriate mitigation implemented to reduce that potential.

(b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?

Answer: No Impact

All structural or non-structural implementation measures would need to be implemented in a manner consistent with plans, policies or regulations to reduce greenhouse gas emissions including those mentioned here. Any water quality control effort must be consistent with the State Water Board Resolution No. 2008-0030 which directs Water Board staffs to "require…climate change considerations, in all future policies, guidelines, and regulatory actions." Also, the proposed project is intended to be implemented in a manner which conforms with the goals of Assembly Bill (AB) 32 (States, 2005, ch 488). AB 32 requires that greenhouse gas emissions be reduced to 1990 levels by 2020. This requirement relates to anthropogenic sources of greenhouse gases.

VIII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:
(a) – Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?
(b) – Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?
(c) – Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?
(d) – Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?
(e) – For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?
(f) – For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?
Answer: Less than significant with mitigation.

The existing regulatory baseline includes numerous federal, state and local laws regarding the designation, handling, transportation and disposal of hazardous substance. Nothing in the proposed TMDL Basin Plan amendment alters this existing regulatory baseline. However, the manner in which hazardous materials are handled and controlled can have environmental impacts as highlighted here.

Specifically, in any action involving chemicals or toxic pollutants, there is a potential for release of pollutants due to an accident or upset condition. The potential for such releases can be greatly reduced by proper planning. Measures to prevent releases of pollutants include such things as pollution prevention technology (e.g., automatic sensors and shut-off valves, pressure and vacuum relief valves, secondary containment, air pollution control devices, double walled tanks and piping), access restrictions, fire controls, emergency power supplies, contingency planning for potential spills and releases, pollution prevention training and other types of mitigation measures. Before implementing structural compliance measures, it is important to consider site geology, hydrology, surrounding land uses and potential receptors, costs, and air quality control plans (including monitoring and contingency plans) if necessary.

Fuels, lubricating oils, and other petroleum products will be used during construction activities. Well established techniques for controlling spills, leaks, and drips should be incorporated in work plans, remedial action plans, treatment plans and site health and safety plans to assure the control of petroleum products and any other chemicals used during the cleanup activity. In order to mitigate the potential adverse effects, pollution prevention plans and waste management BMPs should be used in conjunction with the implementation of compliance measures.

Existing regulations require the proper storage, handling and use of these types of materials. In the event of an accident, responsible parties must comply with the requirements of the California Emergency Management Agency (CalEMA) Hazardous Materials Spill reporting process. Any significant release or threatened release of a hazardous material requires immediate reporting by the responsible person to the Cal EMA State Warning Center (800) 852-7550 and the Certified Unified Program Agency (CUPA) or 911.

The mitigation measures discussed above will likely reduce impacts to a less than significant level.

(g) – Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?
(h)– Expose people or structures to a significant risk of loss injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?
Answer: No Impact

Much of the Russian River valley includes rural residential dwellings and a loosely-defined urban/wildland boundary. The California Department of Forestry and Fire Protection (CalFire) has identified at least 3 communities in the Russian River valley as existing in a Very High Fire Hazard Severity Zone, including: Cloverdale, Santa Rosa, Ukiah. The proposed structural and non-structural compliance measures will not hinder emergency response plans or expose people or structures to wildfires above and beyond that which already exists as the baseline.

IX. HYDROLOGY AND WATER QUALITY -- Would the project:
(a) – Violate any water quality standards or waste discharge requirements?
(c) – Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?

(d) – Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?
(e) – Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?
(f) – Otherwise substantially degrade water quality?
(h) – Place within a 100-year flood hazard area structures which would impede or redirect flood flows?
Answer: Less than significant impact with mitigation.

When replacing or repairing private sewer laterals and OWTS, and operating a centralized or decentralized wastewater treatment plant, it is possible that sewage could be released to surface waters and violate water quality standards and degrade water quality. Mitigation measures such as containment structures and absorption materials are available to reduce transfer of these substances to surface waters. Fuels, lubricating oils, and other petroleum products will be used during construction activities and could be accidentally discharged to surface waters. Well established techniques for controlling spills, leaks, and drips should be incorporated in work plans, remedial action plans, treatment plans and site health and safety plans to assure the control of petroleum products and any other chemicals used during the activity. In order to mitigate the potential adverse effects, pollution prevention plans and waste management BMPs should be used in conjunction with the implementation of permit compliance measures. Mitigation measures such as containment structures, absorption materials, and drip pans are available to reduce the transfer of these substances to surface waters. The possibility that composted biosolids could reach surface waters can be mitigated by siting compost piles away from water courses, covering the piles during storm events, using straw waddles around the piles to filter runoff, build storm water containment, and placing the piles indoors. Pet waste collection systems which provide plastic bags for pet waste cleanup, may cause violations of water quality standards if they are improperly discarded and enter waterbodies. This can be mitigated by providing waste receptacles near the pet waste collection systems to provide a location for people to place the used and unused bags.

Compliance measures related to construction activities could potentially cause an alteration of the existing drainage pattern of a site. In most cases however, these compliance measures would be installed with appropriately designed mitigation measures so as to limit any alteration of the existing drainage pattern, unless beneficial to the environment. In general, compliance measures could be constructed or installed without resulting in substantial erosion of siltation on- or offsite. For example, implementing BMPs such as using straw mulch and hydroseed on exposed areas, placing silt fencing and straw waddle to filter runoff, drip protection and vehicle cleaning for construction equipment, maintenance and site inspections are all methods that can be employed. Entities are commonly required to install and maintain erosion control measures (e.g. mulch, straw waddles, silt fencing) to prevent discharge of excess sediment from soil disturbing activities.

Construction of a new centralized or decentralized wastewater treatment plant, restroom facility, or significant expansion of a wastewater treatment plant, may increase the amount of impervious surface and therefore could result in flooding or polluted runoff. Additionally, these structures may be placed within the 100-year flood hazard area. The possibility of flooding and polluted runoff can be mitigated through the use of Low Impact Development (LID). LID is utilized to infiltrate storm water and reduce changes in drainage patterns due to impervious surfaces and to filter storm water runoff. LID strategies integrate green space, native landscaping, natural hydrologic functions, and various other techniques to generate less runoff from developed land. Examples of LID that could be used are bio swales, green roofs, rain gardens, and sand filters.

(b) – Substantially deplete ground water supplies or interfere substantially with ground water recharge such that there would be a net deficit in aquifer volume or a lowering of the local ground water table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?
(g) – Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?
(i) – Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?
(j) – Inundation by seiche, tsunami, or mudflow?
Answer: No impact.

The structural and non-structural reasonably foreseeable compliance measure identified would not deplete groundwater supplies and should not substantially increase the chances of risk of loss, injury, or death involving flooding, or increase the chance of tsunami or mudflow. No housing development is proposed as a result of this proposed Basin Plan amendment and therefore none will be placed within a 100-year flood hazard area or place housing in the 100-year flood plain.

X. LAND USE AND PLANNING-- Would the project:

(a) – Physically divide an established community?
(b) – Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?
(c) – Conflict with any applicable habitat conservation plan or natural community conservation plan?
Answer: No impact.

The reasonable foreseeable structural and non-structural compliance measures should not divide a community, conflict with land use, policy, or regulation of an agency with jurisdiction over the project, adopted for mitigation purposes, or conflict with any applicable habitat conservation plan or natural community conservation plan. All compliance measures would have to work within the existing regulatory baseline and comply with existing plans, policies, and regulations.

XI. MINERAL RESOURCES -- Would the project:
(a) – Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?
(b) – Result in the loss of availability of a locally –important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?
Answer: No impact.

None of the reasonably foreseeable structural or non-structural compliance measures would result in the loss of availability of a known mineral resource. Based upon a search of the internet in July 2015, including the California Geologic Survey website, water board staff did not find any evidence of current mineral mining practices taking place in the Russian River Watershed. Furthermore, reasonable foreseeable structural and non-structural compliance measures should not preclude the mining of mineral resources.

XII. NOISE -- Would the project result in:
(a) – Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?
Answer: Less than significant with mitigation.

Temporary increases in noise levels would likely be associated with construction activities, including construction of structural compliance measures. Activities might include the use of heavy machinery and the movement of earth and debris, both of which can create noise and ground vibrations. Mitigation measures include the use of standard construction BMPs and operation of equipment according to a time schedule to prevent cumulative noise impacts resulting in further increased noise levels. The majority of the activities that would produce noise are not typically expected to exceed existing standards. Therefore, the temporary noise impacts from construction activities are considered less than significant with mitigation.

(b) – Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?
(e) – For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?
(f) – For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?
Answer: No impact.

None of the reasonably foreseeable structural or non-structural compliance measures would result in excessive noise levels. Groundborne vibration from construction would be at an extremely low level would be temporary and would not be notable above the existing baseline.

(c) – A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?
Answer: Potentially significant.

The every-day running of a new centralized or decentralized wastewater treatment plant may result in increased ambient noise levels above baseline levels for those within the project vicinity. To a large extent, these increases in noise may be mitigated by housing motors, pumps, generators, and other mechanisms that may make noise indoors. Additionally, sound walls and other sound barriers can be constructed if necessary to lessen the noise impacts of the running of the facility. Given that it may be impossible to minimize to less than significant all ambient noise impacts associated with the running of a wastewater treatment plant, the substantial permanent increase in ambient noise levels in the project vicinity may be a potentially significant impact.

(d) – A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?
Answer: Less than significant with mitigation.

During construction activities there may be a brief period when the noise level is increased due to earth moving or construction machinery. Noise may also increase as a result of an increase in traffic due to installation of, or work on collection system lines under roadways. Temporary impacts can be mitigated to a less than significant level by implementing noise abatement procedures, for example, standard construction techniques such as sound barriers, mufflers, and restricted hours of operation. Appropriate mitigation measures should be evaluated on a case-by-case basis when specific projects are determined.

XIII. POPULATION AND HOUSING -- Would the project:
(a) – Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?
Answer: Potentially significant.

The construction of a new centralized or decentralized wastewater treatment plant, or significant expansion of an existing plant, may have a potentially significant impact on population growth in the project area, as people who were considering constructing new homes but were not able to install OWTS due to space, soil, other limitations would potentially be able to connect their homes to the wastewater treatment plant. Where a decentralized wastewater treatment system is used or where upgrades for new or existing OWTS are authorized on existing parcels, larger homes or construction of new homes may be possible on parcels that did not meet minimum site standards prior to the TMDL. The construction of these new homes would have potential environmental impacts that would need to be investigated through a project level CEQA evaluation before construction began. It is acknowledged that other services and infrastructure would need to be established before new development could occur, such as electric lines and roads, and therefore construction or expansion of a wastewater treatment plant would be one of several factors that may indirectly influence population growth. It is also possible that a new wastewater treatment plant or plant expansion could be done so it only served the existing population. All things considered, there may be potentially significant impacts from population growth associated with the construction or significant expansion of a wastewater treatment plant.

(b) – Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?
Answer: Less than significant with mitigation.

Displacement of people from existing housing due to failing OWTS could be mitigated by connecting to a centralized or decentralized wastewater treatment plant, upgrading the OWTS to meet standards, or other efforts that would remedy the effects of the failing OWTS. A very limited number of systems may not be able to remedy their failing OWTS but the number is expected to be very low, will not necessitate the construction of replacement housing, and therefore does not rise to the level of significance.

(c) – Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?
Answer: No impact.

None of the reasonably foreseeable structural and non-structural methods of compliance would displace substantial numbers of people or existing housing, necessitating the construction of replacement housing elsewhere. Therefore, there would be no impact.

XIV. PUBLIC SERVICES

(a) – Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:
Fire protection?
Police protection?
Schools?
Parks?
Other public facilities?
Answer: No impact.

There are no reasonably foreseeable compliance measures that would cause environmental impacts, impeding acceptable service ratios and response times. Limiting parking near areas of the river without adequate restroom facilities would cause a negligible need for increased parking enforcement as compared to the existing baseline as the existing parking capacity at many areas along the river is already highly limited or is located on private property. Reasonably foreseeable compliance measures should not impede services. If roadway access is restricted due to construction equipment associated with the building of a restroom facility or if a roadway must be excavated for collection system maintenance, for example, access to and through that roadway for emergency vehicles should be maintained. Fences, if installed, will likely be constructed in areas that are not currently used as access for fire or police protection or that are not part of a park or school. If a fence is constructed at a park, it would likely surround the park and not impede its use as a park. Therefore, there would be no impact in terms of Public Services.

XV. RECREATION:
(a) – Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?
Answer: Less than significant.

Publicizing the location of public beaches with restroom facilities and limiting parking near areas of the river without adequate restrooms would have a minimal impact on the existing public beaches and facilities compared to the existing baseline. The Russian River Watershed is currently a highly recreated area and the small increase in users at particular public beaches is not expected to cause substantial physical deterioration of the restroom facilities at those locations. Therefore, there would be a less than significant impact.

(b) – Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?
Answer: No impact.

Reasonably foreseeable compliance measures do not include the construction of recreational facilities. Thus, there will be no impact in terms of recreation.

XVI. TRANSPORTATION/TRAFFIC -- Would the project:
(a) – Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?
(f) – Result in inadequate parking capacity?
(g) – Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?
Answer: Less than significant impact.

During construction-related activities, there may be a brief period when traffic congestion will increase due to the presence of earth moving equipment and other construction equipment. Potential impacts would be temporary and less than significant because potential impacts could be reduced by limiting or restricting hours of construction so as to avoid peak traffic times and by providing temporary traffic signals and flagging to facilitate traffic movement. Additionally, a parking lot, street parking, or the alternate transportation infrastructure could potentially be temporarily blocked due to compliance measures that involve construction, particularly construction occurring in roadways and in urban areas. However, the blockage would be temporary and is likely negligible as compared to the existing traffic baseline. Additionally, limiting parking near areas of the river without adequate restroom facilities would be negligible as compared to the existing baseline as the existing parking capacity at many areas along the river is already highly limited or is located on private property. Therefore, these impacts would be less than significant.

(b) – Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?
(c) – Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?
(d) – Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?
(e) – Result in inadequate emergency access?
Answer: No impact.

None of the reasonably foreseeable structural or non-structural compliance measures will affect a level of service standard, air traffic patterns, increase hazards, or result in inadequate emergency access. Changes in traffic due to construction-related activities to install compliance measures should not exceed the service standard level established by the county as these types of activities currently occur, are part of the baseline, and the County's level of service standard should allow for the activities. There should be no change in air traffic patterns due to the reasonably foreseeable compliance measures. This is because the compliance measures in no way increase or decrease air traffic; and, structures should not be tall enough to have an effect on the flight of an airplane. Traffic hazards will not substantially increase, as the reasonably foreseeable compliance measures do not require redesign of roads or incompatible uses. Reasonably foreseeable compliance measures should not impede emergency access and if roadways must be excavated for new sewer line installation or collection system maintenance, access to and through that roadway for emergency vehicles should be maintained. Fences will likely be constructed in areas that are not currently used as access for fire or police protection or that are not part of a park or school.

XVII. UTILITIES AND SERVICE SYSTEMS -- Would the project:
(a) – Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?

Answer: No impact.

Any reasonably foreseeable compliance measure requiring compliance with wastewater treatment requirements of the North Coast Regional Water Board, will be controlled via a permit adopted through a public process by the North Coast Regional Water Board, and will include appropriate controls, limitations, and compliance schedules.

(b) – Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?
(e) – Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?
Answer: Potentially significant.

The proposed Basin Plan Amendment could result in an existing wastewater treatment plant determining it doesn't have the capacity to serve the projects projected demand and thus result in the construction of a new centralized or decentralized wastewater treatment plant or expansion of an existing plant, as a reasonably foreseeable compliance measure. The environmental effects associated with this type of construction, and of construction in general, have been discussed throughout this checklist, as appropriate. Potentially significant effects were identified and discussed in sections XI. Noise (c) and XII. Population and Housing (a).

(c) – Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?
Answer: Less than significant.

Storm water infrastructure is already in place and it is not anticipated that large-scale construction will occur (such as a new subdivision). The expansion or construction of a new centralized or decentralized wastewater treatment facility will not result in significant environmental effects related to storm water drainage as storm water discharges from a wastewater treatment facility may be subject to NPDES industrial storm water general permit requirements that require protection of water quality and prevention of nuisance. Therefore, the effect will be less than significant.

(d) – Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?
(g) – Comply with federal, state, and local statutes and regulations related to solid waste?
Answer: No impact.

Reasonably foreseeable compliance measures should not require an increase in water supply. The solid waste from a new wastewater treatment plant, construction activities, or pet waste from collection receptacles is not expected to have any impact on landfills over current baseline conditions. Any actions related to solid waste must be in compliance with all existing federal, state, and local statutes and regulations related to solid waste. None of the reasonably foreseeable compliance measures would violate existing statutes and regulations.

XVIII. MANDATORY FINDINGS OF SIGNIFICANCE

(a) – Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?
Answer: Less than significant with mitigation.

Reasonably foreseeable non-structural compliance measures will not result in the substantial degradation of the environment for fish, wildlife, and threatened/rare plant and animal species because none of the measures would introduce any new physical effects above the baseline that could impact these characteristics.

Some of the reasonably foreseeable structural compliance measures, however, do have the potential to cause significant degradation of the environment for fish, wildlife, and threatened/rare plant and animal species if not mitigated. As discussed in section IV above, plant and animal species could potentially be adversely affected by construction related activities, creation of riparian buffers, installation of straw waddles, and by exclusion fencing. The mitigation measures discussed in that section, as well as others, could be implemented to ensure that unique, rare or endangered plant and/or animal species and their habitats are not taken or destroyed. When specific projects are developed and sites identified, a focused protocol plant and/or animal survey and/or a search of the California Natural Diversity Database should be performed to confirm that any potentially sensitive or special status plant and/or animal species in the site area are properly identified and protected as necessary. If sensitive plant and/or animal species occur on the project site, mitigation is required in accordance with the Endangered Species Act. Mitigation measures should be developed in consultation with CDFW and USFWS.

The adoption of the proposed Basin Plan amendment should result in improved surface water quality in the Russian River Watershed and will have a significant beneficial effect on the environment over the long-term. However, it should be noted that some of the structural compliance measures do have the potential to adversely impact the environment. In many cases, the impacts of the installation of the structural compliance measures will be temporary, and many of the effects caused by permanent structures can be avoided by adjusting the timing and/or location so as to take into account any candidate, sensitive, or special status species or their habitats. Therefore, with correctly implemented mitigation measures these impacts are considered less than significant.

(b) – Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?
Answer: Potentially significant.

Cumulative impacts, defined in section 15355 of the California Code of Regulations, refer to two or more individual effects, that when considered together, are considerable or increase other environmental impacts. Cumulative impact assessment must consider not only the impacts of the proposed Basin Plan amendment, but also the impacts from other Basin Plan amendments, municipal and private projects which have occurred in the past, are presently occurring, and may occur in the future in the watershed during the period of implementation.

Impacts associated with implementation of the non-structural measures and most of the structural measures will be short-term, temporary, amenable to mitigation, and spatially distributed across the watershed, and will not contribute to significant adverse effects or cumulative impacts on the environment. However, structural compliance measures that involve substantial earth movement could have potentially significant cumulative impacts to traffic, greenhouse gas emissions, and noise when considered in conjunction with other past, present, and future construction; including but not limited to construction and repair of infrastructure (such as roads and the Sonoma-Marin Area Rail Transit project), housing construction, commercial construction activities, and restoration projects involving earth moving and construction equipment. Regional Water Board staff's oversight of construction activities though permits, regulatory programs, and other authorities will provide an opportunity to limit the potential for cumulative impacts by ensuring that multiple projects proposing various compliance measures and implementation of BMPs with the potential to cause short-term impacts are phased appropriately to limit potential cumulative impacts.

Based on a review of the available information, and as a result of implementing various compliance measures including creating riparian buffers, exclusion fencing, construction and daily operations of a new wastewater treatment plant and expansion of an existing wastewater treatment plant, it has been determined that significant and unavoidable impacts to the environment have the potential to occur. Cumulative impacts are especially significant in areas that are already listed as impaired or otherwise degraded since the system or species has already lost resilience to external stressors. Due to the fact that many streams in the region are impaired and several rare, threatened and endangered are present throughout the region any adverse impact that has the potential to occur in multiple instances could be considered significant and unavoidable. Many of the potential impacts discussed throughout this CEQA analysis can be reduced through proper implementation of mitigation measures; however, cumulatively these impacts do have the potential for significant adverse effects on the environment.

(c) – Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?
Answer: Potentially significant.

The purpose of the proposed TMDL Action Plan is to improve water quality conditions to protect human health as well as aquatic ecosystem health. Most of the potentially significant impacts to human beings, such as air quality, aesthetics, biological resources, greenhouse gas emissions, etc., are either short-term in nature, or can be mitigated to less than significant levels as previously discussed. However, some impacts were identified as being potentially significant including impacts to agricultural resources, noise levels, population growth, and utilities as detailed in those sections above. It is possible that when implemented at the project level, some of the reasonably foreseeable compliance measures identified as having potentially significant impacts could be mitigated so as to reduce the impacts to less than significant or that proposed projects could identify additional compliance measures that have less than significant impacts or impacts that can be mitigated. The overall effects of implementing the proposed TMDL Action Plan will be to improve water quality conditions and therefore are seen as a benefit for human beings and the environment.

CHAPTER 12
ECONOMIC CONSIDERATIONS

This chapter describes the economic considerations associated with implementation of the Pathogen Indicator Bacteria Total Maximum Daily Load (TMDL) for the Russian River Watershed, as drafted in the TMDL Action Plan. The triggers for Regional Water Board consideration of economics or costs in basin planning include:

- Establishing water quality objectives that ensure the reasonable protection of beneficial uses.
- Compliance with the California Environmental Quality Act (CEQA)[23] when Regional Water Boards amend their basin plans. CEQA, and the regulations implementing CEQA, require that the Boards identify the reasonably foreseeable methods of compliance with draft performance standards and treatment requirements.[24] This process must include discussion of economic factors.

Chapter 10 of this staff report (CEQA Substitute Environmental Analysis) discusses the potential environmental impacts, as required under CEQA, associated with adopting an amendment to the Water Quality Control Plan for the North Coast Region (Basin Plan) to include an implementation plan for the Pathogen Indicator Bacteria Total Maximum Daily Load (TMDL) for the Russian River Watershed, known as a TMDL Action Plan. Chapter 10 identifies the reasonably foreseeable compliance measures necessary to achieve compliance with the TMDL Action Plan. Compliance measures include treatment technologies and management practices most likely to be implemented to achieve compliance with TMDL load allocations, waste load allocations, and the water quality objectives for bacteria contained in the Basin Plan. There are no new water quality objectives proposed for adoption as part of this TMDL.

This chapter considers the potential costs of implementing the reasonably foreseeable compliance measures without considering whether compliance measures are currently part of the existing regulatory baseline. The costs are generally given as a range, and are dependent on the specific characteristics of the land or operation to which given management practices are applied. A list of potential funding sources is also presented below.

Although the Regional Water Board is required to consider economics during the Basin Plan amendment (TMDL Action Plan) process, it is not obligated to consider the balance of costs and benefits associated with implementation of the amendment. The Regional Water Board is obligated to consider the costs of compliance and potential sources of funding and may adopt a Basin Plan amendment even if the costs are considered to be significant[25]. For

[23] Pub. Resources Code § 21000 *et seq.*

[24] Cal.Code Regs., tit., 23 § 3777 subdivision (b).

[25] See *California Assn. of Sanitation Agencies v. State Water Resources Control Board* (2012) 208 Cal.App. 4th 1438, 1466.

CEQA purposes, the economic and social impacts of the draft proposed project are considered to determine if they will cause or contribute to an adverse environmental impact, not whether the costs of the measures themselves are significant or will cause an economic hardship.

Anticipating costs with precision is challenging for several reasons. Many of the actions, such as review, revision, and development of policies and ordinances by a governmental agency, could incur no significant costs beyond the program budgets of those agencies. However, other actions, such as establishing an ordinance to require property owners to inspect and repair their private sewer laterals carries discrete costs. Cost estimates are further complicated by the fact that some implementation actions are currently part of the baseline condition as they are already required by other regulatory requirements (e.g., NPDES Storm Water) or are actions anticipated regardless of TMDL adoption. Therefore assigning all of these costs to TMDL implementation would be inaccurate.

While the below text discusses the cost of various control measures aimed at improving water quality, it does not discuss the effects (costs) of *not* improving water quality such as impacts to public health.

12.1 ESTIMATED COST OF COMPLIANCE

The majority of costs identified in this chapter were derived from the following sources of information:

- U.S. Environmental Protection Agency (USEPA) Technology Fact Sheets http://water.epa.gov/scitech/wastetech/mtbfact.cfm
- Water Environment Research Foundation (WERF). Performance & Cost of Decentralized Unit Processes. Final Report, 2010. http://ndwrcdp.werf.org/documents/DEC2R08/DEC2R08web.pdf
- San Francisco Bay Regional Water Quality Control Board, Staff Report for Pathogens in the Napa River Watershed Total Maximum Daily Load (TMDL). http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/napapathogens/item8napapathsappb.pdf
- Federal Remediation Technologies Roundtable Screening Matrix and Reference Guide (FRTR) http://www.frtr.gov/default.htm;
- Natural Resource Conservation Service (NRCS) Field Office Technical Guide (FOTG) http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/;
- CDFW Coho Salmon Recovery Strategy http://www.dfg.ca.gov/fish/Resources/Coho/CohoRecovery.asp; and
- California Department of Transportation (Caltrans) 2013 contract proposal award information http://www.dot.ca.gov/hq/esc/oe/project_ads_addenda/.

The cost information provided in the U.S. EPA guidance are available to assist the public and publicly owned treatment works , referred to here as wastewater treatment facilities

(WWTFs), in understanding the necessary components and costs involved with implementing particular technologies. Many of the cost breakdowns are based on a variety of example sites throughout the county over the last two decades. Therefore, it can be generally assumed that these costs have increased with inflation, although some compliance measures have become more affordable as improvements in technologies are made.

The cost information provided in the NRCS FOTG is a national dataset to assist local NRCS Districts in setting cost shares for implementing conservation practices. Cost estimates are provided at the county level and the data used for this analysis are specific to Northern California as described in their Fiscal Year 2014 Payment Schedule. The FOTG represents the NRCS estimate of costs to implement such practices.

The costs included in the CDFG Manual are described as upslope erosion inventory and sediment control guidance. The numbers are based on estimates provided by Pacific Watershed Associates, a consulting firm specializing in erosion control work. Actual costs can vary considerably depending on operator skill and experience, equipment types, local site conditions, and regional location.

12.1.1 POTENTIAL COSTS FOR TREATMENT PLANT UPGRADES AT EXISTING WWTFS

Disinfection Improvements

All municipal wastewater treatment facilities within the Russian River Watershed are required to comply with effluent disinfection requirements contained in waste discharge requirements. No new capital costs are anticipated as a result of implementing this TMDL for WWTFs that are in compliance with effluent limitations for bacteria and disinfection requirements in their waste discharge permits. Permitted wastewater treatment facilities will incur increased costs associated with additional effluent and receiving water bacteria monitoring, so as to demonstrate compliance with this TMDL. In particular, those facilities that discharge treated and disinfected effluent to a holding pond prior to discharge to a surface water, will be required to demonstrate that any regrowth of *e. coli* or total coliform bacteria in the holding pond (including bacteria contributions from bird life) does not otherwise indicate the presence of human pathogens. But these costs are not included here as an economic consideration associated with implementation.

In cases where a municipal wastewater treatment facility does not consistently meet bacteria effluent limitations in its waste discharge permit or cannot demonstrate that discharges from wastewater holding ponds are in compliance with this TMDL, the municipality or special district may have to improve the reliability or upgrade its existing treatment facilities to implement this TMDL. It is anticipated that treatment systems consistent with disinfected tertiary treated water, as defined in title 22 of the California Code of Regulations, are the minimum acceptable processes that are capable of ensuring compliance with effluent limitations for bacteria, excluding consideration of the potential for bacterial regrowth in holding ponds. The costs for complying with effluent limitations for bacteria through improvements in wastewater disinfection systems include capital costs and cost for routine operations and maintenance and are presented in Table 12.1.

Table 12.1
Estimated Cost Range for Centralized Wastewater Treatment Compliance Measures Advanced Treatment and Disinfection

Compliance Measures	Capital Costs	Annual O&M Costs	Cost Source
Membrane Bioreactors	$7.00-$20.00 / gpd capacity	$1.00-$2.00 /gallons treated	USEPA[1], GWRMN
Chlorine Disinfection	1-2.5 mgd = $1.1 to $1.3 million 10-20 mgd = $3.1 to $4 million 100-175 mgd = $14.3 to $1.3 million	1-2.5 mgd = $49K to $76K 10-20 mgd = $158K to $380K 100-175 mgd = $660K to $1.3 million	USEPA[1]
Dechlorination	$6,500 to $383,000	$9,900 to $17,500 $0.10 to $10.00/1,000 gallons treated	USEPA[1]
Ultraviolet Light Disinfection	Lamps 1-5 mgd =$400-$1,375 5-10 mgd = $345-$595 19-100 mgd = $275-$590 Systems $245k	$19,200	USEPA[1]
Ozone Disinfection	Oxygen gas /compressor $245K Contact vessel (500 gpm) $4,000 - $5,000 Destruct unit: Small (around 30 cfm) $800 Large (around 120) $1,000-1,200 Non-component costs $35,000 Engineering $12,000-15,000 Contingencies 30%	Labor $12,000 Power 90 kW Other (filter replacements, compressor oil, spare dielectric, etc.) $6,500	USEPA[1]
Reverse Osmosis	$776k to $81 million / 1.0 to 200 mgd		USEPA[1]
Wetland Treatment Systems	$155,000 to $260,00 /100,000 gpd $359,000 to $1,015,009 /acre of wetland treatment system Operations and maintenance costs	$5,00 to $8,323 /acre per year $0.45 to $1.36 /1,000 gallons over 10 to 30 year timeframe	FRTR, USEPA[3]
Advanced Ecologically Engineered Systems	40K gpd = $985K to $1.2 million 80K gpd = $1.5 to $1.9 million 1 million gpd = $8.5 to $10.5 million		USEPA[1]

gpm – gallons per minute / mgd – million gallons per day / gpd – gallons per day/ cy – cubic yard / ft^2 – square foot / lb – pound / ft- feet
OWTS – Onsite Wastewater Treatment System
SWRCB 1 – State Water Resources Control Board Onsite Wastewater Treatment System Policy Final SED June 19, 2012
FRTR – Federal Remediation Technologies Roundtable
GWRTAC – Groundwater Remediation Technologies Analysis Center, Technology Overview Report TO-97-03
U.S. EPA 1 – US Environmental Protection Agency Technology Fact Sheets http://water.epa.gov/scitech/wastetech/mtbfact.cfm
U.S. EPA 2 – US Environmental Protection Agency Technologies and Cost for Removal of Arsenic from Drinking Water
U.S. EPA 3 – US Environmental Protection Agency Technology Fact Sheet Free Surface Water Wetland & Constructed Wetland Treatment of Municipal Wastewaters
GWRMN- Groundwater Remediation and Management for Nitrate Report – Addressing Nitrate in California's Drinking Water AFCEE –
EN- Eco-Nomic Septic System design Page http://www.eco-nomic.com/indexsdd.htm#Industrial or Non-Residential Wastewater

Expansion of Collection, Treatment, and Disposal or Recycled Water Systems

To accommodate new connections, WWTFs may need to evaluate whether flow from new customers will require expansion of its wastewater collection, treatment and disposal systems. Wastewater collection costs are generally the largest component of costs for expansion of the complete system, but the cost of land purchase is often significant when land suitable for waste management functions is scarce and expensive. Cost estimates for expanding the wastewater collection system for new connections are highly variable depending on terrain and other site constraints, method of collection, and design flow. As part of a 2007 assessment by the City of Los Altos Hills in Santa Clara County, for example, it was estimated that a proposed extension of an existing municipal sewer line to 40 nearby residences would cost approximately $1.5 million (Moody Sewer Extension), and another proposed extension to 57 residences would cost approximately $1.01 million (Robleda Sewer Extension). Both proposed extension were rejected by City staff as too expensive to residents in the targeted subdivisions.

Unit costs for expansion of baseline capacity for treatment unit processes to accommodate additional flow from new customers outside the established service area are highly variable and dependent on many factors and estimating the cost for such an expansion would require a project level evaluation beyond the scope of this TMDL. Consequently, estimating the cost for possible construction costs for treatment plan expansion scenarios would be speculative and inaccurate. The average operation and maintenance costs for wastewater treatment are generally lower for a facility that increases design volume. This is a result of an economy of scale for secondary and tertiary wastewater treatment systems.

In cases where a municipality or special district choses to comply with this TMDL by expanding effluent storage so that the need to discharge to surface water is eliminated, the capital cost may include costs for land acquisition, permitting, pond excavation and earthwork, pond liner, pumping and pumping appurtenances, and electrical systems. The total cost of construction or expansion of effluent storage will vary greatly depending on site constraints, land availability, and level of public support. Two recent examples illustrate the range of costs: In 1999, the Russian River County Sanitation District (Guerneville, CA) evaluated a project to construct a $5.7 million gallon equalization basin to increase wastewater treatment capacity at its Guerneville Treatment Plant. Although the project was never completed, the estimated cost of the expansion was $1.5 million. More recently, the Sonoma Valley Sanitation District (Sonoma, CA) is proposing to construct a 37 million gallon recycled water storage reservoir to reduce its discharge to Shell Slough and San Pablo Bay and provide recycled water for irrigation purposes. Construction of the reservoir is expected to cost approximately $2.3 million. Where discharge to a pond is designed to use percolation to groundwater as the method of disposal, costs associated with ongoing operation and maintenance, as well as groundwater monitoring will also apply.

In order to avoid TMDL implementation requirements for discharges to surface waters, municipalities and special districts that treat municipal wastewater may also expand existing or implement new water recycling programs. Total capital costs will vary depending on site conditions, land acquisition requirements, and public support. In 1999, the Russian River County Sanitation District evaluated expansion of its treated wastewater disposal capacity. Among the alternatives evaluated was expansion of spray irrigation on the Burch Property, which is located adjacent to the Guerneville Treatment Plant and a portion of which is currently leased for spray irrigation of treated wastewater. This alternative was estimated to cost approximately $4.0 million (including purchase of the Burch Property). Other alternatives for this project included extension of the pipelines and spray irrigation to Green Valley and to the Guerneville and Westside Road areas. These projects were estimated at $6.5 to $12 million and $3 to12.5 million, respectively. Annual O&M costs for the Green Valley alternative was estimated at $50,000 to $350,000, and may be considered typical for similar projects, for the purpose of this TMDL. These projects are designed to use vegetative uptake as the primary mechanism for wastewater removal, depending on agronomic rates of wastewater application. Proper operation and maintenance should also include the cost of monitoring to ensure proper application.

12.1.2 POTENTIAL COST FOR SANITARY SEWER SYSTEMS

Sanitary sewer systems greater than one mile in length within the Russian River Watershed are required under the existing General Permit for Sanitary Sewer Systems to be designed, operated, and maintained in such a way as to prevent or minimize sanitary sewer overflows. No new costs to prevent sanitary sewer overflows are anticipated as a result of this TMDL. In the event that public entities that own sanitary sewer systems enact new ordinances or programs to require or promote private property owners to inspect their private sewer laterals, costs to develop the ordinances or programs will be incurred. The cost of developing and implementing a program will depend on the nature and complexity of the local program and are not estimated here.

12.1.3 POTENTIAL COSTS FOR INDIVIDUAL AND DECENTRALIZED ONSITE WASTEWATER TREATMENT SYSTEMS

Individual OWTS Cost Considerations
As outlined in the TMDL Action Plan, certain existing, new, and replacement OWTS in the Russian River Watershed are required to utilize supplemental treatment and meet performance requirements to achieve load allocations for pathogen indicator bacteria. The supplemental treatment components necessary to comply with performance requirements will vary depending on type and age of the existing OWTS, site conditions and constraints, the availability of and proximity to the individual OWTS to community sewer systems, and the availability of financial assistance to private property owners to fund OWTS upgrades. Cost estimates for new OWTS and for supplemental treatment components for new and replacement OWTS are presented in Table 12.2.

In the absence of a TMDL, existing OWTS that do not meet requirements in the statewide Conditional Waiver of Waste Discharge Requirements or the conditions and requirements set forth in an approved LAMP may be required to submit a report of waste discharge, obtain waste discharge requirements, and pay an annual fee for their OWTS. The cost of preparing a complete report of waste discharge will vary depending whether the report will be prepared by the property owner or a qualified professional, how much information is available to characterize the discharge and site conditions, site conditions and constraints, and the proposed supplemental treatment system to be used to meet performance requirements. The cost for a general site evaluation to obtain local agency approvals for a new or replacement OWTS is approximately $1,000. The cost for preparation of a report of waste discharge by a qualified professional could range from $2,000 to $6,000 (Ted Walker, personal communication). The application fee and first annual fee submitted to the Regional Water Board for waste discharge requirements is currently $2,088 (Fiscal Year 2014-15).

Table 12.2
Estimated Cost Range for Wastewater Treatment Compliance Measures
Individual OWTS

Compliance Measures	Capital Costs	O&M Costs	Cost Source
Septic System for single home	Tank replacement: $2,500 - $4,500 Leachfield replacement: $3,300 - $7,400 Whole new OWTS: $5,600-$10,000 With supplemental treatment: $17,600 - $26,000	$44-$400/yr	USEPA[1], EN, SWRCB[1]
Septic System for a Restaurant (approximately 200 meals per day)	Tank replacement: $4,500 - $13,800 Leachfield replacement: $29,500 - $66,000 Whole new OWTS: $34,000-$80,000 With supplemental treatment: $104,000 - $151,000	$44-$400/yr	USEPA[1], EN, SWRCB[1]
Septic System for a School (Approximately 700 students)	Tank replacement: $4,500 - $13,000 Leachfield replacement: $50,000 - $200,000 Whole new OWTS $55,600-$212,000 With supplemental treatment: $104,000 - $151,000	$44-$400/yr	USEPA, EN, SWRCB
Aerobic Pretreatment	500–1,500 gpd = $2,500 to $9,000	$350/yr	USEPA
Chlorine Disinfection	$325 - $4,200 /unit	Tablets $69-$280 (45lb. pail)	USEPA
UV Disinfection	$2,500 – 4,700/unit	Lamp Replacement: $40-$80 Power: 200-300 kWh/yr	USEPA Levernze
Control Panels	$1,500 - $3,000 /unit	-0-	USEPA
Septic Tank Effluent Screen	$70 - $300 per unit, not including installation	Minimal	USEPA

Table 12.2
Estimated Cost Range for Wastewater Treatment Compliance Measures
Individual OWTS

Compliance Measures	Capital Costs	O&M Costs	Cost Source
Sand/Gravel Filters	Range: $4,000 - $15,000 1,500-gallon single compartment septic/pump tank @ $0.57/gallon: $850 ISF complete equipment package (includes dual simplex panel, pump pkg., tank risers, lids, liner, lateral kit, orifice shields, etc.): $3,200 Non-component costs: $750 Engineering (soil evaluation, siting, design, and construction): $2,000	Labor @ $65/hr. (2 hrs./yr.)= $130/yr Power @10 cents/kWh Sludge disposal=$25/yr	USEPA, EN
Low Pressure Pipe System	$1,500 - $5,000	Distribution line and filter flushing: $0 Power: Variable depending on pumping rate, volume per dose pumped, and pump wattage.	USEPA, EN
Pressure Systems	$4,000 - $6,500	Distribution line and filter flushing: $0 Power: Variable depending on pumping rate, volume per dose pumped, and pump wattage.	USEPA, EN
Mound Systems	$9,000 to $20,000	$100/yr	USEPA, EN
Granular Activated Carbon Absorption	$0.80 - $6.30 /1,000 gallons treated	Carbon $0.50 to $1.20 /lb	USEPA
Replace/Upgrade Sewer laterals	Burst Pipe: $40-$80 per linear foot Sliplining: $80-$170 per linear foot Cured In Place Pipe: $25-$65 per linear foot Modified Cross Section: $18-$50 per linear foot		USEPA
Composting Toilets	Household of four: $1,200 - $6,000 Seasonal Usage: $700 - $1,500 Large Capacity/ Public Facility: $20,000	Electric (fan): 120 Wh/day Leachate disposal: variable Bulking agents: variable Compost Disposal: variable	USEPA
Incinerating Toilet	Electric: $2,300 - $2,700 Propane: $2,550	Electric: $2,748/yr Propane: $383.60/yr	

gpm – gallons per minute / mgd – million gallons per day / gpd – gallons per day/ cy – cubic yard / ft^2 – square foot / lb – pound / ft- feet
SWRCB 1 – State Water Resources Control Board Onsite Wastewater Treatment System Policy Final Substitute Environmental Document June 19, 2012
U.S. EPA 1 – US Environmental Protection Agency Technology Fact Sheets http://water.epa.gov/scitech/wastetech/mtbfact.cfm
EN- Eco-Nomic Septic System design Page http://www.eco-nomic.com/indexsdd.htm#Industrial or Non-Residential Wastewater
Leverenz, Harold, J. Darby, and G. Tchobanoglous, 2006. Evaluation of Disinfection Units for Onsite Wastewater Treatment Systems. http://www.waterboards.ca.gov/water_issues/programs/owts/docs/disinfection.pdf

Decentralized OWTS Cost Considerations

An alternative for some small communities, where neither individual OWTS nor connection to an existing centralized municipal sewer system work well, is the establishment of a decentralized onsite waste treatment and disposal system. There is a range of available collection, treatment, and effluent dispersal technologies for a community-owned decentralized OWTS that may be used individually or in combination. Cost estimates for individual property owners to connect to a community-owned decentralized OWTS via a local sewer system (not including connection fees or other related costs) are presented in Table 12.3. Table 12.4 presents estimates for the cost of operating a decentralized OWTS, based on common technologies for waste flows ranging from 5,000 to 50,000.

Table 12.3
Estimated Cost Range for Wastewater Treatment Compliance Measures
Decentralized OWTS- Cost to Property Owner

Compliance Measures	Capital Costs for building sewer and connection to sewer main	Annual O&M Costs	Cost Source
Private Laterals	$20-$30/ft (excluding surface restoration) $50-$100/ft (for paved streets)	Electricity: $0 O&M: $0	CCCSD[1]
Gravity Sewer Systems	Materials and Installation: $1,800 - $2,700	Electricity: $0 O&M: $16 - $24	WERF[2]
Pressure Sewer Systems	Materials and Installation: $4,800 - $7,200	Electricity: $44 - $66 O&M: $120 - $240	WERF
Effluent (STEP) Sewer Systems	Materials and Installation: $3,000 - $5,000	Electricity: $24 - $36 O&M: $56 - $84	WERF

[1] Central Contra Costa County Sanitary District (CCCSD) website: http://www.centralsan.org/index.cfm?navid=27

[2] Water Environment Research Foundation (WERF). Performance & Cost of Decentralized Unit Processes. Final Report, 2010.

Table 12.4
Estimated Cost Range for Wastewater Treatment Compliance Measures[2]
Decentralized OWTS – Cost to Wastewater Utility

Compliance Measures	Cost Factors	Wastewater Volume (gpd)		
		5,000 gpd (or 20 homes)	10,000 gpd (or 40 homes)	50,000 gpd (or 200 homes)
Gravity Sewers	Materials and Installation Annual O&M	$210,000-$315,000 $6,400-$9,600	$419,000-$629,000 $12,800-$19,200	$2,182,000-$3,273,000 $65,000-$97,000
Pressure Sewers	Materials and Installation Annual O&M	$33,000-$49,000 $6,400-$9,600	$65,000-$98,000 $13,000-$19,000	$344,000-$516,000 $56,000-$84,000
Effluent Sewers	Materials and Installation Annual O&M	$32,000-$48,000 $6,000-$9,000	$65,000-$97,000 $12,000-$18,000	$340,000-$510,000 $61,000-$91,000
Extended Aeration	Materials and Installation Annual Electrical Annual O&M	$100,000-$150,000 $900-$1,400 $5,300-$8,000	$148,000-$223,000 $1,800-$2,700 $9,000-$13,000	$410,000-$616,000 $9,000-$14,000 $34,000-$51,000
Fixed-growth Media Filter	Materials and Installation Annual Electrical	$30,000-$46,000 $350-$500	$98,000-$147,000 $900-$1,400	$287,000-$431,000 $4,600-$6,900

Table 12.4
Estimated Cost Range for Wastewater Treatment Compliance Measures[2]
Decentralized OWTS – Cost to Wastewater Utility

Compliance Measures	Cost Factors	Wastewater Volume (gpd)		
		5,000 gpd (or 20 homes)	10,000 gpd (or 40 homes)	50,000 gpd (or 200 homes)
	Annual O&M	$4,100-$6,000	$7,300-$11,000	$30,000-$44,000
Wastewater Lagoons	Materials and Installation	$314,000-$471,000	$628,000-$942,000	$3,141,000-$4,711,000
	Annual Electrical	-0-	-0-	-0-
	Annual O&M	$2,400-$3,500	$4,700-$7,100	$24,000-$35,000
Chlorine Disinfection	Materials and Installation	$3,100-$5,400	$3,100-$5,400	$3,100-$5,400
	Annual Electrical	$40-$50	$50-$80	$3,100-$4,700
	Annual O&M	$900-$1,400	$1,700-$2,500	$7,900-$12,000
UV Disinfection	Materials and Installation	$1,700-$2,500	$2,300-$3,400	$5,200-$7,800
	Annual Electrical	$14-$20	$28-$40	$130-$190
	Annual O&M	$480-$720	$700-$1,100	$2,600-$3,900
Gravity Distribution	Materials and Installation	$54,000-$81,000	$105,000-$158,000	$517,000-$776,000
	Annual Electrical	$80-$120	$160-$230	$750-$1,100
	Annual O&M	$2,300-$3,400	$4,400-$6,600	$21,000-$31,500
Drip Distribution	Materials and Installation	$37,000-$56,000	$85,000-$127,000	#329,000-$494,000
	Annual Electrical	$240-$360	$480-$720	$2,400-$3,600
	Annual O&M	$3,300-$5,000	$6,900-$10,000	$31,000-$47,000
Spray Distribution	Materials and Installation	$138,000-$206,000	$265,000-$397,000	$1,260,000-1,890,000
	Annual Electrical	$240-$360	$460-$690	$2,300-$3,500
	Annual O&M	$2,200-$3,400	$4,300-$6,500	$21,000-$31,000

[1]Water Environment Research Foundation (WERF). Performance & Cost of Decentralized Unit Processes. Final Report, 2010.

Local Oversight Agency Costs
As described in Chapter 5 (Source Analysis), Section 5.4.1 (Onsite Waste Treatment Systems), effective pathogen removal in OWTS is dependent on proper siting and installation of the OWTS components, proper maintenance, and operation of the system within design specifications. Local agencies have been performing OWTS design review and approval for decades. According to the well and septic fees adopted by Sonoma County for the 2015/2016 fiscal year, inspections and field clearance reports range from $400-$1,100 per inspection/plan check. For existing OWTS requiring certification, the cost of a qualified contractor to perform the inspection and generate a report could range from $350 to $1,500.

As a general rule, the local agencies that issue a building permit are often the same entities that oversee the installation and construction of most of the OWTS, as well. In many cases, local agencies have worked with their respective regional water boards to integrate the necessary OWTS-related requirements into the building permit process, allowing one permitting and inspection agency to oversee both programs. Estimating the cost associated complying with the OWTS-related requirements of a building permit, is difficult and speculative, given the combined requirements.

Tier 2 of the Basin Plan's OWTS Policy is written to allow variability in local programs while retaining comparable standards to maintain the function of OWTS for the purpose of protecting the environment and human health through institutional controls and management. This is achieved by requiring regional water board approval of a Local Agency Management Plan (LAMP) developed under Tier 2 of the Basin Plan's OWTS Policy. Conceptually, Tier 2 Programs (approved LAMPs) will include varying degrees of change to the local programs and practices currently in place. An OWTS managed under an approved LAMP may be allowed a variety of technological designs for both the wastewater treatment and effluent dispersal system. The selection of the technology would be made to accommodate site constraints, in order to ensure that the design provides adequate protection given the site's slope, groundwater level, soil conditions, topographic location, and other natural barriers to effective treatment.

There may be additional cost to the local agencies for developing and administering a local agency management program (LAMP). But, that will depend on the extent to which the existing programs and practices require upgrading to meet the goals and requirements of the Basin Plan's OWTS policy. It is expected that some or all of any such additional costs will be passed on to the owners of OWTS in the form of permit fees.

Tier 3 of the Basin Plan's OWTS Policy represents a departure from current practice. It may require that OWTS be upgraded to meet performance standards for nitrogen, pathogens or both where discharges from OWTS have been determined to be contributing to surface water pollution. Compliance with performance standards may require the use of supplemental treatment systems. An assessment of the site, assuming it includes groundwater monitoring with three wells to assess whether the OWTS is contributing to the impairment (by determining pollutant concentrations in the groundwater and groundwater flow direction), could cost as much as $5,000. Assuming that such testing confirmed the need for advanced treatment, Tier 3 costs for inspection and upgrade of the septic tank to a supplemental treatment system could cost $22,000 for a three bedroom home or more, where the OWTS is larger or more complex.

Tier 4 of the Basin Plan's OWTS Policy requires that OWTS owners replace their failing OWTS (e.g. collapsed septic tank, overflowing leachfield) with a new component that will operate correctly and in compliance with conditions and requirements of the OWTS Policy. Replacement components (e.g. septic tank or drainfield) would have to meet the new standards, rather than out of date standards. (See Tables 12.2 and 12.3 for costs associated with individual OWTS)

12.1.4 POTENTIAL COSTS OF ADDRESSING HOMELESS AND FARMWORKER ENCAMPMENTS, ILLEGAL CAMPING, AND RECREATIONAL WATER USE

Homeless and Farmworker Encampments and Illegal Camping
It is anticipated that for the control of waste discharges from homeless and farmworker encampments and illegal camping that responsible parties will employ a combination of non-structural and structural BMPs. Non-structural BMPs include community outreach and public information to reduce the homeless population within the Russian River Watershed, thereby reducing the need for illegal camping and formation of encampments. Many of these efforts are voluntary and are already in development or underway in both Mendocino County and Sonoma County. Cost estimates for these initiatives are not considered as part of this TMDL.

The TMDL also encourages counties, municipalities, and special districts to construct public restroom facilities that are accessible to homeless individuals. Cost estimates for the construction of public restroom facilities is presented in Table 12.5, and are based on nationwide case studies and a local project in the community Guerneville in Sonoma County. These costs also apply to the construction of public restroom facilities at recreational beaches and trailheads in close proximity to the Russian River and its tributaries.

Recreational Water Use
The control of pathogenic waste due to recreational water use primarily relies on the availability of adequate restroom facilities at places of significant recreational water use. These include both private and public recreational beaches. Table 12.5 provides estimates of the cost for construction of restroom facilities. In addition, cities, counties, and special districts may limit the availability of public parking near places of recreational water use, so as to accommodate only as many recreational water users as the facilities can safely support. Estimating costs for these site-specific measures are difficult to determine with the existing baseline of parking and trespassing enforcement during the peak tourism season. Additionally, minor cost may be incurred for posting additional signage informing recreators of such facility limits.

Table 12.5
Estimated Cost for Construction of Public Restroom Facilities

Location/Manufacturer	(1) Room	(2) Room	(4) Room	(6) Room	Source
Salt Lake City 1700 South River Park	N/A	N/A	158,264	N/A	1
Roseburg, OR ROMTEC, Inc.	82,571	N/A	149,293	204,523	1
Spokane, WA CXT Concrete Buildings	78,614	N/A	199,370	127,030	1
LeGrange, KY Hunter Knepshield Co.	93,702	N/A	181,266	222,047	1

Table 12.5
Estimated Cost for Construction of Public Restroom Facilities

Location/Manufacturer	(1) Room	(2) Room	(4) Room	(6) Room	Source
Reno, NV Restroom Facilities Ltd	148,460	N/A	351,483	491,646	1
Reno, NV Public Restroom Co.	117,281	N/A	205,111	247,378	1
Portland, OR Portland Loo	156,000	N/A	N/A	N/A	1
Salt Lake City American Ready Kontainer	N/A	N/A	217,750	N/A	1
Guerneville, CA	N/A	250,000	N/A	N/A	
Durham, NC	N/A	165-200,000	N/A	N/A	2
Range	$78-156,000	$165-250,000	$150-351,000	$127-492,000	

N/A – Not Available
1 Staff report to City Council, Salt Lake City, "Cost of Building Public Restrooms."(Jan 15, 2013)
2 "Going Public: An Assessment of Restroom Facilities in City of Durham Parks" (Jan 15, 2014)

12.1.5 POTENTIAL COSTS TO CONTROL URBAN STORM WATER RUNOFF

Local Agency Program Costs

As described in Chapter 5 (Source Analysis) Section 5.3.3 (Storm Water), urban storm water runoff and non-storm water runoff from MS4[26]s located in urban areas within the Russian River Watershed are regulated under conditions in the Phase I MS4 Permit for the City of Santa Rosa, County of Sonoma, and the Sonoma County Water Agency. Under terms of the Phase I MS4 Permit, permittees are required to develop and implement a Storm Water Management Plan and Monitoring Program that identifies tasks and programs to reduce the discharge of pollutants in storm water to the maximum extent practicable in a manner designed to achieve compliance with water quality standards and objectives. The Storm Water Management Plan and Monitoring Program includes ongoing costs for operations and maintenance, inspections, enforcement, staff training, public education and outreach, illicit connections and discharges response and abatement, and effectiveness monitoring. The costs for implementing the Storm Water Management Plan and Monitoring Program are baseline program costs, and will be incurred by MS4 Permittees with or without additional, incremental costs associated with a specific program to control pathogen indicator bacteria.

The Implementation Plan for the control of urban storm water and non-storm water runoff requires the establishment of effluent limitations and monitoring requirements to attain wasteload allocations for *E. coli* and enterococci bacteria. It is anticipated that MS4 Permittees will comply with effluent limitation by developing specific structural and/or

[26] Municipal Separate Storm Sewer System (MS4) is a conveyance or system of conveyances owned by a public entity and designed for collecting and conveying storm water, including roads, drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains.

nonstructural BMPs to control the sources of bacteria within the MS4 boundary. Potential control measures are unknown at this time. However, in the California Regional Water Quality Control Board, San Francisco Bay Region's *Pathogens in the Napa River Watershed Total Maximum Daily Load*, it was estimated that additional pathogen-specific measures for Napa County would result in a two to 15 percent increase to the annual MS4 program budget based on information for a similar MS4 program in Marin County. Using this estimate, staff estimates a range of incremental costs of implementing MS4 bacteria-control measures between a two percent annual increase (minimum) and a 15 percent annual increase (maximum). As an example of potential added costs for two MS4 Permittees in the Russian River Watershed, the cost calculations for the City of Santa Rosa and the County of Sonoma are shown in Table 12.6. Staff expects that MS4 Permittees that are already addressing pathogen indicator bacteria issues would fall at the low end of incremental cost increases.

Table 12.6
Estimated Cost Range for Incremental Costs for Bacteria Control Measures
Municipal Separate Storm Sewer Systems (MS4s)

	Annual Program Cost	2% Incremental Cost Increase associated with Bacteria Control Program	15% Incremental Cost Increase associated with Bacteria Control Program
Santa Rosa (FY 13/14)[1]	$1,983,913	$39,678	$297,587
Santa Rosa (FY 14/15,est.)[1]	$2,251,609	$45,032	$337,741
Sonoma County (FY 13/14)[2]	$775,949	$15,519	$116,392

1 City of Santa Rosa, December 2014. City of Santa Rosa's 2013-2014 Annual Report of Compliance with Order No. R1-2009-0050

2 County of Sonoma, December 2014. NPDES Phase I Annual Report: July 1, 2013 – June 30, 2014, Term 3, Year Five

Costs for Storm Water Controls for Caltrans

In the North Coast Region (Caltrans District 4), BMPs installed to comply with Caltrans' statewide NPDES Permit conditions currently are focused on activities to prevent and minimize erosion and sediment discharges from Caltrans right-of-way. Effective erosion control will reduce the migration of pollutants, including human pathogens and pathogen indicator bacteria, to surface waters.

Proactive bridge design is a cost-effective method to prevent the creation of tempting encampment sites for homeless persons. For retrofitting existing bridge underpasses, security fencing and other exclusionary structures are effective BMP to discourage the formation of homeless encampments under bridges within the Caltrans right-of-way. As an example of potential costs, in 2014, the City of Santa Rosa installed exclusion structures designed to exclude access to flat areas at the base of old bridge abutments that have been used for camping at three road crossings within the Russian River Watershed. The cost estimate for the project was $38,960, plus $1,170 for inspection of the three sites. In

Pennsylvania, the Pennsylvania Department of Transportation spent an average of $24,000 per location to fences bridges and highway ramps to deter homeless. Based on available information, the cost estimate per location for exclusionary fencing is from $13,000 to $24,000, depending on site conditions.

General Storm Water Compliance Measures Costs
Structural controls for nonpoint sources divert, store, treat, and/or infiltrate storm water to prevent the discharge of waste material to the river with storm water runoff. Structural controls for point sources can be implemented to treat waste before discharge and/or prevent the direct discharge of waste into a waterbody, as highlighted in Table 12.7.

Table 12.7
Estimated Costs of Reasonably Foreseeable Compliance Measures Associated with Storm Water Control

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
Sediment/Bacteria Controls	Fiber roll / Straw Wattle	$1.20- 20.00/Lft	Home Depot/ Caltrans 2013
Sediment/Bacteria Controls	Sand Filters	$6,000 -$18,500 /acre	U.S. EPA
Bioretention	Green Roofs, Rain Gardens, vegetated strips, and bioswales	$500-$7,000/per unit	U.S. EPA

12.1.6 POTENTIAL COSTS FOR OWNERS OF NON-DAIRY LIVESTOCK AND FARM ANIMALS

Activities associated with raising, feeding, and maintaining non-dairy livestock and farm animals occur throughout the North Coast Region both on private and public lands. Best management practices are recommended to prevent the migration of animal waste to surface waters. Estimates of potential cost to the grazing community are derived from NRCS Fiscal Year 2013 Payment Schedule, as depicted in Table 12.8.

Table 12.8
Estimated Cost Range for Incremental Costs for Bacteria Control Measures Owners of Non-dairy Livestock and Farm Animals

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
Use Exclusion	Forage exclusion	$0.64-$1.32/ft	#472
Vegetated filter strips	Filter strip	$210-$448/acre	#393
Stream buffer areas/Field borders	Field Borders: Riparian tree & shrub establishment; Non-native or native	$211-$1,617/acre	#386

Table 12.8 Estimated Cost Range for Incremental Costs for Bacteria Control Measures Owners of Non-dairy Livestock and Farm Animals			
Reasonably Foreseeable Compliance Measure	**Practice Name**	**Range of Practice Costs**	**NRCS Practice Code or Source**
	seedbed preparation		
Fencing	NA	\$3-\$12/ft	CDFW Coho Recovery Plan

Owners of non-dairy livestock and farm animals who fail to implement these or substantially similar best management practices will be required to submit a report of waste discharge for possible establishment of waste discharge requirements for the discharge of waste. The cost for preparing a report of waste discharge, or Notice of Intent, will vary depending whether the report will be prepared by the property owner or a qualified professional, how much information is available to characterize the discharge and site conditions, and site conditions and constraints. The application fee and first annual fee for waste discharge requirements for small-scale animal operations is approximately $455 (FY 2013-14).

12.1.7 POTENTIAL COSTS FOR PET WASTE MANAGEMENT PROGRAMS

A successful pet waste management program is dependent of the participation and cooperation of individual pet owners. The cost of a public education program depends on the type of materials produced and the method of distribution. Implementation of a pet waste management program is an existing program under the MS4 permit for the City of Santa Rosa, the County of Sonoma, and Sonoma County Water Agency. No new costs are anticipated to continue implementing this program beyond the installation of new trash receptacles and pet waste bag dispensers. The cost of a bag dispenser is approximately $60 (Washington State Department of Ecology).

12.1.8 POTENTIAL COSTS FOR DAIRIES

The structural BMPs to reduce and prevent discharges of animal waste associated with the operation of cow dairies are similar to practices identified in section 12.1.6 for non-dairy livestock and farm animals. Cost estimates for bacteria control measures for these BMPs are presented in Table 12.8. Where the structural BMP involves the construction of a new manure storage pond or enlargement of an existing manure storage pond, costs depend on the required design storm and the resulting required pond volume. Average national installation costs for livestock ponds is 2.2 cents per gallon for ponds with a capacity less than 1 million gallons, 1.8 cents per gallon for capacities from 1 million to 3 million gallons, and 1.5 cents per gallon for capacities greater than 3 million gallons (USDA)[27]. Increasing capacity in existing ponds by raising the levels of pond berms would cost considerably less.

12.1.9 POTENTIAL COSTS FOR BIOSOLID APPLICATION

Current options for managing wastewater biosolids include both beneficial reuse technologies (such as land application, landfilling with biogas recovery, and energy recovery through incineration) and non-reuse options, including landfilling. While implementing some type of beneficial reuse is the preferred method for managing wastewater biosolids, this is not always practical. For example, land acquisition constraints or poor material quality may limit beneficial reuse options. Composting is one of several methods for treating biosolids to create a marketable end product that is easy to handle, store, and use.

Recycling biosolids through land application serves several purposes. It improves soil properties, such as texture and water holding capacity, which make conditions more favorable for root growth and increases the drought tolerance of vegetation. Biosolids application also supplies nutrients essential for plant growth, including nitrogen and phosphorous, as well as some essential micronutrients such as nickel, zinc, and copper. Biosolids can also serve as an alternative or substitute for expensive chemical fertilizers.

Cost for controlling biosolid application as related to this pathogen TMDL are associated with the development of erosion control plans and the implementation of erosion and sediment control measures. If a facility already has a water pollution control plan in place, modification to address storm water contamination concerns will require minimal cost. If a facility will be developing a site plan for the first time, the initial cost will depend on the type of material at the facility, the facility size, and other related parameters. Costs for structural containment devices will also need to be identified for each facility. The need to control erosion is an existing regulatory requirement and the cost of site assessment and plan development range from $500 to $7,000 (the average construction site range is $2,000-$3,500 per plan). Structural erosion and sediment control measures that also address potential pathogens from biosolid application are identified in Tables 12.7 and 12.8.

[27] **USDA Natural Resources Conservation Service (Rhode Island). Comprehensive Nutrient Management Plans (CNMP): Costs Associated with Development and Implementation of Comprehensive Nutrient Management Plans -** Part I—Nutrient Management, Land Treatment, Manure and Wastewater Handling and Storage, and Recordkeeping. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ri/technical/dma/?cid=nrcs143_014041

12.2 SOURCES OF FUNDING

Potential sources of funding include monies from private and public sources. Public financing includes, but is not limited to: grant funds, as described below; single-purpose appropriations from federal, state, and/or local legislative bodies; and bond indebtedness and loans from government institutions.

12.2.1 SUMMARY OF PERTINENT STATE FUNDING PROGRAMS

There are several potential sources of public financing through grant and loan funding programs administered, at least in part, by the Regional Water Board and the State Water Board. The Division of Financial Assistance (DFA) administers the implementation of the State Water Board financial assistance programs that include loan and grant funding for construction of municipal sewage and water recycling facilities, remediation for underground storage tank releases, watershed protection projects, and nonpoint source pollution control projects.

The resources available through these programs vary over time depending upon federal and state budgets and ballot propositions approved by voters. State funding programs pertinent to this TMDL and Basin Plan Amendment are summarized and described below. Additional information can be found on the State Water Resources Control Board webpage. (http://www.waterboards.ca.gov/water_issues/programs/grants_loans/).

Clean Water State Revolving Fund
The Federal Water Pollution Control Act (Clean Water Act or CWA), as amended in 1987, provides for establishment of a Clean Water State Revolving Fund (CWSRF) program. The program is funded by federal grants, State funds, and Revenue Bonds. The purpose of the CWSRF program is to implement the CWA and various State laws by providing financial assistance for the construction of facilities or implementation of measures necessary to address water quality problems and to prevent pollution of the waters of the State, including federal waters.

The CWSRF Loan Program provides low-interest loan funding for construction of publicly-owned wastewater treatment facilities, local sewers, sewer interceptors, water recycling facilities, as well as, expanded use projects such as implementation of nonpoint source (NPS) projects or programs, development and implementation of estuary Comprehensive Conservation and Management Plans, and storm water treatment. Additional information can be found on the State Water Resources Control Board webpage http://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

Onsite Wastewater Treatment Systems – Mini-Loan Program
Local agencies designated under the OWTS Policy may apply to the State Water Board for loans from the CWSRF for use in mini-loan programs that provide for low interest loan assistance to private property owners with costs associated with complying with the OWTS

Policy. Technical and administrative program requirements are established by the public agency and the State Water Board Department of Financial Assistance. Low interest rates will be set by the State Water Board. Typical types of projects include: abandonment of OWTS on private property, installation and connection of laterals to main sewer line on private property, and OWTS repair or replacement on private property.

With a Mini-Loan Program, the CWSRF Program provides financing to a local public agency (i.e., city, county, or district). Private parties are not eligible for direct assistance from the CWSRF Program; however, financing provided through the CWSRF Program may be made available to private parties through a Mini-Loan Program. The local public agency:

- Administers loans to private parties in their service area
- Is responsible for promoting the program, inspecting the work, reporting, and invoicing
- May hire a loan management firm to administer the loans

The interest rate charged to private entities is the State Water Board interest rate, plus additional interest points to cover administration costs. Interest rate: ½ the most recent General Obligation bond sale (typically 2.5 to 3 percent). Other features of the CWSRF Program include:

- Financing term: Standard is 20 years
- Extended terms of 30 years are possible for small, disadvantaged communities
- Repayments: due annually, starting one year after completion of construction
- Disbursements are typically limited to $50 million per agency per year

The CWSRF Program commonly funds construction of publicly-owned wastewater facilities, but also makes funding available for Expanded Use Projects, including:

- Implementation of nonpoint source (NPS) projects or programs, or
- Development and implementation of one of three Estuary Comprehensive Conservation
- Management Plans (CCMPs) - San Francisco, Morro Bay, or Santa Monica

Additional information can be found on the State Water Resources Control Board webpage http://www.waterboards.ca.gov/water_issues/programs/grants_loans/

<u>Linked Deposit Program</u>
In a linked deposit program, a local public agency typically applies to the State Water Board to establish "linked deposit loans" to address a specific water quality problem in its area. The State Water Board arranges with local banks to provide loans to individual property owners for the specific water quality projects or actions. The CWSRF agrees to buy a Certificate of Deposit (CD) at below market rate. In exchange, the bank agrees to provide

reduced interest rate loans to private property owners for eligible projects that were reviewed and approved by the local public agency.

Safe Drinking Water State Revolving Fund
The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. A noted priority of the program is to provide funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water. The fund provides low interest loans, grants, and other assistance to public water systems for the purpose of infrastructure improvements to correct system deficiencies and improve water quality. Detailed information on the program can be found in the annual Intended Use Plan.
http://www.cdph.ca.gov/services/funding/Pages/SRF.aspx

Proposition 50
Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Water Code Section 79500, et seq.) was passed by California voters in the November 2002 general election. DDW is responsible for portions of the Act that deal with water security, safe drinking water, and treatment technology. DDW currently has funding available for projects designed to remove contaminants from drinking water supplies and/or install UV or ozone disinfection.

Proposition 84
Proposition 84, the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Act of 2006 (Public Resources Code Section 75001, et seq.), was passed by California voters in the November 2006 general election. DDW is responsible for portions of the Act that deal with safe drinking water supplies, including emergency and urgent funding, infrastructure improvements, and groundwater quality. The Integrated Regional Water Management program from DWR has funding available under Proposition 84 for projects that address critical drinking water supply or water quality needs for Disadvantaged Communities. Funding is also available for Urban Water Suppliers implementing leak detection and repair and installation of water meters as Best Management Practices.

Integrated Regional Water Management Grants
Integrated Regional Water Management (IRWM) is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. DWR has a number of IRWM grant program funding opportunities. Current IRWM grant programs include: planning, implementation, and storm water flood management. DWR's IRWM Grant Programs are managed within DWR's Division of IRWM by the Financial Assistance Branch with assistance from the Regional Planning Branch and regional offices.

<u>Proposition 84 Storm Water Grant Program</u>
The Public Resources Code (PRC) requires that the Proposition 84 Storm Water Grant Program (SWGP) funds be used to provide matching grants to local public agencies for the reduction and prevention of storm water contamination of rivers, lakes, and streams. The Legislature may enact legislation to further define this grant program.

AB 739 requires the development of project selection and evaluation guidelines for the Proposition 84 SWGP, and provides additional information regarding types of projects eligible for funding. AB 739 also requires creation of a Storm Water Advisory Task Force that will provide advice to the State Water Board on its Storm Water Management Program that may include program priorities, funding criteria, project selection, and interagency coordination of State programs that address storm water management.

<u>Clean Beaches Initiative Grant Program</u>
The Clean Beaches Initiative (CBI) Grant Program provides funding for projects that restore and protect the water quality and the environment of coastal waters, estuaries, bays, and near shore waters. The CBI Grant Program was initiated in response to the poor water quality and significant exceedances of bacterial indicators revealed by Assembly Bill (AB) 411 (Stats. 1997, Ch. 765) monitoring at California's beaches. Scientific studies have shown that water with high bacteria levels can cause infections rashes, and gastrointestinal and respiratory illnesses.

The CBI Grant Program has provided about $100 million from voter-approved bonds for approximately 100 projects since it was started under the 2001 Budget Act. Typical projects include the construction of disinfecting facilities, diversions that prevent polluted storm water from reaching the beach, and scientific research that will enable early notification of unhealthy swimming conditions.

<u>Agricultural Drainage Program</u>
The Agricultural Drainage Loan Program was created by the Water Conservation and Water Quality Bond Act of 1986 to address treatment, storage, conveyance, or disposal of agricultural drainage water that threatens waters of the State. Loan repayments are for a period of up to 20 years. Eligible applicants include any city, county, district, joint powers authority or other political subdivision of the State involved with water management. Projects must address treatment, storage, conveyance or disposal of agricultural drainage that threaten waters of the State.

12.2.2 SUMMARY OF PERTINENT FEDERAL FUNDING PROGRAMS

Several federal agencies, including but not limited to the U.S. EPA, NOAA Fisheries, U.S. Fish and Wildlife Service, and USDA Natural Resources Conservation Service also provide grants and other funding opportunities. Table 12.9 presented below provides a summary of the pertinent federal funding programs.

The U.S. EPA provides access through its webpage to a catalog of federal funding opportunities: http://water.epa.gov/grants_funding/shedfund/databases.cfm

The U.S. Department of Agriculture – Natural Resource Conservation Service has a wide variety of agricultural/timber financial support programs. The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland. In addition, one purpose of EQIP is to help producers meet Federal, State, Tribal and local environmental regulations. The financial assistance programs include:

- Agricultural Management Assistance
- Agricultural Water Enhancement Program
- Air Quality Initiative
- Cooperative Conservation Partnership Initiative
- Conservation Innovation Grants
- Conservation Stewardship Program
- Environmental Quality Incentives Program
- Emergency Watershed Protection Program
- Wildlife Habitat Incentive Program
- For additional agriculture specific grants:

  http://www.grants.gov/search-grants.html?fundingCategories%3DAG%7CAgriculture
  http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

Table 12.9 Summary of Federal Funding Programs		
Funding Program	**Programs Description**	**2014 Funding**
Agency : National Fish and Wildlife Foundation (A non-profit organization created by Congress in 1984 to implement conservation grant funding through public/private partnerships under the leadership of the Secretary of the Interior)		
Environmental Solutions for Communities	In 2012, Wells Fargo and the National Fish and Wildlife Foundation launched the Environmental Solutions for Communities initiative, designed to support projects that link economic development and community well-being to the stewardship and health of the environment. This 5-year initiative is supported through a $15 million contribution from Wells Fargo that will be used to leverage other public and private investments with an expected total impact of over $37.5 million. Funding priorities for this program include: (1)	$3 million (est.)

Table 12.9 Summary of Federal Funding Programs		
Funding Program	**Programs Description**	**2014 Funding**
	supporting sustainable agricultural practices and private lands stewardship; (2) conserving critical land and water resources and improving local water quality; (3) restoring and managing natural habitat, species and ecosystems that are important to community livelihoods; (4) facilitating investments in green infrastructure, renewable energy and energy efficiency; and (5) encouraging broad-based citizen participation in project implementation.	
Pulling Together Initiative	The National Fish and Wildlife Foundation's Pulling Together Initiative (PTI) provides a means for federal agencies to partner with state and local agencies, private landowners, and other interested parties to develop long-term weed management projects within the scope of an integrated pest management strategy. The goals of PTI are: (1) to prevent, manage, or eradicate invasive and noxious plants through a coordinated program of public/private partnerships; and (2) to increase public awareness of the adverse impacts of invasive and noxious plants. PTI provides support on a competitive basis for the formation of local weed management area (WMA) partnerships, allowing them to demonstrate successful collaborative efforts and develop permanent funding sources for the maintenance of WMAs from the involved parties. Successful projects will serve to increase public awareness and interest in future partnership projects.	TBD
Agency : National Oceanic and Atmospheric Administration		
Coastal Services Center Cooperative Agreements	The National Oceanic and Atmospheric Administration (NOAA) guides the conservation and management of coastal resources through a variety of mechanisms, including collaboration with the coastal resource management programs of the nation's states and territories. The mission of the NOAA Coastal Services Center (CSC) is to support the environmental, social, and economic well-being of the coast by linking people, information, and technology. The vision of the NOAA Coastal Services Center is to be the most useful government organization to those who manage and care for our nation's coasts.	$3.21million
Agency : U.S. Department of Agriculture		
Conservation Reserve Program	The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners. Through CRP, you can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland.	$1.965 billion
Farm and Ranch Lands Protection Program (FRPP)	The USDA Natural Resources Conservation Service's Farmland Protection Program (FPP) is a voluntary program that helps farmers and ranchers to keep their land in agriculture and prevents conversion of agricultural land to non-agricultural uses. The program provides matching funds to agencies and organizations with existing farmland protection programs that enable them to purchase conservation easements. These cooperating entities purchase easements from landowners in exchange for a lump sum payment. The Federal contribution cannot to exceed 50 percent of the appraised fair market value of the land's development rights. The easements are for perpetuity unless prohibited by state law. Eligible land is land on a farm or ranch that has prime, unique, statewide, or locally important soil, that contains historical or archaeological resources; or that	$142.5 million (for technical and financial assistance) (est.)

Table 12.9
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	supports the policy of a State or local farm and ranch land protection policy; is subject to a pending offer by an eligible entity; and includes cropland, rangeland, grassland, pasture land, forest land and other incidental land that is part of an agricultural operation.	
Agricultural Management Assistance	Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming.	$2.5 million
USDA's Small Business Innovation Research	To stimulate technological innovation in the private sector, strengthen the role of small businesses in meeting Federal research and development needs, increase private sector commercialization of innovations derived from USDA-supported research and development efforts, and foster and encourage participation, by women-owned and socially disadvantaged small business firms in technological innovation. The selected areas for research are Forests and Related Resources; Plant Production and Protection-Biology; Plant Production and Protection - Engineering; Animal Production and Protection; Air, Water and Soils; Food Science and Nutrition; Rural and Community Development; Aquaculture; Biofuels and Biobased Products; and Small and Mid-size Farms.	$20.5 million (est.)
Sustainable Agriculture Research and Education	The Sustainable Agriculture Research and Education (SARE) program of the U.S. Department of Agriculture National Institute of Food and Agriculture (NIFA) works to advance farming systems that are productive, profitable, environmentally sound and good for communities through a regional grants program. SARE funds research and extension activities to reduce the use of chemical pesticides, fertilizers, and toxic materials in agricultural production; to improve management of on-farm resources to enhance productivity, profitability, and competitiveness; to promote crop, livestock, and enterprise diversification and to facilitate the research of agricultural production systems in areas that possess various soil, climatic, and physical characteristics; to study farms that are managed using farm practices that optimize on-farm resources and conservation practices; and to promote partnerships among farmers, nonprofit organizations, agribusiness, and public and private research and extension institutions. Click on program name and check the link in the Primary Internet box for more information about grant opportunities and program results.	$22.7 million
Wetlands Reserve Program	Through this voluntary program, the USDA Natural Resources Conservation Service (NRCS) provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land. To participate in the program landowners may sell a conservation easement or enter into a cost-share restoration agreement (landowners voluntarily limit future use of the	$230.5 million (est.)

Table 12.9 Summary of Federal Funding Programs		
Funding Program	**Programs Description**	**2014 Funding**
	land, but retain private ownership). Landowners and the NRCS jointly develop a plan for the restoration and maintenance of the wetland.	
Environmental Quality Incentives Program	The USDA Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) was established to provide a voluntary conservation program for agricultural producers to address significant natural resource needs and objectives. Through a competitive process, EQIP offers financial assistance contracts with a maximum term of ten years, to help implement eligible conservation practices. Persons or legal entities, who are owners of land under agricultural production or who are engaged in livestock or agricultural production on eligible land, including private non-industrial forest land, or Indian Tribes may participate in EQIP. Conservation practices implemented through EQIP are subject to NRCS technical standards adapted for local conditions. NRCS or Technical Service Providers (TSPs) help applications develop a plan of operations which identifies practices needed to address natural resource concerns and support the EQIP contract.. EQIP-related programs include Conservation Innovation Grants (CIG), Resource Conservation Partnership Program (RCPP), and the National Water Quality Initiative (NWQI).	$981.7 million (Cost Share)
National Integrated Water Quality Program (NIWQP)	The National Integrated Water Quality Program (NIWQP) provides funding for research, education, and extension projects aimed at improving water quality in agricultural and rural watersheds. The NIWQP has identified eight "themes" that are being promoted in research, education and extension. The eight themes are (1) Animal manure and waste management (2) Drinking water and human health (3) Environmental restoration (4) Nutrient and pesticide management (5) Pollution assessment and prevention (6) Watershed management (7) Water conservation and agricultural water management (8) Water policy and economics. Awards are made in four program areas - National Projects, Regional Coordination Projects, Extension Education Projects, and Integrated Research, Education and Extension Projects. Please note that funding is only available to universities.	Not available
Agency : U.S. Department of Housing and Urban Development		
Community Development Block Grants/Entitlement Grants	The objective of this program is to develop viable urban communities, by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for persons of low and moderate income. Recipients may undertake a wide range of activities directed toward neighborhood revitalization, economic development and provision of improved community facilities and services.	$1.95 billion (est.)
Agency : U.S. Environmental Protection Agency		
Source Reduction Assistance Grant Program	The Source Reduction Assistance Grant Program provides grants and cooperative agreements to fund pollution prevention (source reduction and resource conservation) activities. Specifically, the Agency is interested in funding projects that help reduce hazardous substances, pollutants, or contaminants entering waste streams or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, disposal or energy recovery	$1.0 million (est.)

Table 12.9
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	activities.	
Clean Water State Revolving Fund	The EPA's Clean Water State Revolving Fund (CWSRF) program provides a permanent source of low-cost financing for a wide range of water quality infrastructure projects. These projects include traditional wastewater treatment and collection, nonpoint source pollution controls, and estuary management. Funds to capitalize the program are provided annually through federal grants and state matching funds (equal to 20 percent of federal grants). Monies are loaned to assistance recipients at below-market rates. In addition, states also have the ability to customize loan terms to benefit small and disadvantaged communities. Loan repayments are recycled back into the programs to fund additional projects. Since its inception, the CWSRF has provided over $95.4 billion in assistance to eligible borrowers, including communities of all sizes, farmers, small businesses, and nonprofit organizations. More information on the CWSRF program can be obtained at http://www.epa.gov/owm/cwfinance/cwsrf/	$1.1 billion (est.)
Nonpoint Source Implementation Grants (319 Program)	Through its 319 program, U.S. EPA provides formula grants to the states, territories and tribes to implement nonpoint source programs and projects and programs in accordance with section 319 of the Clean Water Act (CWA). Nonpoint source pollution projects can be used for a wide range of activities including agriculture, forestry, construction, and urban challenges. When set as priorities within a state's Nonpoint source management program, projects may also be used to protect source water areas and high quality waters. Examples of previously funded projects include installation of best management practices (BMPs) for animal waste; design and implementation of BMP systems for stream, lake, and estuary watersheds; and basin-wide landowner education programs. Most states provide opportunities for 3rd parties to apply for funds under a state request for proposal.	$159.3 million
Urban Waters Small Grants	EPA's Urban Waters Program protects and restores America's urban waterways. EPA's funding priority is to achieve the goals and commitments established in the Agency's Urban Waters Strategic Framework (www2.epa.gov/urbanwaters/urban-waters-strategic-framework). This program has an emphasis on engaging communities with environmental justice concerns. The objective of the Urban Waters Small Grants is to fund projects that will foster a comprehensive understanding of local urban water issues, identify and address these issues at the local level, and educate and empower the community. In particular, the Urban Waters Small Grants seek to help restore and protect urban water quality and revitalize adjacent neighborhoods by engaging communities in activities that increase their connection to, understanding of, and stewardship of local urban waterways.	$2.08 (est.)
Pollution Prevention Grant Program	The Pollution Prevention Grant Program provides grants and cooperative agreements to state agencies, instrumentalities of a state and federally recognized tribes to implement pollution prevention projects that provide technical assistance to businesses. The program	$4.1 million (est.)

Table 12.9
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	requires applicants to work towards reducing pollution, conserving energy and water, and saving dollars through P2 efforts; as indentified in EPA's Strategic Plan under Goal 4: Ensuring Safety of Chemicals and Preventing Pollution, Objective 4.2: Promote Pollution Prevention.	
Science to Achieve Results	The Science to Achieve Results (STAR) program is designed to improve the quality of science used in EPA's decision-making process. STAR funds are provided for research in the following the following priority areas: (1) Air, Climate and Energy: Anthropogenic Influences on Organic Aerosol Formation and Regional Climate Implications; Measurements and Modeling for Quantifying Air Quality and Climatic Impacts of Residential Biomass or Coal Combustion for Cooking, Heating, and Lighting. (2) Chemical Safety and Sustainability: Center for Sustainable Molecular Design; Center for Material Life Cycle Safety; Human Exposure to Chemicals in Consumer Products and Indoor Environments; Development and Use of Adverse Outcome Pathways that Predict Adverse Developmental Neurotoxicity. (3) Safe and Sustainable Water Resources: Sustainable Chesapeake: A Community-Based Approach to Stormwater Management Using Green Infrastructure; Performance and Effectiveness of Green Infrastructure Stormwater Management Approaches in the Urban Context: A Philadelphia Case Study; High Priority Water Quality and Availability Research. (4) Safe and Healthy Communities: Research with Children's Health; Children's Environmental Health and Disease Prevention Research Centers (with NIEHS); Science for Sustainable and Healthy Tribes; Healthy and Sustainable Schools: Environmental Factors, Children's Health and Performance, and Sustainable Building Practices. In addition to the solicitations identified above, other solicitations may be announced in the coming year. Please check the NCER website for an updated listing of all solicitations.	$61.1 million (est.)
Five-Star Restoration Program	The U.S. EPA supports the Five-Star Restoration Program by providing funds to the National Fish and Wildlife Foundation and its partners, the National Association of Counties, NOAA's Community-based Restoration Program and the Wildlife Habitat Council. These groups then make subgrants to support community-based wetland and riparian restoration projects. Competitive projects will have a strong on-the-ground habitat restoration component that provides long-term ecological, educational, and/or socioeconomic benefits to the people and their community. Preference will be given to projects that are part of a larger watershed or community stewardship effort and include a description of long-term management activities. Projects must involve contributions from multiple and diverse partners, including citizen volunteer organizations, corporations, private landowners, local conservation organizations, youth groups, charitable foundations, and other federal, state, and tribal agencies and local governments. Each project would ideally involve at least five partners who are expected to contribute funding, land, technical assistance, workforce support, or other in-kind services that are equivalent to the federal contribution.	TBD

Table 12.9 Summary of Federal Funding Programs		
Funding Program	**Programs Description**	**2014 Funding**
Regional Agricultural IPM Grants	The objective is to support Integrated Pest Management (IPM) implementation and approaches that reduce the risks associated with agricultural pesticide use in the United States. Regional Agricultural IPM Grants will support the implementation of IPM approaches to reduce pesticide risk in agricultural settings in the United States. Projects must address the national pesticide program stewardship priorities related to pest management needs and IPM program implementation stated in the announcement.	TBD
Agency : U.S. Fish and Wildlife Service		
Partners for Fish and Wildlife Program	The Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners to restore fish and wildlife habitats on their lands via cooperative agreements. Since 1987, the program has partnered with more than 37,700 landowners to restore 765,400 acres of wetlands; over 1.9 million acres of grasslands and other upland habitats; and 6,560 miles of in-stream and streamside habitat. In addition, the program restores stream habitat for fish and other aquatic species by removing barriers to passage.	$20 million
Cooperative Endangered Species Conservation Fund	The U.S. Fish and Wildlife Service's (USFWS) Cooperative Endangered Species Conservation Fund provides financial assistance to states and territories that have entered into cooperative agreements with the USFWS to assist in the development of programs for the conservation of endangered and threatened species. The assistance provided to the state or territorial wildlife agency can include animal, plant, and habitat surveys; research; planning; monitoring; habitat protection, restoration, management, and acquisition; and public education. The Fund is dispersed to the states and territories through four programs: Conservation Grants, Habitat Conservation Planning Assistance Grants, Habitat Conservation Plan Land Acquisition Grants, and Recovery Land Acquisition Grants. Although not directly eligible for these grants, third parties such as nonprofit organizations and local governments may work with their state or territorial wildlife agency to apply for these funds.	$62 million (est.)
North American Wetlands Conservation Act Grants Program	The U.S. Fish and Wildlife Service's Division of Bird Habitat Conservation administers this matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Mexican partnerships may also develop training, educational, and management programs and conduct sustainable-use studies. Project proposals must meet certain biological criteria established under the Act. Visit the program web site for more information. (Click on the hyperlinked program name to see the listing for "Primary Internet".)	$70 million (est.)

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CHAPTER 13
ANTIDEGRADATION ANALYSIS

13.1 INTRODUCTION

This Chapter briefly describes the state and federal antidegradation policies and how they apply to the Russian River Watershed Pathogen Indicator Bacteria TMDL Action Plan (TMDL Action Plan). Both U.S. EPA and the State Water Board have adopted antidegradation policies as part of an approach to develop water quality standards and regulate the discharge of waste. This chapter analyzes whether approval of the draft amendment would be consistent with the federal and state antidegradation policies.

13.2 STATE AND FEDERAL ANTIDEGRADATION POLICIES

The federal antidegradation policy, described in 40 CFR 131.12(a), requires that existing instream designated uses and the level of water quality necessary to protect the existing uses be maintained and protected. Where, however, the quality of the water exceeds levels necessary to support propagation of fish, shellfish, and wildlife, and recreation in and out of the water, that quality must be maintained and protected unless the state finds that:

1. Such activity is necessary to accommodate important economic or social development in the area in which the waters are located;
2. Water quality is adequate to protect existing beneficial uses fully; and
3. The highest statutory and regulatory requirements for all new and existing point source discharges and all cost-effective and reasonable best management practices for nonpoint source control are achieved.

In addition, where high quality waters constitute an outstanding National resource that water quality shall be maintained and protected.

The state antidegradation policy incorporates the federal Antidegradation Policy (see State Water Board Order No. WQ 2001-16, p. 19, fn 83). The state policy establishes several conditions that must be met before the quality of high quality waters may be lowered by waste discharges. ("Statement of Policy With Respect to Maintaining High Quality Waters in California", State Water Board Resolution No. 68-16; See also Basin Plan pages 3-2.00 to 3-3.00). The state must determine that lowering the quality of high quality waters:

1. Will be consistent with the maximum benefit to the people of the state,
2. Will not unreasonably affect present and anticipated beneficial uses of such water, and
3. Will not result in water quality less than that prescribed (e.g., by water quality objectives).

In addition, before any degradation of water quality is permitted, it must be shown that the discharge will be required to meet waste discharge requirements that result in best practicable treatment or control of the discharge necessary to assure that:

1. Pollution or nuisance will not occur;
2. The highest water quality consistent with maximum benefit to the people of the State is maintained.

13.3 APPLICABILITY TO THE RUSSIAN RIVER WATERSHED PATHOGEN INDICATOR TMDL ACTION PLAN AND WASTE DISCHARGE PROHIBITION

The draft TMDL Action Plan is based in part on the principles contained in the state and federal antidegradation policies. The recommended alternative – adoption of the draft TMDL Action Plan – will not delete or limit beneficial use designations and will not relax any water quality standard. The draft TMDL Action Plan is designed to result in water quality improvements and is consistent with both the state and federal antidegradation policies.

The draft TMDL Action Plan identifies a wide range of factors affecting the fate and transport of pathogens and the appropriate choice of compliance measures that will help attain water quality objectives and ensure the protection of beneficial uses of the state's waters. The draft TMDL Action Plan directs the Regional Water Board staff to incorporate pathogen protection measures into its point source and nonpoint source permitting actions, which relies on implementation of best management practices and other measure that can be considered best practicable treatment or control methods. It is important to note that the draft TMDL Action Plan includes a prohibition of the discharge of fecal waste materials that cause or contribute to an exceedance of bacteria water quality objectives.

Management measures are generally defined in individual water quality control plans such as Erosion Control Plans, Sanitary Sewer Management Plans, Advanced Protection Management plans for OWTS, or Bacteria Load Reduction Plans. These plans must tailor measures to a particular site and include an iterative planning approach based on monitoring feedback. The draft TMDL Action Plan dos not itself authorize or permit any activity that will discharge waste into high quality waters.

In its environmental analyses (see Chapter 11), the Regional Water Board found that potentially significant impacts to hydrology/water quality are less than significant with the proposed implementation of mitigation measures. As such, degradation of water quality is not anticipated if mitigation measures are properly implemented.

For example, when replacing or repairing private sewer laterals and OWTS, and operating a centralized or decentralized wastewater treatment plant, it is possible that sewage could be released to surface waters and violate water quality standards and degrade water quality. Mitigation measures such as containment structures and absorption materials are available to reduce transfer of these substances to surface waters. Fuels, lubricating oils, and other petroleum products will be used during construction activities and could be accidentally discharged to surface waters. Well established techniques for controlling spills, leaks, and drips should be incorporated in work plans, remedial action plans, treatment plans and site health and safety plans to assure the control of petroleum products and any other chemicals used during the activity.

In order to mitigate the potential adverse effects, pollution prevention plans and waste management BMPs should be used in conjunction with the implementation of permit compliance measures. Mitigation measures such as containment structures, absorption materials, and drip pans are available to reduce the transfer of these substances to surface waters. The possibility that composted biosolids could reach surface waters can be mitigated by siting compost piles away from water courses, covering the piles during storm events, using straw waddles around the piles to filter runoff, build storm water containment, and placing the piles indoors. Pet waste collection systems which provide plastic bags for pet waste cleanup may cause violations of water quality standards if they are improperly discarded and enter waterbodies. This can be mitigated by providing waste receptacles near the pet waste collection systems to provide a location for people to place the used and unused bags.

Compliance measures related to construction activities could potentially cause an alteration of the existing drainage pattern of a site. In most cases however, these compliance measures would be installed with appropriately designed mitigation measures so as to limit any alteration of the existing drainage pattern, unless beneficial to the environment. In general, compliance measures could be constructed or installed without resulting in substantial erosion of siltation on- or offsite. For example, implementing BMPs such as using straw mulch and hydroseed on exposed areas, placing silt fencing and straw waddle to filter runoff, drip protection and vehicle cleaning for construction equipment, maintenance and site inspections are all methods that can be employed. Entities are commonly required to install and maintain erosion control measures (e.g. mulch, straw waddles, silt fencing) to prevent discharge of excess sediment from soil disturbing activities.

Construction of a new centralized or decentralized wastewater treatment plant, restroom facility, or significant expansion of a wastewater treatment plant, may increase the amount of impervious surface and therefore could result in flooding or polluted runoff. Additionally, these structures may be placed within the 100-year flood hazard area. The possibility of flooding and polluted runoff can be mitigated through the use of Low Impact Development (LID). LID is utilized to infiltrate storm water and reduce changes in drainage patterns due to impervious surfaces and to filter storm water runoff. LID strategies integrate green space, native landscaping, natural hydrologic functions, and various other techniques to generate less runoff from developed land. Examples of LID that could be used are bio swales, green roofs, rain gardens, and sand filters.

With respect to exceedances of water quality objectives, short term impacts may be acceptable in cases where long term benefits to beneficial uses outweigh short term impacts, based on detailed, site-specific information and findings. A full antidegradation analysis is appropriate at the time of permit development, with the proper findings made by the Regional Water Board prior to adoption.

The existing water quality objective for bacteria in surface water is based on different fecal indicator bacteria and cannot be compared side-by-side numerically to the waste load allocations and load allocations to evaluate a potential degradation and backsliding of standards.[28] However, the values can be evaluated when comparing the potential risk to recreation. The draft allocations are based on the National Epidemiological and Environmental Assessment of Recreational Water Gastro Intestinal Illness risk of 32 cases per 1,000 recreators as compared to the existing water quality objective that used older criteria and is based on 36 cases per 1,000 recreators. Therefore, adopting the draft waste load allocations would result in greater protection of the contact recreation beneficial use and would not result in any degradation to waters of the state.

This draft TMDL action plan complies with antidegradation policies by ensuring the protection of contact recreation use, and by implementing a program to achieve bacteria source reduction and to reach attainment if discharges are to occur. The waste load allocations and load allocations are set at a level that would improve conditions in the Russian River Watershed. Additionally, the prohibition of the discharge of fecal waste materials that cause or contribute to an exceedance of bacteria water quality objectives will help to ensure the attainment of standards.

[28] As discussed in more detail in Chapter 2, staff recommends the TMDL not be presented to the State Board until the state water quality bacteria objective is adopted by the State Board, and as a result the existing bacteria objective is updated.

CHAPTER 14
PUBLIC PARTICIPATION SUMMARY

This chapter describes some of the opportunities that have been made available to the public for comment on and participation in the development of the Russian River Watershed Pathogen Indicator Bacteria TMDL Staff Report and Implementation Plan.

14.1 STAKEHOLDER AND PUBLIC OUTREACH

Regional Water Board staff has held numerous meetings to update and inform key stakeholders and the public throughout the Russian River Watershed TMDL development process. The outreach meetings related to the TMDL have included both public meetings and meetings targeted to small groups of individuals and local agency representatives who were identified by Regional Water Board staff as key stakeholders in the TMDL process in the Russian River Watershed. A list of the stakeholder and public meetings that have been held about the Russian River Watershed TMDL is presented in Table 14.1.

Table 14.1
Stakeholder and Public Meetings for the Russian River Watershed TMDL

Subject	Date	Participants
Monte Rio Community Forum	October 20, 2012	Public Meeting in Monte Rio
Public Outreach	May 28, 2013	Fitch Mountain Neighborhood Association Sonoma County Supervisor Mike McGuire
Implementation Plan Outreach	August 21, 2013	Sonoma County Community Development Agency
Implementation Brainstorming Session 1	May 20, 2014	Sonoma County Water Coalition Russian Riverkeepers Green Valley Watershed Committee
Implementation Brainstorming Session 2	June 5, 2014	Sonoma County Continuum of Care
Implementation Brainstorming Session 3	June 5, 2014	Sonoma County Water Agency Sonoma County Permit and Resource Management Department (PRMD) Sonoma County Community Development Agency Board Members Bill Massey and David Noren
Implementation Brainstorming Session 4	July 1, 2014	Sonoma County Water Agency Sonoma County PRMD City of Santa Rosa City of Sebastopol City of Cotati City of Rohnert Park Town of Windsor City of Ukiah Sonoma County Agricultural Commissioner
Implementation Brainstorming Session 5	July 3, 2014	Sonoma County Department of Health Services

Table 14.1
Stakeholder and Public Meetings for the Russian River Watershed TMDL

Subject	Date	Participants
Implementation Brainstorming Session 6	July 9, 2014	Sonoma Resource Conservation District Gold Ridge Resource Conservation District Mendocino Resource Conservation District Sonoma County Agricultural Commissioner
Implementation Plan Update	August 15, 2014	Summer Home Park Monte Rio Villa Grande Russian River Redevelopment Oversight Committee (Fitch Mountain) Sonoma County Supervisor Efren Carrillo Sonoma County Water Agency Sonoma County PRMD Board Members Bill Massey and David Noren
Implementation Plan Outreach	August 28, 2014	Public Meeting in Santa Rosa
Stakeholder Outreach Meeting	January 9, 2015	North Bay Association of Realtors in Santa Rosa
Russian River Watershed Pathogen TMDL Technical Group Meeting	January 30, 2015	Representatives from the Communities of: Guerneville Occidental Monte Rio Villa Grande Fitch Mountain Northwood Property Owners
Public Workshops on draft TMDL and Action Plan	September 22, 2015 September 23, 2015 September 24, 2015	Lower river stakeholders Upper river stakeholders Middle river stakeholders
Regional Water Board hearing on proposed TMDL and Action Plan	November 19, 2015	All interested stakeholders

14.1.1 CEQA SCOPING MEETING

The purpose of the California Environmental Quality Act (CEQA) Scoping Meeting was to solicit public comments to help staff assess the potential environmental scope of the environmental analysis. Holding a scoping meeting is a requirement of the CEQA. The CEQA scoping meeting for the Russian River Watershed TMDL was held on January 30, 2015, in Santa Rosa, CA. The comments received at the CEQA scoping meeting that concerned the scope of the environmental review are summarized in Chapter 11. These comments, and others, helped to shape the scope of the environmental review and specific aspects of the analysis.

14.1.2 RUSSIAN RIVER TMDL WEBPAGE

In addition to holding public meetings, Regional Water Board staff has maintained a webpage on the North Coast Regional Water Quality Control Board's website where the latest, up-to-date information on the Russian River TMDL development process can be found. The webpage also includes a map of the watershed, a description of the current Clean Water Act Section 303(d) listing, project documents, quality assurance plans, technical memoranda, and board presentations. The website can be accessed at: http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/russian_river/

14.2 PRESENTATIONS TO THE REGIONAL WATER BOARD

Periodically, Regional Water Board staff has presented updates and status reports to the Regional Water Board and interested members of the public on the Russian River Watershed Pathogen Indicator Bacteria TMDL. The presentations were opportunities for the public and Board members to hear status updates and background information regarding progress and emerging issues related to the TMDL development process. At each of these meetings, the public also had the opportunity to give comment before the Board. All such comments are part of the public record. Table 14.2 presents a complete list of the presentations given to the Regional Water Board about various aspects of Russian River Watershed Pathogen Indicator Bacteria TMDL development.

Table 14.2
Presentations given at Regional Water Board meetings

Subject	Date	Location
Early TMDL Implementation and Monitoring	November 3, 2011	Santa Rosa, CA
Update on Regulatory and TMDL Efforts	January 27, 2011	Santa Rosa, CA
Update on Russian Basin Watershed TMDL	August 23, 2012	Santa Rosa, CA
Russian River Biological Opinion, Fish Habitat & Water Rights Project, and Pathogen TMDL	August 22, 2013	Santa Rosa, CA
Update on Russian Basin Watershed TMDL	March 13, 2014	Santa Rosa, CA

14.3 PRESENTATIONS TO COUNTY SUPERVISORS

In order to keep local agencies informed of the details of the Russian River Watershed TMDL, Regional Water Board staff met with County Supervisors from Sonoma County and Mendocino County. A list of these presentations is available in Table 14.3.

Table 14.3 Presentations given to County Supervisors		
Subject	**Date**	**Venue**
Russian Basin TMDL	January 22, 2015	Sonoma County Board Supervisors Efren Carrillo and James Gore
Russian River TMDL	February 6, 2015	Sonoma County Board Supervisor Shirlee Zane
Russian River TMDL	February 9, 2015	Sonoma County Board Supervisor David Babbitt
Russian River TMDL	February 18, 2015	Sonoma County Board Supervisor Susan Gorin
Russian River TMDL	April 6, 2015	Sonoma County Board Supervisors Efren Carrillo and James Gore

14.4 PEER REVIEW

Prior to development of the Public Review Draft of the Russian River Watershed TMDL Staff Report, a peer- review draft report was reviewed by the following two professors as part of a formal state-mandated peer-review process:

- Dr. Nicholas J. Ashbolt, Alberta Innovates Translational Research Chair in Water, School of Public Health, at the University of Alberta, Canada;
- Dr. Patricia A. Holden, Professor of Bren School, Director of UCSB Natural Reserve System at the University of California, Santa Barbara

14.5 AUGUST 2015 PUBLIC REVIEW DRAFT

Chapters 1-9 of the August 2015 Public Review Draft of the Staff Report were posted on the Regional Water Board website on August 21, 2015. The proposed Staff Report and the Implementation Plan will be posted and available for public review and comment on prior to the adoption hearing on November 19, 2015. The public review period for the Staff Report and Action Plan was set to close on October 8, 2015.

The August 2015 Public Review Draft release and public comment period dates are summarized below.

August 2015 Public Review Draft Release: Postings:................................ August 21, 2015

End of August 2015 Public Review Draft Comment Period..................... October 8, 2015

Throughout the Basin Plan amendment process, there are opportunities for public participation and comment, including at the CEQA scoping meetings, and three Regional

Water Board workshops planned to be held prior to the Regional Water Board hearing for the proposed TMDL Basin Plan amendment, at the Regional Water Board hearing to consider adoption of the TMDL Basin Plan amendment, before the State Water Board, and during public forum at any Regional Water Board meeting. The following opportunities and their estimated dates remain for public comment on the proposed Russian River Pathogen Indicator Bacteria TMDL Basin Plan amendment. Please note that the following dates and meeting locations may change and additional meetings may be scheduled. Interested parties should check the Regional Water Board website for announcements regarding Regional Water Board meetings, revisions to the DO objectives, and the Russian River TMDL at: http://www.waterboards.ca.gov/northcoast/.

Public Workshop 1 .... September 22, 2015
Monte Rio Middle School in Monte Rio

Public Workshop 2 .... September 23, 2015
University of California Cooperative Extension in Ukiah

Public Workshop 3 .... September 24, 2015
Regional Water Board Office in Santa Rosa

End of August 2015 Public Review Draft Comment Period .... October 8, 2015

Public Adoption Hearing .... November 19, 2015
before the Regional Water Board in Santa Rosa, CA

CHAPTER 15
NINE KEY ELEMENTS

The California Nonpoint Source (NPS) Grant Program allocates Clean Water Act section 319(h) funding from the U.S. EPA to support projects that implement full scale, on-the-ground management measures or practices in alignment with the watershed-based plans to address water quality problems in surface water and groundwater resulting from NPS pollution. Before giving 319 NPS grants to projects, the project proponent/grantee must demonstrate that the USEPA's Nine Key Elements are in place for a watershed. The purpose of this chapter is to explicitly identify which of the nine key elements are included in this TMDL and described in this Staff Report.

In California, wide ranges of plans are being used to comply with the nine key elements, often in combination with each other. Examples of plans that are being used to comply with the key elements include local watershed plans, coordinated resource management plans, TMDL implementation plans, comprehensive conservation and management plans, and Regional Water Quality Control Plans (Basin Plans), and combinations thereof. Applicants that need assistance may work with their Regional Water Boards to verify that the combination of plans has the nine elements. Those elements that are not included in existing plans will need to be incorporated into the plans, as appropriate, to be eligible for Clean Water Act 319(h) funds.

Grant awards may be withdrawn if all nine key elements are not adequately addressed. During the full proposal stage of the grant selection process, applicants will complete a table (see Table F-1 under Appendix 1 on the Clean Water Act 319(h) Grant Solicitation webpage) to indicate where each key watershed plan element is addressed. The State Water Board NPS grant website is at:
http://www.waterboards.ca.gov/water_issues/programs/nps/solicitation_notice.shtml

Although many different components may be included in a watershed plan, U.S. EPA has identified nine key elements that are critical for achieving improvements in water quality. U.S. EPA requires that these nine elements be addressed in watershed plans funded with incremental Clean Water Act section 319 funds and strongly recommends that they be included in all other watershed plans intended to address water quality impairments. In general, state water quality or natural resource agencies and U.S. EPA will review watershed plans that provide the basis for section 319-funded projects. Although there is no formal requirement for U.S. EPA to approve watershed plans, the plans must address the nine elements discussed below if they are developed in support of a section 319-funded project.

All projects supported with Clean Water Act section 319(h) funds must implement activities based on sound watershed-based plans as defined by the United States Environmental Protection Agency (U.S. EPA) in its "Handbook for Developing Watershed

Plans to Restore and Protect Our Waters (U.S. EPA's Handbook)". U.S. EPA's Handbook is based on the idea that significant environmental results are more likely where plans provide detailed information to ensure that priority activities are being undertaken to achieve water quality objectives and beneficial uses within a specific time frame.

The nine key elements are listed below and are further detailed throughout this Staff Report to help future project proponents obtain funds. This report is intended to satisfy the requirements of a watershed plan / TMDL for the purposes of 319(h) grant funding.

Element 1: Identification of Causes & Sources

Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at significant subcategory level along with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

Chapter 5 (Source Analysis) describes the studies conducted to identify sources and categories of fecal waste and their relationship to elevated concentrations of fecal indicator bacteria as measured in the surface waters of the Russian River Watershed.

The major human sources of fecal waste include:
- Discharges of municipal wastewater directly to surface waters;
- Discharges of untreated sewage from sanitary sewer systems;
- Discharges of wastewater from percolation ponds and through spray irrigation;
- Discharges of runoff from land application of municipal Biosolids;
- Discharges to land from water recycling projects;
- Discharges from onsite wastewater treatment systems;
- Discharges from recreational water uses and users;
- Discharges from homeless encampments; and
- Discharges of storm water to municipal separate storm sewer system (MS4s) and from areas outside MS4 boundaries.

Sources of domestic animal and farm animal waste identified in this TMDL project include:
- Discharges of pet waste;
- Discharges from non-dairy livestock and farm animals; and
- Discharges of manure from dairy cows.

An assessment of the exact location of many of the potential sources of fecal waste (e.g., leaking sanitary sewer lines, leaking onsite waste treatment systems) will be identified through individual inspections or the development and implementation of a Bacteria Load

Reduction Plan (BLRP) by a responsible party (e.g., municipality or county). The development of implementation of BLRPs and other similar site specific management plans could benefit from funding under the 319(h) grant program.

Element 2: Load Reductions Expected for Management Measures

Load reductions for management measures are generally calculated on a project by project basis. On the basis of the existing source loads estimated for element (1), the watershed plan will similarly determine the reductions needed to meet the water quality standards. The watershed plan will then identify various management measures (see element 3 below) that will help to reduce the pollutant loads and estimate the load reductions expected as a result of these management measures to be implemented, recognizing the difficulty in precisely predicting the performance measures over time.

Estimates for loading reductions should be provided at the same level as that required in the scale and scope component in Element 1 (e.g., the total load reduction expected for dairy cattle feedlots, row crops, or eroded streambanks). For waters for which U.S. EPA has approved or established TMDLs, the plan should identify and incorporate the TMDLs. Applicable loads for downstream water should be included so that water delivered to a downstream or adjacent segment does not exceed the water quality standards for the pollutant of concern at the water segment boundary. The estimate should account for reductions in pollutant load from point and nonpoint sources identified in the TMDL as necessary to attain the applicable water quality standards.

Waste load allocations and load allocations are established for the identified sources as described in Chapter 8 (TMDL, Loading Capacities, and Margin of Safety). The load allocations are given as concentrations. Critical to attaining the load allocations will be developing individual management plans, updating existing permits, or developing new permits by which to establish appropriate best management practices and/or treatment technologies. Developing individual monitoring requirements will also be critical to tracking compliance, measuring trends, and determining appropriate adaptations to the management plans. Each of these elements could benefit from funding from the 319(h) program.

Element 3: Management Measures

The watershed plan should include a description of the management measures or management practices and associated costs that will need to be implemented to achieve the load reductions in Element 2, and a description (using a map or a description) of the critical areas where those measures are needed to implement the plan.

The plan should describe the management measures that need to be implemented to achieve the load reductions estimated under element 2, as well as to achieve any additional pollution prevention goals called out in the watershed plan (e.g., habitat conservation and protection). Pollutant loads will vary even within land use types, so the plan should also identify the critical areas in which those measures will be needed to implement the plan. This description should be detailed enough to guide implementation activities and can be greatly enhanced by identifying on a map priority areas and practices.

As above, Chapter 5 (Source Analysis) defines the specific and categories of sources, Chapter 8 establishes the load and waste load allocations, and Chapter 9 (Implementation) describes the implementation plan by which allocation will be achieved. Specific to the draft TMDL Action Plan is the requirement of responsible parties to develop Bacteria Load Reduction Plans and other management plans, as appropriate, by which to identify the management and treatment approaches best suited for the specific site or sites. Development and implementation of these plans would benefit from funding under the 319(h) program. A list of the reasonably foreseeable compliance measures (a.k.a, management measures) are identified and evaluated for their potential environmental impacts, costs and sources of funding in Chapter 11 (CEQA) and Chapter 12 (economic considerations). Management measures that qualify for project funding are not limited to the measures evaluated in this Staff Report. Funding is based on measures that address the specific type of impairment

Element 4: Technical and Financial Assistance

Estimate of the amount of technical and financial assistance needed associated costs, and / or the sources and authorities that will be relied upon to implement this plan. The watershed plan should estimate the financial, technical assistance and authorities needed to implement the entire plan. This includes implementation and long-term operation and maintenance of management measures, I/E activities, monitoring, and evaluation activities. The watershed plan should also document which relevant authorities might play a role in implementing the plan. Plan sponsors should consider the use of federal, state, local, and private funds or resources that might be available to assist in implementing the plan. Shortfalls between needs and available resources should be identified and addressed in the plan.

Responsible parties for each of the source categories is described in detail in Chapter 9 (Implementation). Costs and sources of funding for management measures are identified in some detail in Chapter 12 (Economic Considerations).

Element 5: Information and Education Component

An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented should be included in the watershed plan.

The plan should have a component that identifies the education and outreach activities or actions that will be used to implement the plan. These activities may support the adoption and long-term operation and maintenance of management practices and support stakeholder involvement efforts.

Chapter 9 (Implementation), Chapter 11 (CEQA) and Chapter 12 (Economic Considerations) each describe the need for and components of an educational/outreach efforts. Responsible parties are required to develop such program, where appropriate. In addition, the Regional Water Board is collaborating with the Russian River Watershed Association to establish a Russian River Regional Monitoring Program through which substantial education and outreach will occur. This collaboration is for multiple purposes and to serve multiple projects in the Russian River Watershed. As the program becomes more fully developed, it will become a cornerstone of the monitoring and outreach efforts necessary to support continued implementation of the Russian River Pathogen TMDL.

Element 6: Schedule

Chapter 9 (Implementation) presents various implementation measures and the estimated time schedule associated with implementation for this TMDL. Project proponents seeking funds should have project specific schedules. A plan should include a schedules for implementing the management measures outlined in you watershed plan. The schedule should reflect the milestones developed in Element 7.

Element 7: Measureable Milestones

Plans should have description of interim measurable milestones for determining whether nonpoint source management measures, BMPs, or other control actions are being implemented. Measurable milestones quantify progress in implementing the measures for watershed plan. These milestones may indicate whether they are being implemented on schedule, whereas Element 8 will measure the effectiveness of the management measure, for example, by documenting improvements in water quality.

Chapter 9 (Implementation) defines the multi-steps necessary to fully implement appropriate controls for each of the sources areas of concern. Milestones are given as deadlines, deliverables, and concentration trends.

Element 8: Evaluation of Progress

The watershed plan should also include a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards. As projects are implemented in the watershed, water quality benchmarks should be identified to track progress. The *criteria* in Element 8 *(*not to be confused with *water quality criteria* in federal regulations) are the benchmarks or waypoints to measure against through monitoring. These interim targets can be direct measurements (e.g., *E. Coli* concentrations) or indirect indicators of load reduction (e.g., number of beach closings). The plan should also indicate how the watershed plan needs to be revised if interim targets are not met. The revisions could involve changing management practices, updating the loading analyses, and reassessing the time it takes for pollution concentrations to respond to treatment.

Chapter 4 (Numeric Targets) and Chapter 7 (Linkage Analysis) describe the targets proposed to measure protection of the recreation beneficial use and their linkage to the existing water quality objective. As above, the first step in controlling many of the identified sources in this TMDL is for responsible parties to develop and then implement BLRPs, or other management plans, as appropriate. The load and waste load allocations are given as concentrations, as are the numeric targets. Adequate effluent monitoring and receiving water monitoring will be an important element of individual management plans, new or upgraded programs (e.g., Local Area Management Plans for onsite waste treatment systems), discharge permits, and other actions as described in Chapter 9 (Implementation). Collaboration under the Russian River Regional Monitoring Program will also play an important role in measuring progress towards attainment of numeric targets and water quality objectives.

Element 9: Monitoring

The watershed plan should also incorporate a monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established in Element 8. Chapter 9 (Monitoring) describes TMDL requirements and responsible parties for monitoring, assessment, and adaptive management, while also providing an umbrella stewardship approach for cooperation and collaboration in the Russian River Watershed. A monitoring component should be designed to determine whether progress is being made toward attaining or maintaining the applicable water quality standards. The monitoring program should be fully integrated with the established schedule and interim milestones criteria identified above. The monitoring component should be designed to determine whether loading reductions are being achieved over time and substantial progress in meeting water quality standards is being made. Watershed-scale monitoring can be used to measure the effects of multiple programs, projects, and trends over time. Instream monitoring is particularly relevant to the project. As above, the Regional Water Board is collaborating with the Russian River Watershed Association in the development of a Russian River Regional Monitoring Program to serve this and many other monitoring needs in the Russian River Watershed.

Summary

The level of detail needed to address the nine key elements of watershed management plans listed above will vary in proportion to the homogeneity or similarity of land use types and variety and complexity of pollution sources. Urban and suburban watersheds will therefore generally be planned and implemented at a smaller scale than watersheds with large areas of a similar rural character. Similarly, existing watershed plans and strategies for larger river basins often focus on flood control, navigation, recreation, and water supply but contain only summary information on existing pollutant loads. They often generally identify only source areas and types of management practices. In such cases, smaller sub-basin and watershed plans and work plans developed for nonpoint source management grants, point sources, and other storm water management can be the vehicles for providing the necessary management details. Additional information is included in the Federal Clean Water Act section 319(h) Guidelines.

Specific to the Russian River Watershed and this Pathogen TMDL, Chapter 9 (Implementation) describes the multiple entities and regulatory mechanisms by which appropriate management measures will be implemented and monitored. Some of the sources identified in the watershed require further site specific evaluation prior to determining appropriate management measures or treatment. In those cases, the parties responsible for developing and ultimately implementing approved management plans (e.g., BLRPs, erosion control plans) are clearly identified. The availability of 319(h) grant funds to support the development and implementation of both the watershed plan and the individual management plans may be critical to the success of this TMDL. As required by U.S. EPA, the TMDL describes each of the nine key elements of a watershed plan in chapters throughout the staff report and as summarized here.

CHAPTER 16
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Appendices

CHAPTER 17 -- APPENDICES

CHAPTER 18 APPENDIX A
CHAPTER 19 TYPES OF PATHOGENS & TYPES OF FECAL INDICATOR BACTERIA

A.1 TYPES OF BACTERIA

Pathogens most commonly identified and associated with waterborne diseases can be grouped into the three general categories: bacteria, protozoans, and viruses (U.S. EPA 2001).

A.1.1 BACTERIA

Bacteria are microscopic unicellular organisms ranging from approximately 0.2 to 10 micrometers (μm) in length. They are distributed ubiquitously 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. In addition, pathogenic (disease-causing) bacteria, such as verotoxigenic *E. coli* (including serotype 0157:H7), *Salmonella*, and *Campylobacter*, 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. Many groups of intestinal bacteria, including the coliform and enterococci groups, have historically been used as an indication that an environment has been contaminated with human sewage.

A.1.2 PROTOZOANS

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. Protozoan cysts do not reproduce in the environment, but are capable of surviving dormant in the soil and surface water for extended periods of time, which makes them a prominent public health concern.

Two waterborne protozoans of major public health concern are *Giardia lamblia* and *Cryptosporidium parvum*. The *Giardia* organism inhabits the digestive tract of a wide variety of domestic and wild animal species, as well as humans. Once shed in feces, G*iardia* cysts are frequently found in rivers and lakes. Infection by *Giardia* can result in giardiasis in humans, which is characterized by gastroenteritis, particularly among the young and elderly. *Giardia* is considered nonpathogenic in cattle because it is usually found in animals that have normal feces and no sign of disease. However, among the human population, giardiasis affects approximately 200 million people worldwide and is one of the most prevalent waterborne diseases in the United States. *Cryptosporidium* species are a group of parasitic protozoa that are recognized as pathogens of domesticated livestock, poultry, and wildlife and are readily transmitted to humans. *Cryptosporidium* oocysts are about 4-6 µm in diameter, slightly larger than bacteria, and relatively unaffected by conventional methods of wastewater disinfection, such as chlorination. Infection by *Cryptosporidium* can cause cryptosporidiosis, whose symptoms include loss of appetite, nausea, and abdominal pain followed by acute or persistent diarrhea. Although *Cryptosporidium* infections are usually of short duration and self-limiting in individuals with an intact immune system, there is no specific treatment available and the infection can be life threatening in patients with profound impairment of immune function.

A.1.3 VIRUSES

Viruses are obligate intracellular parasites, incapable of replication outside of a host organism. They are very small, ranging from 0.02 to 0.2 µm. 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. Sewage overflows and improperly functioning sewage systems are considered to be primarily responsible for water contamination. Individuals can become infected through consumption of contaminated water, swimming in contaminated water, or through person-to-person contact with an infected person. Symptoms of infection include vomiting and diarrhea, with the severity of disease and mortality increasing in older age groups. The most significant human enteric viruses include hepatitis A, rotaviruses, noroviruses, adenoviruses, enteroviruses, and reoviruses.

A.2 TYPES OF PATHOGEN INDICATOR BACTERIA

Several groups of intestinal bacteria have been 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. Indicator bacteria are described in Chapter 2 and include:

A.2.1 TOTAL COLIFORM BACTERIA

Total coliforms are a group of bacteria that are widespread in nature. All members of the total coliform group can occur in human feces, but some can also be present in animal manure, soil, submerged wood, and other places outside the human body. Thus, the usefulness of total coliforms as an indicator of fecal waste contamination depends on the extent to which the bacteria species found are fecal and human in origin. Because total coliforms can come from non-fecal sources, they are no longer recommended as an indicator for assessing the support of recreation beneficial uses (U.S. EPA 1986). However, total coliform is still recommended for use in assessing support of shellfish consumption based on criteria adopted in 1925. The shellfish criteria are based on investigations made by the U.S. Public Health Service that assessed the occurrence of typhoid fever or other enteric diseases attributed to shellfish harvesting (U.S. FDA 2011).

A.2.2 FECAL COLIFORM BACTERIA

Fecal coliform bacteria are a subgroup of total coliform bacteria found in the intestinal tracts of animals, and thus, are considered a more specific indicator of fecal waste 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) The studies concluded that the U.S. EPA (1976) recommended fecal coliform bacteria criteria had no scientific basis. As a result of the new information derived from epidemiological studies, the U.S. EPA (1986) changed the criteria recommendation to use the pathogen bacteria indicators of *E. coli* and enterococci bacteria, instead of fecal coliform bacteria.

In addition, detection of fecal coliform bacteria in recreational waters may overestimate the level of fecal waste contamination because this bacteria group contains several genera that are not of fecal origin (e.g., Enterobacter, Klebsiella, Citrobacter). For example, *Klebsiella* bacteria are commonly associated with soils and the surfaces of plants, so that areas with allochthonous organic debris may show high levels of fecal coliform bacteria that do not have a fecal-specific bacteria source.

A.2.3 *ESCHERICHIA COLI* (E. COLI) BACTERIA

E. coli is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. U.S. EPA (2012) compiled numerous epidemiological studies and concluded that *E. coli* bacteria another 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). The geometric mean criterion is compared to the logarithmic average of the bacteria concentration distribution. The STV criterion is compared to the 90th percentile of the bacteria concentration distribution.

Criteria were published for two different levels of illness risk (Table A.1). 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., USEPA 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 (USEPA 2002a; USEPA 2002b). Many laboratories, including the Regional Water Board Microbiology Laboratory, use a different analysis method to measure *E. coli* (and *Enterococcus*) 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 USEPA in the Code of Federal Regulations (40 CFR 136.3).

Table A.1. Recreational Water Quality Criteria for *E. coli* Bacteria Concentrations (USEPA 2012)

Pathogen Indicator Bacteria	**Recommendation 1** Estimated Illness Rate 36 per 1,000 recreators		**Recommendation 2** Estimated Illness Rate 32 per 1,000 recreators	
	Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)	Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)
E. coli	126	410	100	320

A.2.4 ENTEROCOCCI BACTERIA

Enterococci bacteria are a subgroup within the fecal streptococcus bacteria group. enterococci bacteria are distinguished by their ability to survive in salt water, and therefore more closely mimic pathogens than the other indicators in marine environments. U.S. EPA (2012) recommends enterococci bacteria concentration as another bacteria indicator of human health risk in salt water for recreation.

U.S. EPA (2012) states that enterococci bacteria concentrations may also be used as an indicator of human health risk in fresh water. Similar to *E. coli* bacteria, the enterococci bacteria criteria are established for both the geometric mean and the STV for protection of water contact recreation (Table A.2). The criteria are based on epidemiological studies at U.S. beaches. The studies enrolled participants at a number of beach study sites and followed them to compare incidence of illness between the exposed (swimmers) and unexposed groups. Exposed groups involved swimmers with exposure to waters known to be impacted by domestic wastewater.

Table A.2
Recreational Water Quality Criteria for Enterococci Bacteria Concentrations (USEPA 2012)

Pathogen Indicator Bacteria	**Recommendation 1** Estimated Illness Rate 36 per 1,000 recreators		**Recommendation 2** Estimated Illness Rate 32 per 1,000 recreators	
	Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)	Geometric Mean (cfu/100mL)	Statistical Threshold Value (cfu/100mL)
Enterococci	35	130	30	110

APPENDIX B
ONSITE WASTEWATER TREATMENT SYSTEM IMPACT STUDY REPORT

1.0 INTRODUCTION

North Coast Regional Water Board staff conducted a source analysis study for the development of the Russian River TMDL. The study was organized into individual tasks to collect information to help address the identified TMDL management questions (NCRWQCB 2012). Based on results of the study, Regional Water Board staff made the following findings:

1. Pathogenic indicator bacteria concentrations were higher during wet periods compared to dry periods
2. Human-source *Bacteroides* bacteria were detected in all sample locations and land use categories throughout the watershed.
3. Stable isotope analysis results showed that the dominant sources of source water for bacteria samples were manure and septic wastes.
4. During wet periods, pathogenic indicator bacteria concentrations were higher in urban sewered areas and areas with septic systems compared to less developed areas.
5. Human-source Bacteroides was higher in onsite septic areas compared to urban sewered areas.

The study appeared to indicate that septic systems were a contributing source of pathogenic indicator bacteria. We wanted to confirm this hypothesis by more focused monitoring. We did this by comparing water samples collected downstream of hydrologic catchments that drain areas with densely situated Onsite Wastewater Treatment System (OWTS) and catchments that drain areas with a relatively low density of OWTS. Additionally, provisions of the recently adopted statewide OWTS Policy require Regional Water Board staff to identify impaired waterbodies where septic systems are believed to be source of the impairment and establish additional protections, including supplemental treatment systems, in these areas. These new requirements highlight the need to explicitly identify sources of pathogens from onsite systems.
To address questions arising from the study findings, Regional Water Board staff collected wet-weather water samples from various locations in the lower Russian River Watershed during 2012-2013 to identify possible pathogen impacts from catchments that drain areas with a high density of OWTS. A Quality Assurance Project Plan (Butkus 2012a) was developed that detailed the water sample collection and analysis of the *E. coli*, *Enterococcus*, and *Bacteroides* bacteria concentrations. Additional water samples were also collected and analyzed for stable isotopes of nitrate to assess the relative water source differences in oxygen ($\delta^{18}O$) and nitrogen ($\delta^{15}N$).

2.0 MONITORING QUESTION

Pathogenic indicator bacteria can be transported to surface waters from malfunctioning or poorly sited OWTS. An OWTS doesn't have to be malfunctioning to contribute pathogenic indicator bacteria to surface waters. An OWTS can also be poorly sited so that there is insufficient and/or ineffective soil treatment upon effluent dispersal. During dry weather periods, OWTS effluent can travel in shallow groundwater to perennial streams, entering through shallow groundwater, through springs or the stream hyphoreic zone. During storm events, runoff from the landscape surface can flood OSWT systems resulting in the direct transport of untreated human waste to surface waters. This mode of transport can also occur in ephemeral streams that exist only for a short period following a storm event. This study focused sampling efforts during storm events when transport of bacteria to surface waters is most likely to occur.

The OWTS Impact Study was designed to answer the following management question:

- Do catchments with high density of OWTS contribute pathogenic indicator bacteria from human sources?

3.0 WATER SAMPLING LOCATIONS

Regional Water Boards staff selected catchments and sampling locations for the study based on parcel density and the perceived risk of bacterial transport from OWTS in the study area. Parcel data was obtained from the Sonoma County Assessor. The risk of bacterial transport from OWTS systems was assessed using a spatial data model developed by Regional Water Board staff (Fortescue 2012) using factors selected from the Basin Plan's Policy on the Control of Water Quality with Respect to On-Site Waste Treatment and Disposal Practices (NCRWQCB 2011). Landscape analysis of spatial data was conducted to select sampling locations that best represent the identified parcel density and fecal indicator bacteria (FIB) transport risk categories (Tables 1 & 2). Catchments were selected based on the risk of FIB transport to surface waters and the parcel density (Butkus 2012b).

Three sample locations were selected to represent catchments draining each of the following four categories, for a total of twelve sites:

- High parcel-density with a high risk of FIB transport from OWTS
- High parcel-density with a low risk of FIB transport from OWTS
- Low parcel-density with a high risk of FIB transport from OWTS
- Low parcel-density with a low risk of FIB transport from OWTS

In addition, three additional sample locations were selected by Regional Water Board staff to represent catchments that drain areas served by OWTS that have high parcel density and are near a stream. It is hypothesized by Regional Water Board staff that catchments with these characteristics present a high potential to contribute pathogens to the Russian River. Based on these catchment characteristics, additional sampling locations were selected from the Fitch Mountain area near Healdsburg, downtown Monte Rio and Camp Meeker.

Figure 1 presents the parcel density and FIB transport risk for each of the catchments sampled. This figure shows the relative relationship between the categories and the additional catchments of concern between these variables.

Figure 2 through Figure 28 show comparisons of the distribution of sample data between various groups using Box and whisker plots. The horizontal line in each box shows the median value of the data set. The boxes represent the interquartile range and the error bars (i.e. whiskers) represent the 10th and 90th percentiles of the data set.

Figure 2 presents the range of catchment areas for each of the four categories. The figure shows that the catchment areas for low transport risk catchments are larger than those selected to represent a high transport risk. Figure 3 presents the range of parcel densities for selected catchments. The figure confirms the large difference in parcel densities between the high parcel density categories and the low parcel density categories. Figure 4 shows the distribution of FIB transport risk for each category. The figure confirms the large difference in FIB transport risk between the high transport risk categories and the low transport risk categories.

Wet weather water samples were collected from fifteen (15) catchments in the lower Russian River Watershed (Table 1). Site number 14 (Monte Rio) was relocated to another location than identified in the Quality Assurance Project Plan. The originally selected location simply did not have runoff to sample that drained from the catchment after a storm event. The sample was collected at a nearby location in Monte Rio that had runoff available to collect.

4.0 MONITORING RESULTS

As described in the Quality Assurance Project Plan (Butkus 2012a), samples for analysis were collected from each location five (5) times during the study period. Despite the occurrence of early storm events in November 2012, the first storm event sampled was not until December 2, 2012, due to logistical reasons. The December 2, 2012 sample represented the largest of all the storm events sampled (Table 3). Water samples were collected at every site during this storm event. However, because subsequent storm events sampled were smaller and did not generate runoff at all locations, not all locations were sampled during every storm event. The locations and the dates sampled are shown in Table 4.

The results of FIB sample analysis are shown in Table 5. The result shown in the table is the median concentration value derived from replicate samples of fecal indicator bacteria at each location. Table 6 presents the ratio of stable isotopes of nitrogen ($\delta^{15}N$) and oxygen ($\delta^{18}O$) in dissolved nitrate. Several of the reported nitrate concentrations were below the level of quantitation. These data were not used in the assessment since isotope values for samples below the limit of quantitation may not be reliable.

Triplicate samples were collected once from each sampling location during the study to assess sampling variability, except at Sites 9 and 14, where samples were not collected due to the lack of runoff. Only one storm event on December 3, 2012 was large enough to generate runoff at these two locations. Table 7 – 10 shows the variability of the triplicate samples of FIB concentrations. The mean coefficient of variation ranges from 18% to 32%. The precision of the sampling was similar to the measurements made from replicate sampling in the Russian River during 2011-2012 which found coefficient of variations of 34% for *E. coli* bacteria and 37% for *Enterococcus* bacteria (NCRWQCB 2012; Butkus 2013).

5.0 ASSESSMENT RESULTS

Assessment Methods

Each of the sampling locations was selected to represent a particular catchment category of parcel density and FIB transport risk (i.e., high parcel density and high transport risk). The measured FIB concentrations were used to assess whether any particular sampling location is significantly different that the other locations selected to represent that category.

Visual comparisons and statistical hypothesis tests were made between different groupings of the measured FIB concentrations and other metrics. Distributions of the measured FIB concentrations are compared visually using box and whisker plots. The boxes represent the interquartile range of the distribution around the median and the whiskers represent the 10th and 90th percentiles. Hypothesis tests were considered statistically significantly different if the resulting probability of rejecting the null hypothesis (H_o)was equal or lower than $\alpha = 0.05$. Nonparametric (i.e., distribution-free) inferential statistical methods were used to assess differences between groups. These hypothesis tests make no assumption about the frequency distributions of the measured data. Nonparametric methods are the most appropriate approach for assessing water quality data, which can have widely varying frequency distributions (Helsel and Hirsch 2002).

The Kruskal-Wallis statistical test was used to assess if any particular sampling location showed a statistical difference in FIB concentrations from the other locations sampled for that catchment category (H_o). The Kruskal-Wallis test is a hypothesis test conducted using ranked data (Helsel and Hirsch 2002). This non-parametric test was used for testing if samples originate from the same distribution by assessing the equality of population medians among the groups. The parametric equivalent of the Kruskal-Wallis test is the one-way analysis of variance. When the Kruskal-Wallis test indicates significant results ($H_o < \alpha$), then at least one of the samples is different from the other samples in the group.

The relationships between FIB concentrations and catchment characteristics were investigated. In addition, the relationship of stable isotope of nitrate and catchment characteristics was also evaluated. Catchment characteristics included the area, parcel density and FIB transport risk.

<u>Water Sample Measurements:</u>
E. coli bacteria concentration
Enterococcus bacteria concentration
All *Bacteroides* bacteria concentration
Human-host *Bacteroides* bacteria concentration
Stable isotopes of oxygen ($\delta^{18}O$)
Stable isotopes of nitrogen ($\delta^{15}N$)

<u>Catchment Characteristics:</u>
Catchment size (acres)
Parcel Density (number of parcel centroids/catchment size)
FIB Transport Risk (index number)

The relationships between these variables were investigated using the Spearman's rank correlation coefficient (ρ) (Helsel and Hirsch 2002). Spearman's rank correlation coefficient is a nonparametric statistical measure of the dependence between two variables. Spearman correlation coefficients approach either plus one ($\rho \sim +1.0$) or minus one ($\rho \sim -1.0$), as the relationship become stronger. A small correlation coefficient (between -0.5 and 0.5) indicates a weak relationship between the variables. For example, a strong relationship means that when *E. coli* bacteria concentration is high in a sample, there is a large likelihood that *Enterococcus* bacteria concentrations will also be high.

Statistical tests were used to evaluate whether there was a significant difference between different catchment categories. The Mann-Whitney U statistical test was applied to assess the difference between the distributions of measured FIB concentrations and stable isotopes of nitrate based on parcel density and FIB transport risk. For example, the test was used to determine if there was a significant difference in E. coli concentrations from catchments with a high parcel density as opposed to catchment with a low parcel density.

The Mann-Whitney U test is a non-parametric hypothesis test for assessing whether two samples of observations come from the same distribution (Helsel and Hirsch 2002). The test null hypothesis is that the two samples are drawn from a single population. The test is similar to performing an ordinary parametric two-sample t test, but is based on ranking the data set. This statistical test is a nonparametric inferential statistical method that makes no assumption about the frequency distributions.

<u>Assessment of Sampling Location influence on FIB Concentrations</u>

Tables 11 – 14 show the results of the Kruskal-Wallis statistical tests between sampling locations for each catchment category. Only three of the tests showed a statistically significant difference between locations. *Enterococcus* bacteria concentrations were different in the high parcel density & high FIB transport risk category (Table 11). Visual observation of the distribution of *Enterococcus* bacteria concentrations show that Site 2 is much higher than the other locations sampled. In addition, the distribution of both *E.coli* and All *Bacteriodes* bacteria concentrations show that Site 10 is much higher than the other locations sampled. These data (i.e., *Enterococcus* bacteria concentrations from Site 2 and both *E.coli* and All *Bacteriodes* bacteria concentrations from Site 10) were excluded from further assessment since they may not be representative of the high parcel density & high FIB transport risk category based on both visual observation and the hypothesis tests.

<u>Relationship between FIB Concentrations and Other Variables</u>

Table 15 presents the matrix of Spearman's rank correlation coefficients between the FIB concentrations and the other variables. Three of the relationships are relatively strong. All *Bacteroides* bacteria concentrations are positively correlated with both human-host *Bacteroides* and *Enterococcus* bacteria concentrations. *Enterococcus* bacteria concentrations are also positively correlated with *E. coli* bacteria concentrations. Neither of the stable isotopes of nitrate was correlated with any of the FIB concentrations. FIB transport showed a weak, negative correlation to all of the FIB concentrations.

Assessment of Catchment Category influence on FIB Concentrations

The Kruskal-Wallis statistical test was also used to assess if there was statistical difference in FIB concentrations and stable isotopes of nitrate between catchment categories. Table 16 presents the results of the hypothesis test that the equality of population medians among the groups is the same. Figures 8 – 11 show the distributions of the FIB concentrations for each catchment category. The results indicate that each of the FIB groups were significantly different between the catchment categories. There was no significant different found between these categories for the stable isotopes of nitrate.

Assessment of Catchment Characteristics Influence on FIB Concentrations

Table 17 presents the results of the Mann-Whitney U test comparing FIB concentrations and stable isotopes of nitrate between catchments with a high parcel density (>0.75 parcels/acre) and those with a low parcel density (<0.12 parcels/acre). A statistically significant difference was observed in both All *Bacteroides* and *E. coli* bacteria concentrations based on parcel density. Visual comparison of the distributions of these concentrations show that higher parcel density is associated with higher concentrations of both All *Bacteroides* and *E. coli* bacteria (Figures 12 & 13).

Table 18 presents the results of the Mann-Whitney U test comparing FIB concentrations and stable isotopes of nitrate between catchments with a high FIB transport risk (index ≥10) and those with a low parcel density. (index <10). A statistically significant difference was observed in all FIB concentrations based on transport risk. Visual comparison of the distributions of these concentrations show that lower transport risk is associated with higher FIB concentrations (Figures 14-17). These results and observations support the previous finding that FIB transport is negatively correlated to FIB concentrations.

Assessment of Catchment Transport Risk influence on FIB Concentrations

The FIB transport risk index was evaluated further to determine why there appears to be a negative relationship between the index value and measured FIB concentrations. Each of the four (4) elements of the index was assumed to have a positive relationship to FIB transport. This assumption appears to be invalid for the set of catchments selected for this study. The index was separated into each of the elements for the study catchments. The spatial data used as input to the index were area-weighted for each study catchment (Table 19). Both the setback rank and the hydrologic group rank very little variability between the study sites. These two elements have relatively little influence on the ability of the index to discern differences between the groups and were excluded from the assessment. Therefore, the assessment was focused only on the effect of the remaining two elements, hill slope rank and soil depth rank, on the index values.

The Mann-Whitney U statistical test was applied to assess the difference between the distributions of measured FIB concentrations based on soil depth rank and hill slope rank. Table 20 shows that no significant differences were observed in all FIB concentrations between catchments with a high soil depth rank (>3.0) and those with a low soil depth rank (<3.0). Table 21 shows that highly significant differences were observed in all FIB concentrations between catchments with a high hill slope rank (>3.5) and those with a low hill slope rank (<3.5). Visual comparison of the distributions of these concentrations shows that lower hill slope is associated with higher FIB concentrations (Figures 18-21). These results and observations support the finding that hill slope index is not positively correlated with FIB concentrations for the set of catchments selected for this study. The assumption that there was a positive correlation between hill slope and FIB concentrations is invalid.

Assessment of Catchment Transport Risk influence on the Stable Isotopes of Nitrate

Measurements of the stable isotopes of oxygen ($\delta^{18}O$) and nitrogen ($\delta^{15}N$) were assessed to help identify the source of the water associated with the bacteria samples. The results were compared to typical values of $\delta^{18}O$ and $\delta^{15}N$ of nitrate (Figure 22).

- Samples with $\delta^{15}N$ values between 2‰ and 8‰ and $\delta^{18}O$ values below 15‰ are derived from soil sources, likely from storm water erosion.
- Samples with $\delta^{18}O$ values above 15‰ are largely runoff processes.
- Samples with $\delta^{15}N$ values below 5‰ are typically ammonium from in situ processes such as wastewater treatment.
- Samples with $\delta^{15}N$ values above 5‰ are manure and septic waste.
-

Most of the samples fell within the range of a soil source of nitrate derived from ammonia through nitrification (Table 22 and Figure 23). These sources of nitrate were likely derived from erosion caused by storm events. Relatively few of the samples had $\delta^{15}N$ values above 10‰ or below 5‰. There were no significant differences found in stable isotope values based on parcel density (Table 17) or FIB transport risk (Table 18). These results were similar to the values found in other wet period water samples collected in the Russian River Watershed (NCRWQCB 2012).

Assessment of FIB Concentrations in the Study Areas of Concern

Three sample locations were sampled that represent catchments draining areas of concern for OWTS impacts. The sampling locations were selected from catchments from the Fitch Mountain area near Healdsburg (Site 13), downtown Monte Rio (Site 14) and Camp Meeker (Site 15). These areas generally have a high parcel density on OWTS. The distribution of FIB concentrations from these catchments of concern were compared to the other catchments sampled (Figures 24- 28). Only a single storm event was sampled at Site 14 due to a lack of runoff so the results may not be representative of the catchment. However, this storm event showed much higher FIB concentration the other catchment samples. The other two catchments of concern (Sites 13 & 15) showed similar range of FIB concentrations as the other catchments sampled.

6.0 FINDINGS

Based on the assessments of FIB concentrations presented in this report, Regional Water Board staff can make the following findings:

- Triplicate samples were collected to assess sampling variability. The mean coefficient of variation ranges from 18% to 32%.
- *Enterococcus* bacteria concentrations from Site 2 (River Road culvert, Monte Rio) were much higher than the other locations sampled. In addition, both *E.coli* and All *Bacteriodes* bacteria concentrations from Site 10 (Fredson Road, Healdsburg) were also much higher than the other locations sampled. These data were excluded from further assessment since they may not be representative of the catchment category they were placed.
- All *Bacteroides* bacteria concentrations were positively correlated with both human-host *Bacteroides* and *Enterococcus* bacteria concentrations. *Enterococcus* bacteria concentrations were also positively correlated with *E. coli* bacteria concentrations. This means that as bacteria concentrations increase the other indicators also likely increase. For example, one is likely to measure high *E. coli* bacteria concentrations in a water sample with high *Enterococcus* bacteria concentrations
- Neither of the stable isotopes of nitrate was correlated with any of the FIB concentrations.
- FIB transport risk showed a weak, negative correlation to all of the FIB concentrations. This means that the higher the assumed risk, the lower the FIB concentrations were likely to be measured in a water sample.
- Each of the FIB groups was significantly different between the catchment categories.
- There was no significant difference found between the catchment categories for the stable isotopes of nitrate. Most of the samples fell within the range of a soil source of nitrate derived from ammonia through nitrification. These sources of nitrate were likely derived from erosion caused by storm events. These results were similar to the values found in other wet period water samples collected in the Russian River Watershed.
- A higher parcel density is associated with higher concentrations of both All *Bacteroides* and *E. coli* bacteria.
- No significant differences were observed in FIB concentrations between catchments with different soil depths.
- The FIB transport risk index is invalid for the set of catchments selected for this study. Lower transport risk is associated with higher FIB concentrations. This anomaly was caused by the incorrect assumption that hill slope index is positively correlated with FIB concentrations
- There were no significant differences found in stable isotope values based on parcel density or FIB transport risk. The results indicate the source of nitrate is soil likely derived from the storm event causing erosion. The stable isotope values were

similar to the values found in other wet period water samples collected in the Russian River Watershed.

- The catchments of concern showed similar range of FIB concentrations as the other catchments sampled.

7.0 CITATIONS

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7.0 TABLES

Table 1. Study Sampling Locations

Category	Site ID	SWAMP ID	Latitude	Longitude	Location Description
High Parcel Density High Risk	Site 1	114DFMR68	38.6131	-122.8410	1740 Fitch Mtn Road - west of Villa Anna (Healdsburg)
	Site 2	114C01EDR	38.4776	-122.9762	River Road - culvert 100' east of Duncan Road (Monte Rio)
	Site 3	114C02SPR	38.5063	-121.0735	River Drive at Summerhome Park Road (Forestville)
High Parcel Density Low Risk	Site 4	114C03OMR	38.4781	-121.0018	19375 Old Monte Rio Road (across street from Northwood golf course)
	Site 5	114CO4TRF	38.4903	-121.1022	8612 Trenton Road (Forestville)
	Site 6	114DDRC59	38.4978	-121.0979	Along west shoulder of Del Rio Court (Forestville)
Low Parcel Density High Risk	Site 7	114C05MNS	38.4581	-122.9891	9632 Main Street (Monte Rio)
	Site 8	114C06VRG	38.5059	-121.0423	12656 River Road at Von Renner Grading (near Rio Nido)
	Site 9	114C07MRC	38.4575	-122.9531	Moscow Road box culvert - 100' west of 'Right Curve' sign (near Cassini Campgound)
Low Parcel Density Low Risk	Site 10	114CO8FRS	38.6561	-121.1264	Fredson Road south of Salvation Army driveway (Healdsburg)
	Site 11	114C09W	38.646	-	3654 West Dry Creek

		DC	7	121.0805	Road (Healdsburg)
	Site 12	114C10AVR	38.6509	-121.1316	148 Alexander Valley Road (Healdsburg)
Areas of Concern	Site 13	114C11RDH	38.6238	-122.8452	West end of Redwood Drive (Healdsburg)
	Site 14	114C12FSM	38.4697	-123.0124	Foothill Drive at B Street (Monte Rio)
	Site 15	114C13LSA	38.4252	-121.0399	Lakeside Ave at Market Street (Camp Meeker)

Table 2. Catchment Characteristics

Category	Site ID	Catchment Area (acres)	Parcel Density (# per acre)	FIB Transport Risk Index
High Parcel Density High Risk	Site 1	34.7	2.25	12.4
	Site 2	4.6	3.88	11.0
	Site 3	45.3	1.90	10.0
High Parcel Density Low Risk	Site 4	74.0	3.37	8.7
	Site 5	167.0	0.76	7.9
	Site 6	90.6	2.91	9.6
Low Parcel Density High Risk	Site 7	82.6	0.01	10.8
	Site 8	43.0	0.02	10.9
	Site 9	16.4	0.06	10.6
Low Parcel Density Low Risk	Site 10	108.8	0.04	6.4
	Site 11	113.5	0.05	7.3
	Site 12	36.8	0.11	8.2

Areas of Concern	Site 13	30.9	0.39	10.2
	Site 14	6.7	2.54	9.7
	Site 15	6.3	7.84	10.2

Table 3. Precipitation during samples storm events as measured in Santa Rosa (CDEC Station STA at latitude 38.479, longitude -122.712)

Storm Event Dates	Two-day Antecedent Total Precipitation (inches)
12/3/2012	1.39
2/19/2013	0.16
3/6/2013	0.38
3/20/2013	0.54
4/4/2013	1.00

Table 4. Storm event dates sampled by location

* No sample collected due to a lack of runoff flow

Location	Date Sampled				
	Storm Event 1	Storm Event 2	Storm Event 3	Storm Event 4	Storm Event 5
Site 1	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 2	12/3/2012	3/20/2013	4/4/2013	*	*
Site 3	12/3/2012	3/6/2013	3/20/2013	4/4/2013	*
Site 4	12/3/2012	3/6/2013	3/20/2013	4/4/2013	*
Site 5	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 6	12/3/2012	3/20/2013	4/4/2013	*	*
Site 7	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 8	12/3/2012	3/20/2013	4/4/2013	*	*
Site 9	12/3/2012	*	*	*	*
Site 10	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 11	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 12	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 13	12/3/2012	2/19/2013	3/6/2013	3/20/2013	4/4/2013
Site 14	12/3/2012	*	*	*	*
Site 15	12/3/2012	3/6/2013	4/4/2013	*	*

Table 5. Median Fecal Indicator Bacteria Concentration Results

Location	Collection Date	All *Bacteroides* (16SrRNA genes/100mL)	Human *Bacteroides* (16SrRNA genes/100mL)	*E. coli* (MPN/100mL)	*Enterococcus* (MPN/100mL)
Site 1	12/3/2012	7,880	98	20	173
	2/19/13	29,682	349	109	61
	3/6/13	19,978	2,700	3,179	220
	3/20/13	15,413	<60	51	20
	4/4/13	37,600	238	84	10
Site 2	12/3/2012	12,100	217	1,019	384
	3/20/13	128,069	490	152	>24,196
	4/4/13	162,916	<60	187	5,172
Site 3	12/3/2012	2,150	178	158	295
	3/6/13	52,036	11,200	160	432
	3/20/13	158,524	27,700	3,654	216
	4/4/13	74,930	4,750	146	613
Site 4	12/3/2012	7,278	624	3,255	1,046
	3/6/13	169,775	39,200	2,613	12,997
	3/20/13	290,952	11,000	1,050	1,396
	4/4/13	322,490	48,800	2,481	2,603
Site 5	12/3/2012	45,667	5,644	1,376	1,236
	2/19/13	68,502	48,200	393	86
	3/6/13	531,524	220,000	1,664	3,873
	3/20/13	221,299	46,600	749	4,611
	4/4/13	487,550	167,400	4,892	4,950
Site 6	12/3/2012	10,800	2,131	246	211
	3/20/13	79,321	3,460	8,164	>24,196
	4/4/13	2,796,000	135,600	2,755	41,060
Site 7	12/3/2012	813	<60	52	10
	2/19/13	2,087	166	<10	<10
	3/6/13	3,824	523	80	21
	3/20/13	19,239	2,740	10	10
	4/4/13	10,373	2,260	31	275
Site 8	12/3/2012	6,409	<60	62	171

	3/20/13	35,711	1,450	836	1,450
	4/4/13	78,628	5,750	1,695	3,551
Site 9	12/3/2012	5,043	<60	327	85

Table 5. Median Fecal Indicator Bacteria Concentration Results *continued*

Location	Collection Date	All *Bacteroides* (16SrRNA genes/100mL)	Human *Bacteroides* (16SrRNA genes/100mL)	*E. coli* (MPN/100mL)	*Enterococcus* (MPN/100mL)
Site 10	12/3/2012	32,700	81	323	410
	2/19/13	570,924	6,730	5,827	20
	3/6/13	574,218	12,950	10,099	8,686
	3/20/13	172,543	8,580	1,137	2,098
	4/4/13	528,882	17,500	11,199	7,701
Site 11	12/3/2012	49,667	1,156	154	205
	2/19/13	32,558	4,280	598	128
	3/6/13	63,479	4,040	857	2,247
	3/20/13	53,642	5,070	373	1,565
	4/4/13	25,925	2,720	2,755	7,701
Site 12	12/3/2012	4,143	<60	171	139
	2/19/13	31,979	1,920	31	15
	3/6/13	31,298	2,143	132	288
	3/20/13	26,291	1,610	201	52
	4/4/13	164,674	5,560	121	2,310
Site 13	12/3/2012	9,450	698	327	384
	2/19/13	19,045	4,380	377	10
	3/6/13	22,678	2,310	789	233
	3/20/13	35,295	14,100	122	98
	4/4/13	66,357	2,280	3,076	12,997
Site 14	12/3/2012	1,640,000	371,000	2,489	2,481
Site 15	12/3/2012	24,000	2,680	96	563
	3/6/13	56,827	17,700	31	41
	3/20/13	47,050	1,530	238	605
	4/4/13	56,045	15,500	31	83

Table 6. Stable Isotope Analysis of Nitrate Results
* Indicates samples are below the limit of quantitation.
Isotope values for samples below the limit of quantitation may not be reliable.

Location	Collection Date	δ 15 N	δ 18 O	Nitrate-N (mg/L)
Site 1	12/3/2012	6.10	3.82	0.40
	2/19/2013	6.87	6.44	0.33
	3/6/2013	8.15	4.66	0.14
	3/20/2013	8.04	3.80	0.23
	4/4/2013	6.76	3.42	0.1m
Site 2	12/3/2012	9.61	6.24	0.03
	3/20/2013	16.26*	18.84*	0.06
	4/4/2013	6.54*	12.13*	<0.01
Site 3	12/3/2012	7.05	3.54	1.45
	3/6/2013	6.74	1.95	0.69
	3/20/2013	7.65	3.07	0.94
	4/4/2013	6.44	1.75	0.71
Site 4	12/3/2012	11.61	7.32	1.07
	3/6/2013	4.15	0.99	0.74
	3/20/2013	1.55	5.25	0.12
	4/4/2013	4.20	0.57	0.23
Site 5	12/3/2012	8.68	6.08	0.99
	2/19/2013	10.83	5.26	0.24
	3/6/2013	7.45	1.84	0.72
	3/20/2013	8.16	6.09	0.26
	4/4/2013	6.49	0.41	0.38
Site 6	12/3/2012	8.20	3.83	2.58
	3/20/2013	18.26	12.46	0.66
	4/4/2013	12.25	6.46	0.18
Site 7	12/3/2012	5.76*	10.81*	0.05
	2/19/2013	26.70*	18.36*	<0.01
	3/6/2013	20.95*	14.96*	<0.01
	3/20/2013	18.93*	21.70*	<0.01
	4/4/2013	12.91*	22.47*	<0.01
Site 8	12/3/2012	4.21	3.69	0.74
	3/20/2013	8.81	15.56	0.07
	4/4/2013	8.68	10.28	0.09
Site 9	12/3/2012	2.81	3.89	0.69

Table 6. Stable Isotope Analysis of Nitrate Results *continued*
* Indicates samples are below the limit of quantitation.
Isotope values for samples below the limit of quantitation may not be reliable.

Location	Collection Date	$\delta^{15}N$	$\delta^{18}O$	Nitrate-N (mg/L)
Site 10	12/3/2012	10.78	9.65	0.58
	2/19/2013	12.13*	13.18*	<0.01
	3/6/2013	7.65	3.17	0.10
	3/20/2013	8.86*	22.84*	<0.01
	4/4/2013	4.01*	6.02*	<0.01
Site 11	12/3/2012	3.66	4.84	0.80
	2/19/2013	6.48	7.61	0.11
	3/6/2013	7.83	-0.75	0.88
	3/20/2013	7.60	5.69	0.11
	4/4/2013	9.83	2.34	0.69
Site 12	12/3/2012	7.26	1.98	1.07
	2/19/2013	8.59	2.93	1.24
	3/6/2013	10.70	2.17	0.64
	3/20/2013	8.98	6.33	1.25
	4/4/2013	10.85	6.84	0.22
Site 13	12/3/2012	7.42	3.91	1.10
	2/19/2013	8.54	6.34	0.20
	3/6/2013	4.80	2.09	0.25
	3/20/2013	8.81	4.15	0.13
Site 14	12/3/2012	9.70	5.04	4.27
Site 15	12/3/2012	8.05	4.98	4.25
	3/6/2013	7.23	0.38	7.20
	3/20/2013	9.60	2.62	0.97
	4/4/2013	6.06	-0.29	4.38

Table 7 – Replicate Sample Variability for *E. coli* Bacteria Concentrations

Location	Collection Date	*E. coli* Bacteria Concentration (MPN/100mL)			Coefficient of Variation (%)
		Replicate 1	Replicate 2	Replicate 3	
Site 1	12/3/2012	20	50	20	58%
Site 2	12/3/2012	1019	1017	1274	13%
Site 3	12/3/2012	156	158	160	1%
Site 4	3/6/2013	3076	2613	2481	11%
Site 5	3/6/2013	1723	1624	1664	3%
Site 6	3/20/2013	8664	7701	8164	6%
Site 7	3/6/2013	86	97	31	50%
Site 8	3/20/2013	836	581	984	25%
Site 10	3/20/2013	882	1137	1374	22%
Site 11	3/20/2013	292	495	373	26%
Site 12	3/20/2013	231	201	132	27%
Site 13	3/20/2013	84	171	122	35%
Site 15	3/6/2013	31	52	20	47%
Mean Variability					25%

Table 8 – Replicate Sample Variability for *Enterococcus* Bacteria Concentrations

Location	Collection Date	*Enterococcus* Bacteria Concentration (MPN/100mL)			Coefficient of Variation (%)
		Replicate 1	Replicate 2	Replicate 3	
Site 1	12/3/2012	185	135	173	16%
Site 2	12/3/2012	295	384	432	19%
Site 3	12/3/2012	243	295	359	19%
Site 4	3/6/2013	12997	10462	14136	15%
Site 5	3/6/2013	3076	3873	4106	15%
Site 6	3/20/2013	>24196	>24196	>24196	-
Site 7	3/6/2013	10	97	31	99%
Site 8	3/20/2013	1450	1354	2987	47%
Site 10	3/20/2013	2098	2098	2143	1%
Site 11	3/20/2013	1565	1935	1201	23%
Site 12	3/20/2013	63	10	52	67%
Site 13	3/20/2013	98	109	85	12%
Site 15	3/6/2013	31	75	41	47%
Mean Variability					32%

Table 9 – Replicate Sample Variability for All *Bacteriodes* Bacteria Concentrations

Location	Collection Date	All *Bacteroides* Bacteria Concentration (16SrRNA genes/100mL)			Coefficient of Variation (%)
		Replicate 1	Replicate 2	Replicate 3	
Site 1	12/3/2012	7,880	11,100	7,570	22%
Site 2	12/3/2012	12,100	12,526	10,313	10%
Site 3	12/3/2012	2,537	2,060	2,150	11%
Site 4	3/6/2013	165,210	169,775	234,262	20%
Site 5	3/6/2013	68,502	56,317	68,802	11%
Site 6	3/20/2013	72,940	80,789	79,321	5%
Site 7	3/6/2013	5,373	3,824	3,291	26%
Site 8	3/20/2013	29,927	35,722	35,711	10%
Site 10	3/20/2013	141,008	172,543	260,919	32%
Site 11	3/20/2013	53,642	54,365	43,647	12%
Site 12	3/20/2013	24,063	31,466	26,291	14%
Site 13	3/20/2013	31,932	41,662	35,295	14%
Site 15	3/6/2013	56,827	83,452	29,923	47%
Mean Variability					18%

Table 10 – Replicate Sample Variability for Human-host *Bacteroides* Bacteria Concentrations

Location	Collection Date	Human-host *Bacteroides* Bacteria Concentration (16SrRNA genes/100mL)			Coefficient of Variation (%)
		Replicate 1	Replicate 2	Replicate 3	
Site 1	12/3/2012	98	69	156	41%
Site 2	12/3/2012	217	381	128	53%
Site 3	12/3/2012	178	178	127	18%
Site 4	3/6/2013	39,200	36,400	50,750	18%
Site 5	3/6/2013	50,600	42,500	48,200	9%
Site 6	3/20/2013	2,080	4,080	3,460	32%
Site 7	3/6/2013	557	293	523	31%
Site 8	3/20/2013	1,600	1,450	1,250	12%
Site 10	3/20/2013	4,680	8,580	8,620	31%
Site 11	3/20/2013	6,310	5,070	4,390	19%
Site 12	3/20/2013	1,610	1,140	2,020	28%
Site 13	3/20/2013	16,300	14,100	11,100	19%

Site 15	3/6/2013	17,300	23,800	17,700	19%
Mean Variability					32%

Table 11. Kruskal-Wallis Statistical Test for a difference in FIB concentrations between sampling locations in the high parcel density - high FIB transport risk category (i.e., Sites 1, 2 & 3).

Constituent	Kruskal-Wallis Statistic	Probability Value	Statistically Significant?
E. coli bacteria	3.503	0.174	No
Enterococcus bacteria	8.060	0.018	**Yes**
All *Bacteroides* bacteria	2.060	0.357	No
Human-host *Bacteroides* bacteria	3.534	0.171	No
$\delta^{15}N$	2.651	0.266	No
$\delta^{18}O$	5.864	0.053	No

Table 12. Kruskal-Wallis Statistical Test for a difference in FIB concentrations between sampling locations in the high parcel density -low FIB transport risk category (i.e., Sites 4, 5 & 6).

Constituent	Kruskal-Wallis Statistic	Probability Value	Statistically Significant?
E. coli bacteria	0.799	0.671	No
Enterococcus bacteria	1.041	0.594	No
All *Bacteroides* bacteria	0.179	0.914	No
Human-host *Bacteroides* bacteria	2.388	0.303	No
$\delta^{15}N$	4.754	0.093	No
$\delta^{18}O$	1.938	0.379	No

Table 13. Kruskal-Wallis Statistical Test for a difference in FIB concentrations between sampling locations in the low parcel density - high FIB transport risk category (i.e., Sites 7, 8 & 9).

Constituent	**Kruskal-Wallis Statistic**	**Probability Value**	**Statistically Significant?**
E. coli bacteria	4.912	0.086	No
Enterococcus bacteria	4.708	0.095	No
All *Bacteroides* bacteria	3.271	0.195	No
Human-host *Bacteroides* bacteria	1.453	0.484	No
$\delta^{15}N$	3.000	0.180	No
$\delta^{18}O$	2.000	0.655	No

Table 14. Kruskal-Wallis Statistical Test for a difference in FIB concentrations between sampling locations in the low parcel density - low FIB transport risk category (i.e., Sites 10, 11 & 12).

Constituent	**Kruskal-Wallis Statistic**	**Probability Value**	**Statistically Significant?**
E. coli bacteria	9.380	0.009	**Yes**
Enterococcus bacteria	2.289	0.318	No
All *Bacteroides* bacteria	7.220	0.027	**Yes**
Human-host *Bacteroides* bacteria	4.340	0.114	No
$\delta^{15}N$	2.908	0.234	No
$\delta^{18}O$	1.185	0.553	No

Table 15. Spearman's Rank Correlation Matrix

ρ	All *Bacteroides* bacteria	Human-host *Bacteroides* bacteria	*E. coli* bacteria	*Enterococcu s* bacteria
All *Bacteroides* bacteria	1.00			
Human-host *Bacteroides* bacteria	0.77	1.00		
***E. coli* bacteria**	0.48	0.46	1.00	
***Enterococcus* bacteria**	0.64	0.50	0.73	1.00
$\delta^{15}N$	0.06	0.06	0.25	0.21
$\delta^{18}O$	-0.08	-0.18	0.20	0.05
Parcel Density	0.38	0.16	0.20	0.17
FIB Transport Risk	-0.38	-0.49	-0.39	-0.43
Catchment Size	0.26	0.58	0.33	0.40

Table 16. Kruskal-Wallis Statistical Test for a difference between the four categories.

Constituent	Kruskal-Wallis Statistic	Probability Value	Statistically Significant?
E. coli bacteria	15.974	0.001	**Yes**
Enterococcus bacteria	13.195	0.004	**Yes**
All *Bacteroides* bacteria	14.912	0.002	**Yes**
Human-host *Bacteroides* bacteria	17.576	0.001	**Yes**
$\delta^{15}N$	2.629	0.452	No
$\delta^{18}O$	2.725	0.436	No

Table 17. Mann-Whitney U Statistical Test for a difference between a high and low parcel density

Constituent	Mann-Whitney U Statistic	Probability Value	Statistically Significant?
E. coli bacteria	327.5	0.015	**Yes**
Enterococcus bacteria	312	0.172	No
All *Bacteroides* bacteria	335	0.009	**Yes**
Human-host *Bacteroides* bacteria	357	0.154	No
$\delta^{15}N$	158	0.595	No
$\delta^{18}O$	149	0.425	No

Table 18. Mann-Whitney U Statistical Test for a difference between a high and low FIB transport risk

Constituent	Mann-Whitney U Statistic	Probability Value	Statistically Significant?
E. coli bacteria	110	0.003	**Yes**
Enterococcus bacteria	105.5	0.001	**Yes**
All *Bacteroides* bacteria	117	0.006	**Yes**
Human-host *Bacteroides* bacteria	112.5	<0.001	**Yes**
$\delta^{15}N$	115	0.109	No
$\delta^{18}O$	172	0.904	No

Table 19. Area-weighted Index Component Rank Scores

Location	FIB Transport Risk Index	Hill Slope Rank	Hydrologic Soil Group Rank	Soil Depth Rank	Setback Rank
Site 1	12.4	4.49	3.00	4.76	0.00
Site 2	11.0	4.92	3.00	3.00	0.00
Site 3	10.0	3.90	3.00	3.04	0.01
Site 4	8.7	1.41	3.00	3.00	0.00
Site 5	7.9	1.91	3.00	3.00	0.00
Site 6	9.6	3.79	3.00	2.81	0.00
Site 7	10.8	4.88	3.00	3.00	0.23
Site 8	10.9	4.65	3.00	3.28	0.00
Site 9	10.6	4.61	3.00	3.00	0.00
Site 10	6.4	1.58	3.00	1.81	0.00
Site 11	7.3	3.27	3.00	1.00	0.00
Site 12	8.2	2.29	3.05	1.12	0.00

Table 20. Mann-Whitney U Statistical Test for a difference between a high and low soil depth rank

Constituent	Mann-Whitney U Statistic	Probability Value	Statistically Significant?
E. coli bacteria	58	0.277	No
Enterococcus bacteria	76.5	0.182	No
All *Bacteroides* bacteria	63	0.415	No
Human-host *Bacteroides* bacteria	75	0.162	No

Table 21. Mann-Whitney U Statistical Test for a difference between a high and low hill slope rank

Constituent	Mann-Whitney U Statistic	Probability Value	Statistically Significant?
E. coli bacteria	117	0.006	**Yes**
Enterococcus bacteria	112.5	<0.001	**Yes**
All *Bacteroides* bacteria	110	0.003	**Yes**
Human-host *Bacteroides* bacteria	105.5	0.001	**Yes**

Table 22. Median Values of the Stable Isotopes by Category

Category	Median $\delta^{15}N$	Median $\delta^{18}O$
High Parcel Density – High FIB Transport Risk	7.0	3.7
High Parcel Density – Low FIB Transport Risk	8.2	5.3
Low Parcel Density – High FIB Transport Risk	6.4	7.1
Low Parcel Density – Low FIB Transport Risk	8.2	4.0

Areas of Concern	8.1	3.9
All Locations	7.8	3.9

8.0 FIGURES

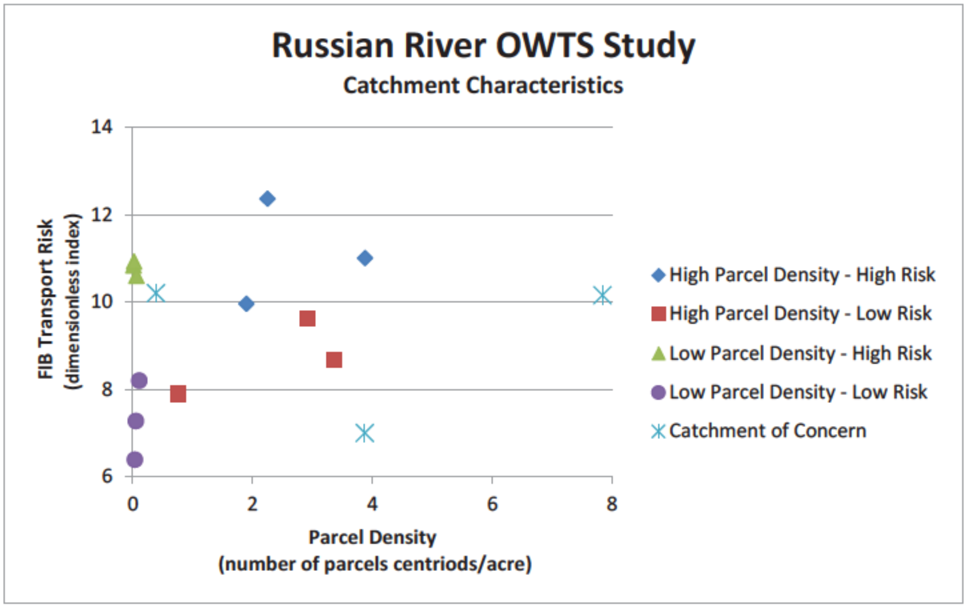

Figure 1. Characteristics of the catchments studied

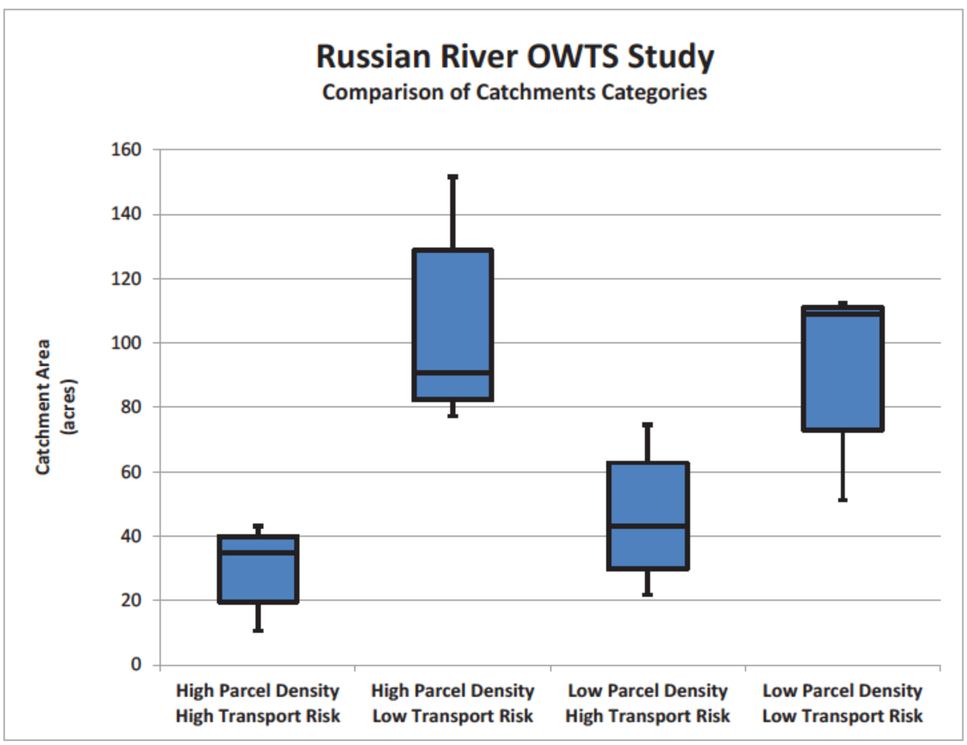

Figure 2. Comparison of the drainage areas between catchment categories

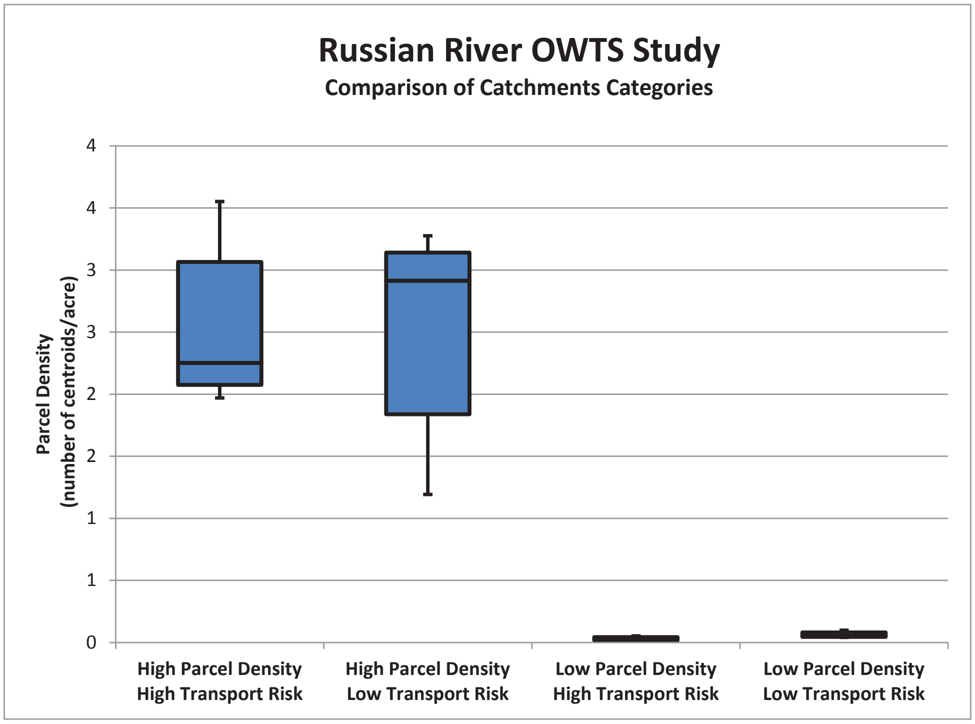

Figure 3. Comparison of the parcel density between catchment categories

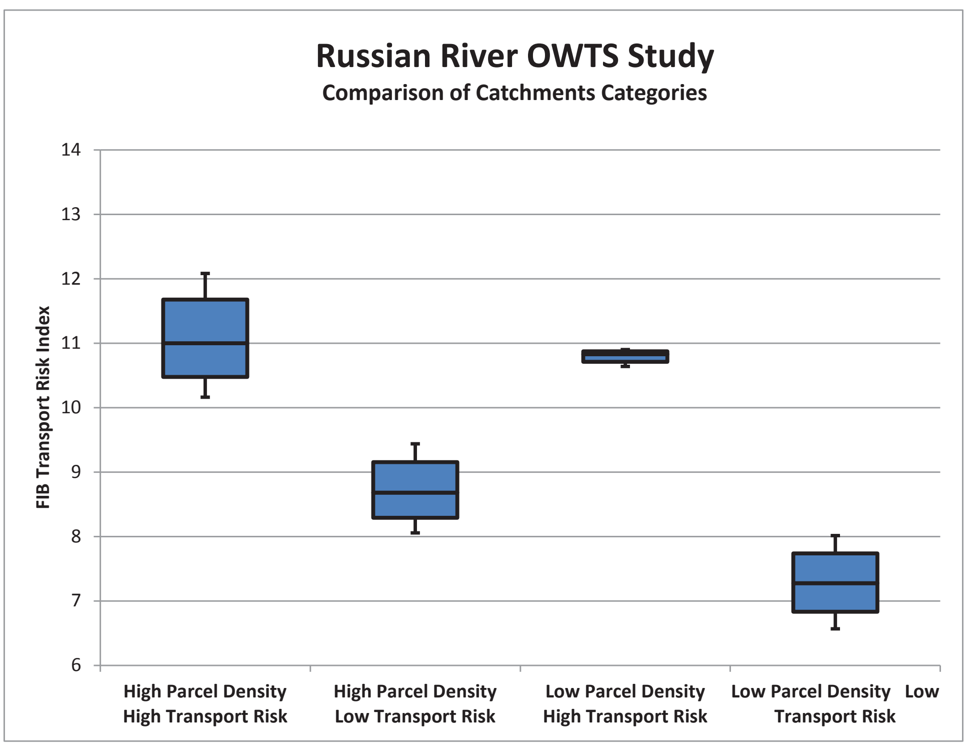

Figure 4. Comparison of the transport risk index between catchment categories

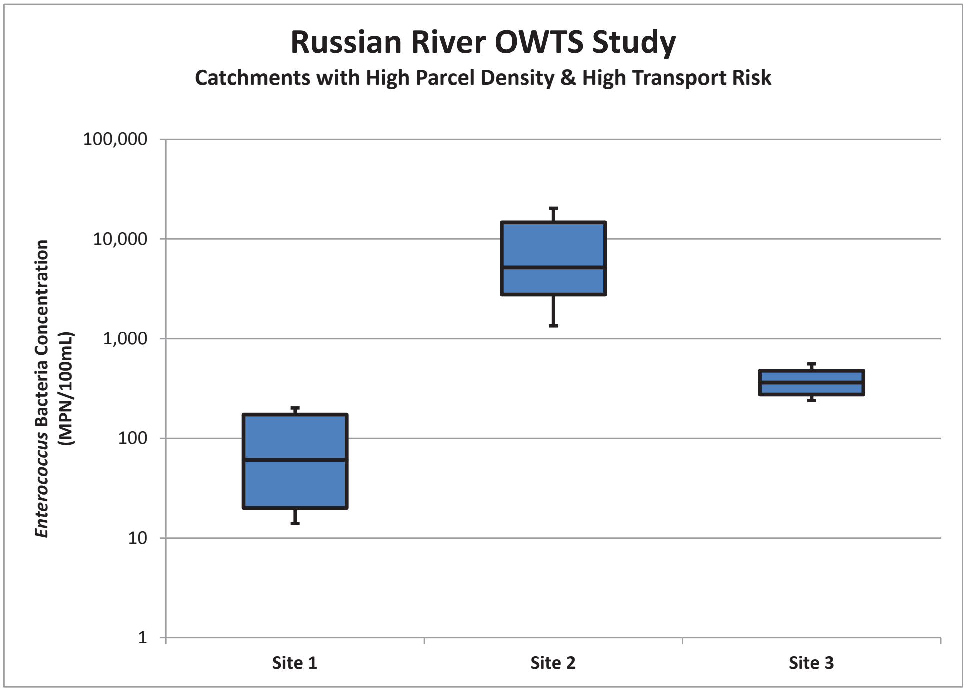

Figure 5. Comparison of *Enterococcus* bacteria concentrations from catchments with a high parcel density and a high FIB transport risk

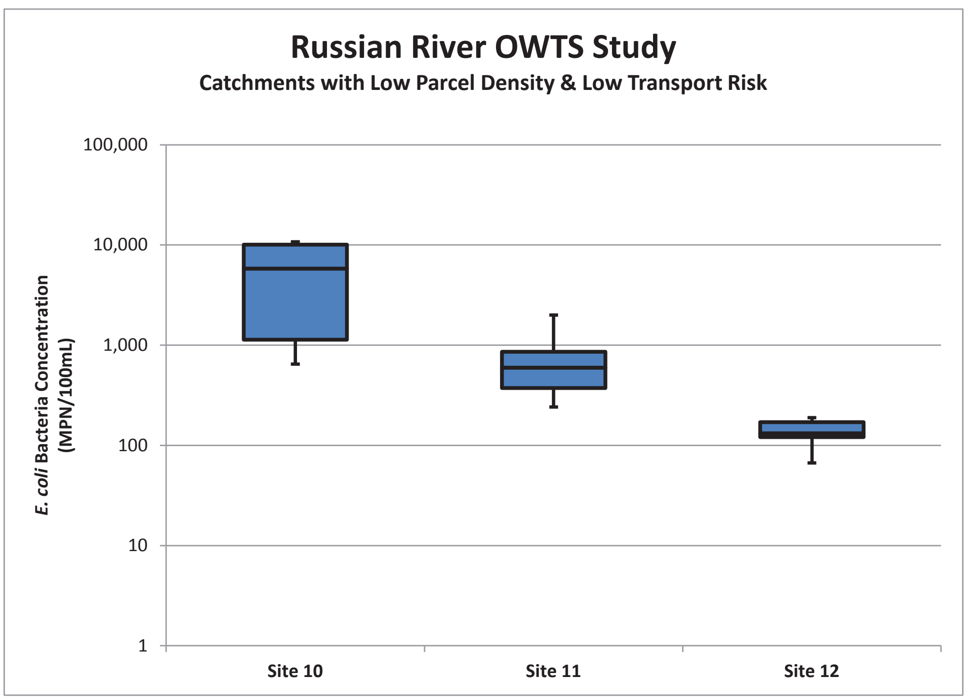

Figure 6. Comparison of *E. coli* bacteria concentrations from catchments with a low parcel density and a low FIB transport risk

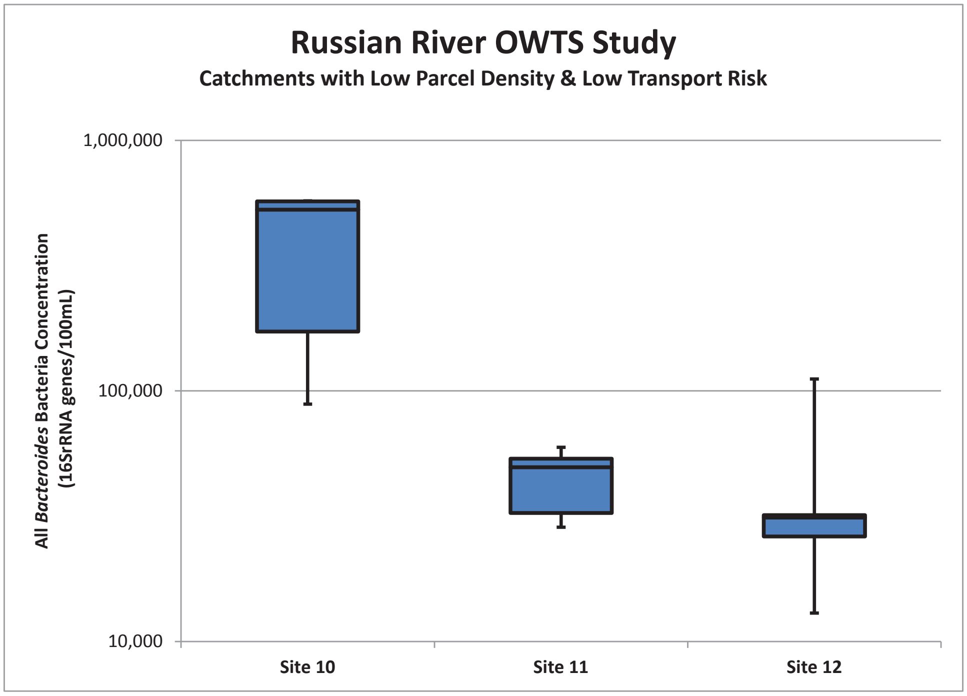

Figure 7. Comparison of All *Bacteroides* bacteria concentrations from catchments with a low parcel density and a low FIB transport risk

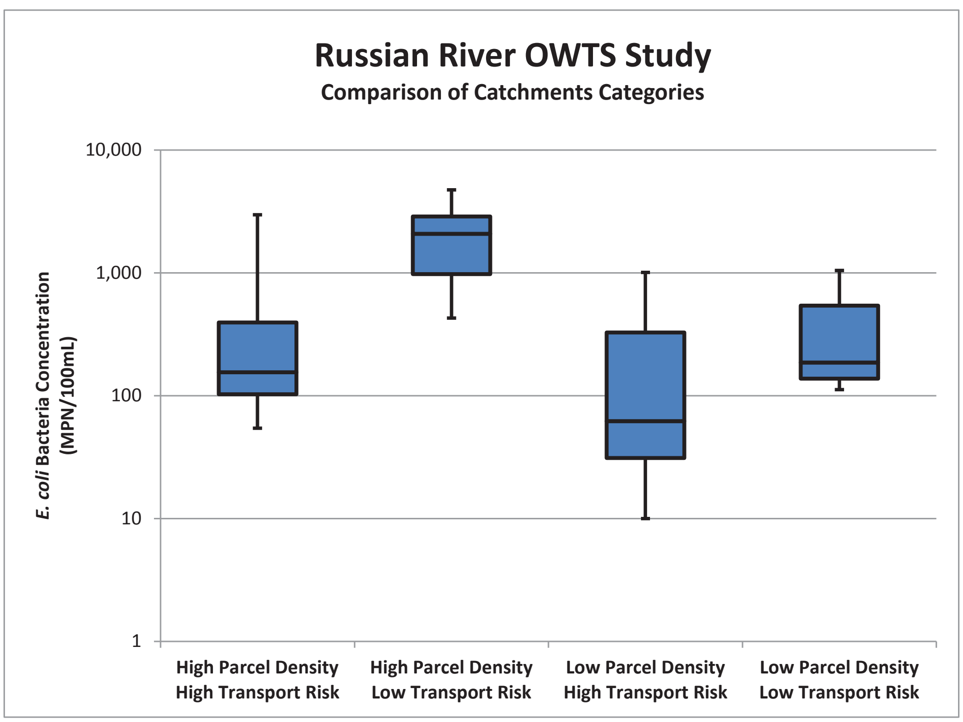

Figure 8. Comparison of *E. coli* bacteria concentrations between catchment categories

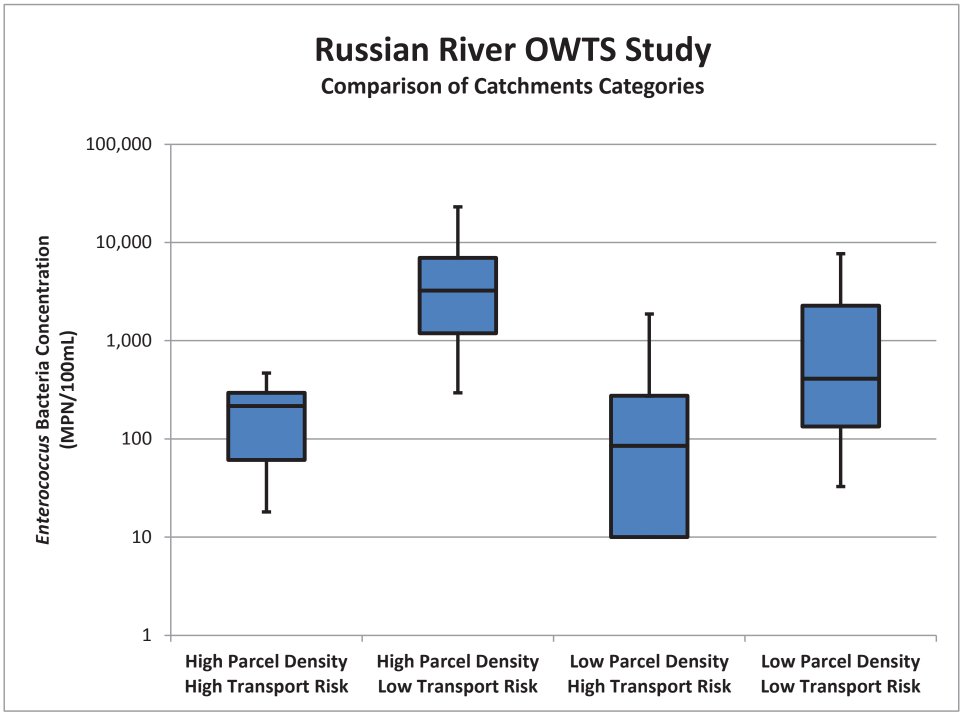

Figure 9. Comparison of *Enterococcus* bacteria concentrations between catchment categories

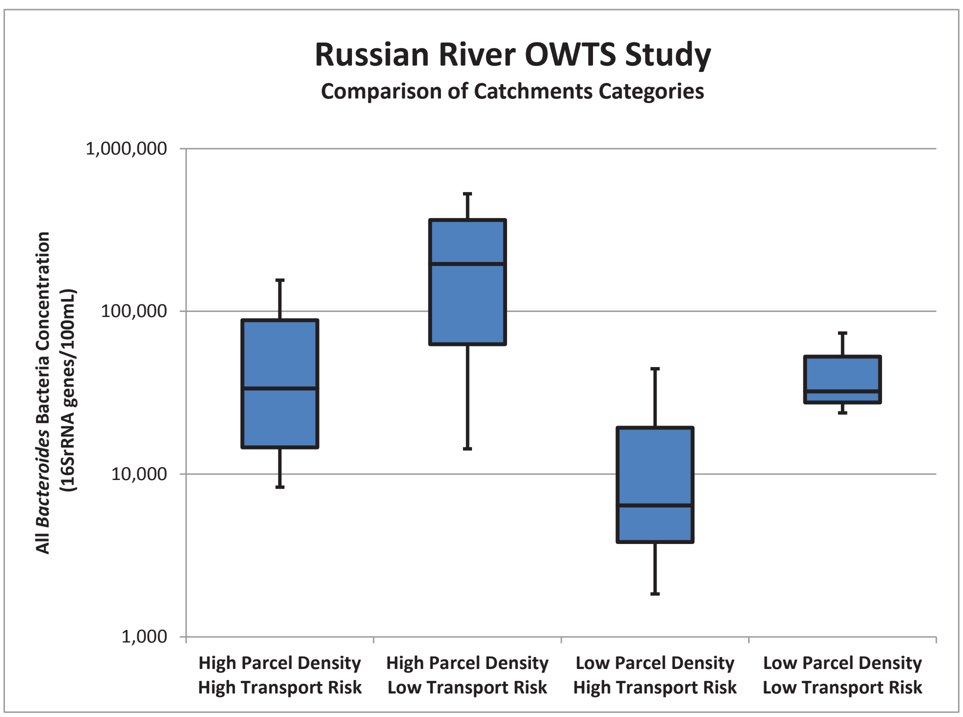

Figure 10. Comparison of All *Bacteroides* bacteria concentrations between catchment categories

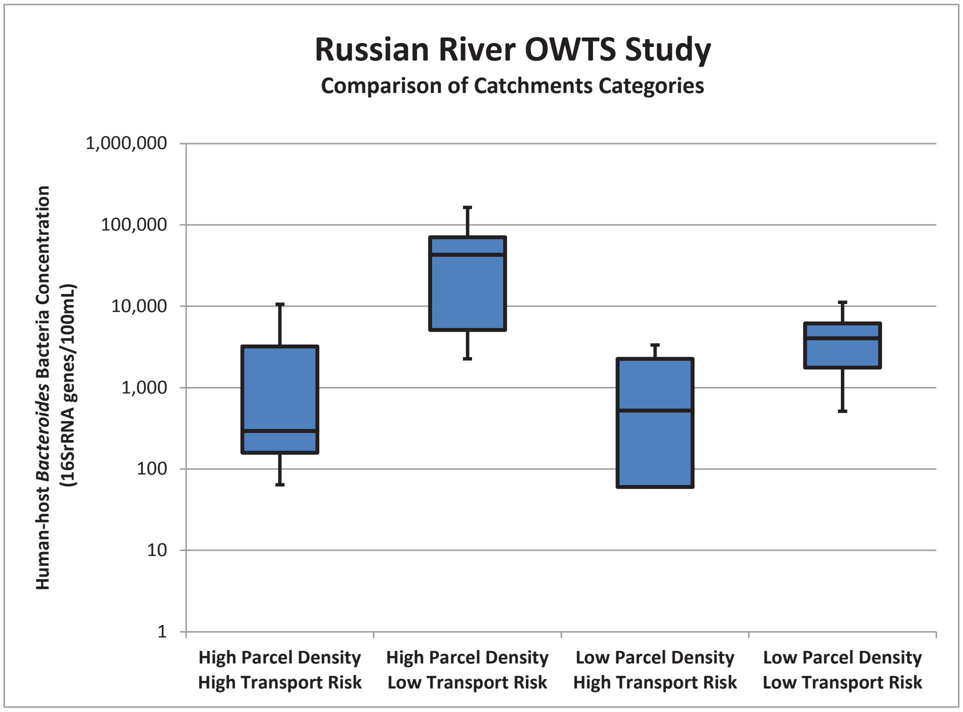

Figure 11. Comparison of Human-host *Bacteroides* bacteria concentrations between catchment categories

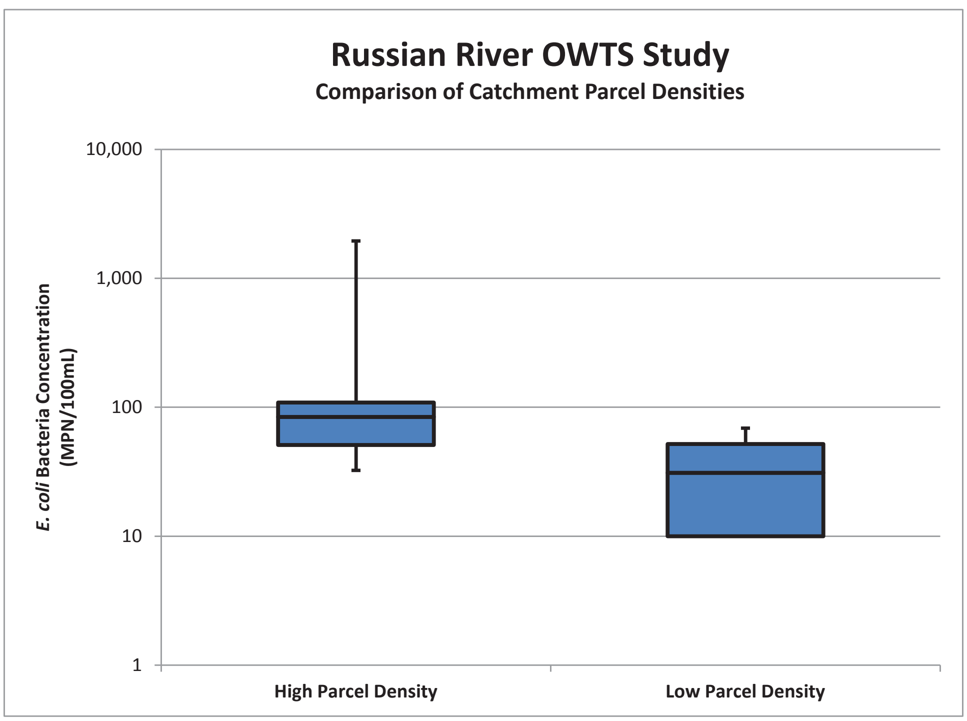

Figure 12. Comparison of *E. coli* bacteria concentrations based on catchment parcel density.

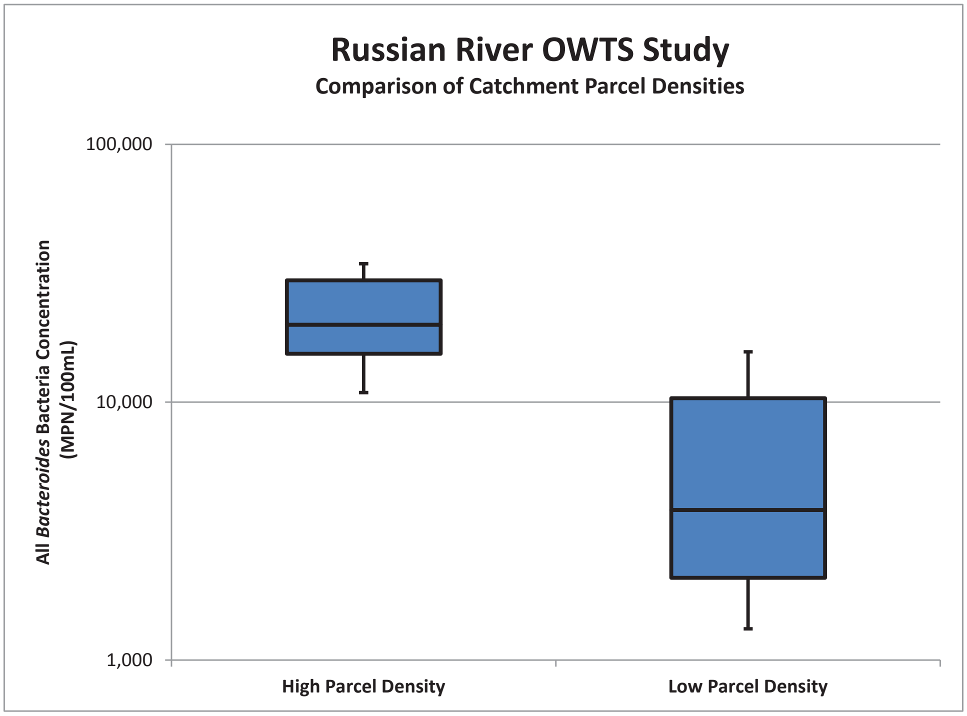

Figure 13. Comparison of All *Bacteroides* bacteria concentrations based on catchment parcel density.

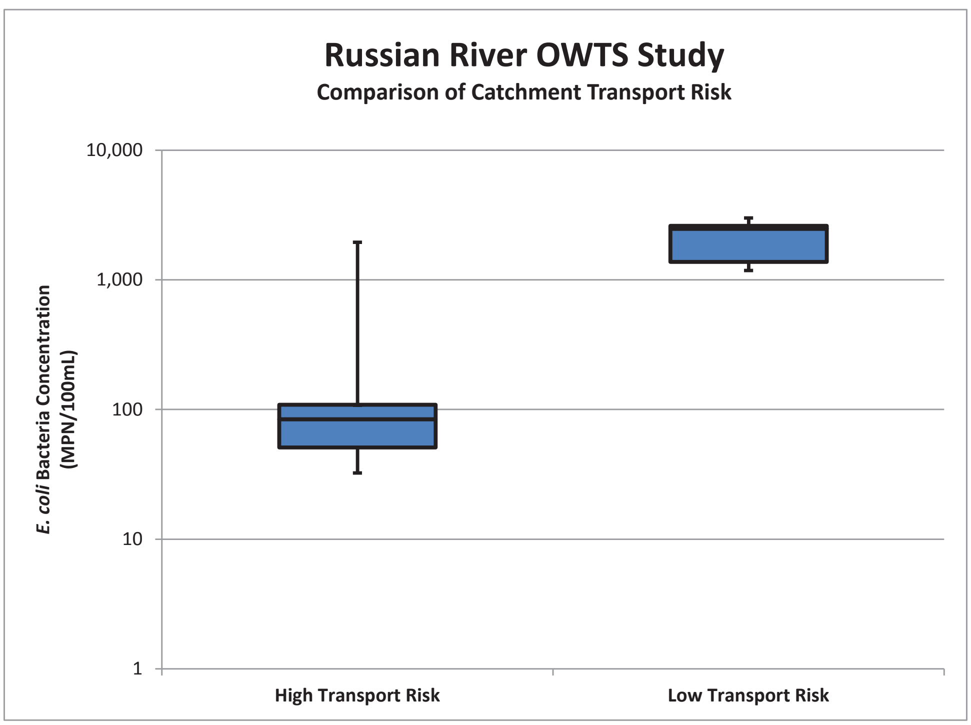

Figure 14. Comparison of *E. coli* bacteria concentrations based on catchment FIB transport risk.

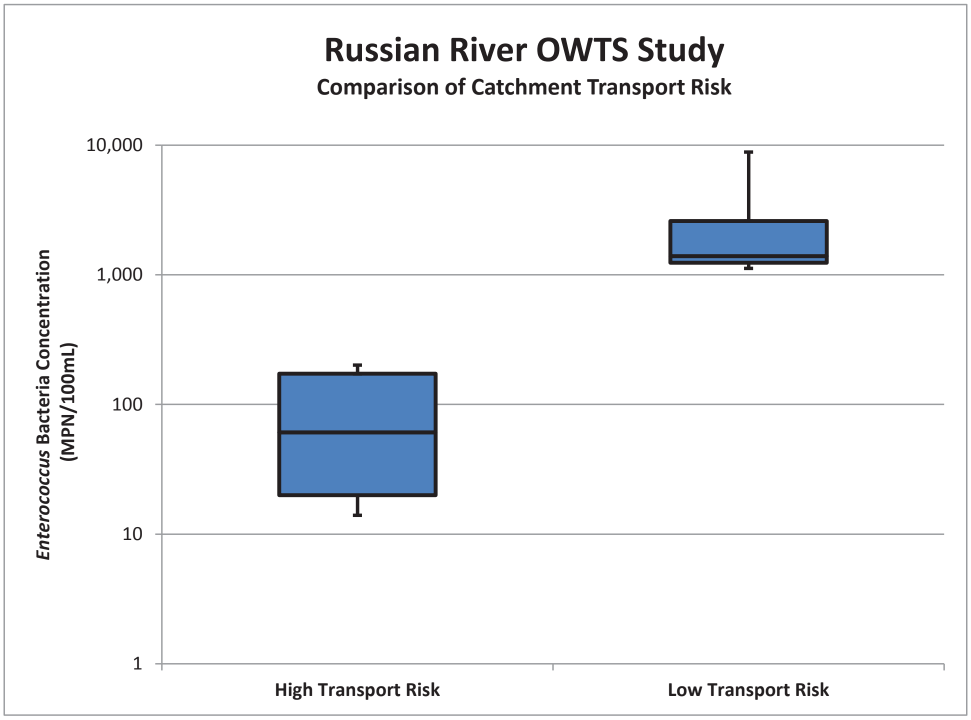

Figure 15. Comparison of *Enterococcus* bacteria concentrations based on catchment FIB transport risk.

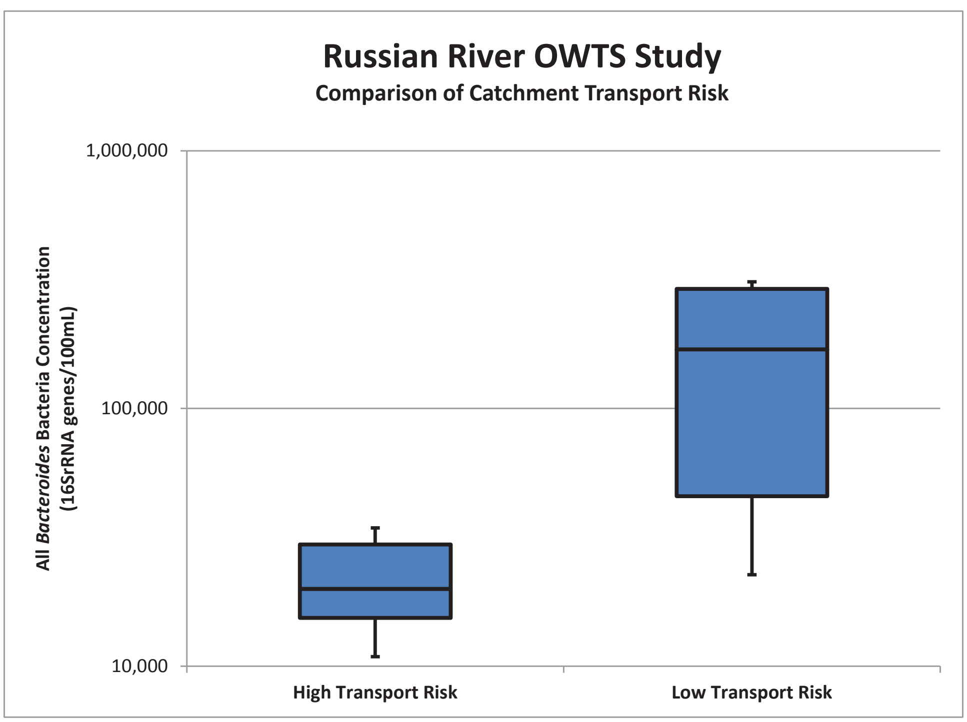

Figure 16. Comparison of All *Bacteroides* bacteria concentrations based on catchment FIB transport risk.

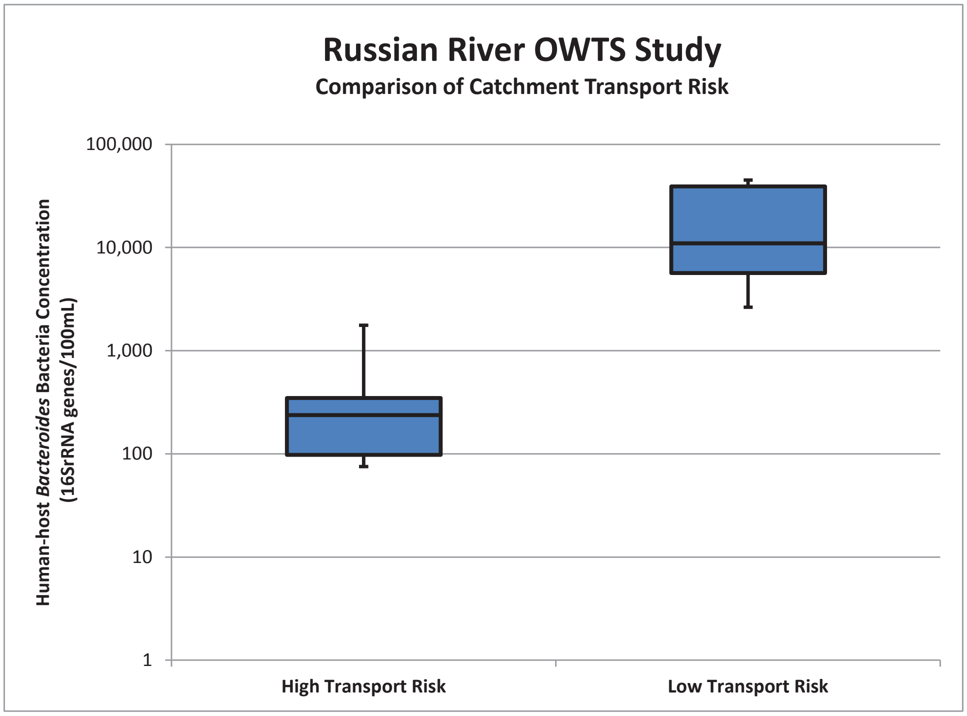

Figure 17. Comparison of Human-host *Bacteroides* bacteria concentrations based on catchment FIB transport risk.

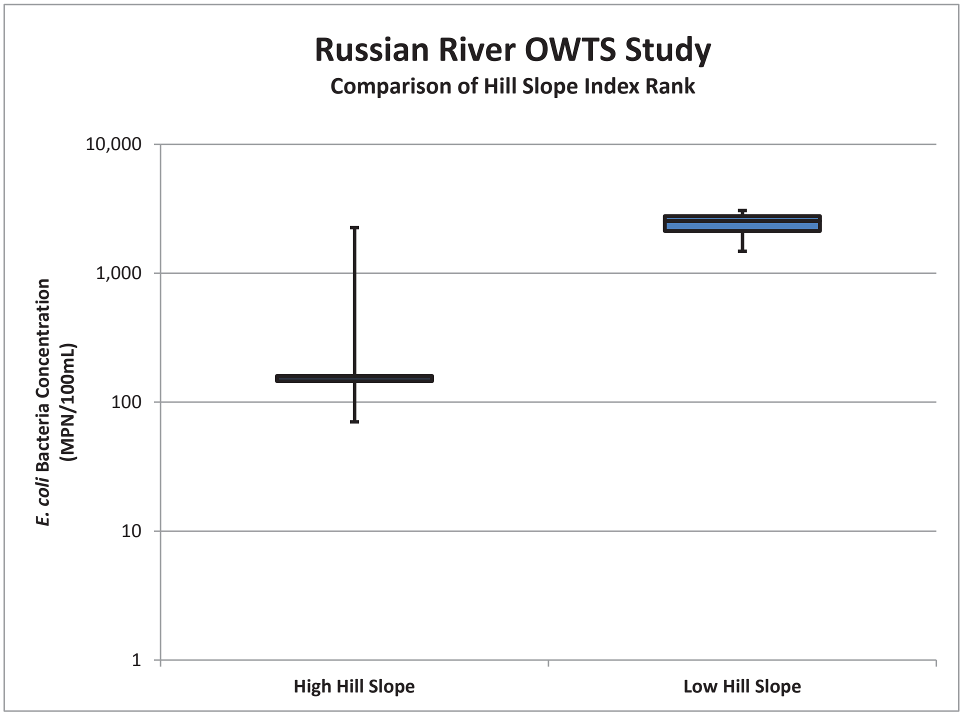

Figure 18. Comparison of *E. coli* bacteria concentrations based on catchment hill slope index rank.

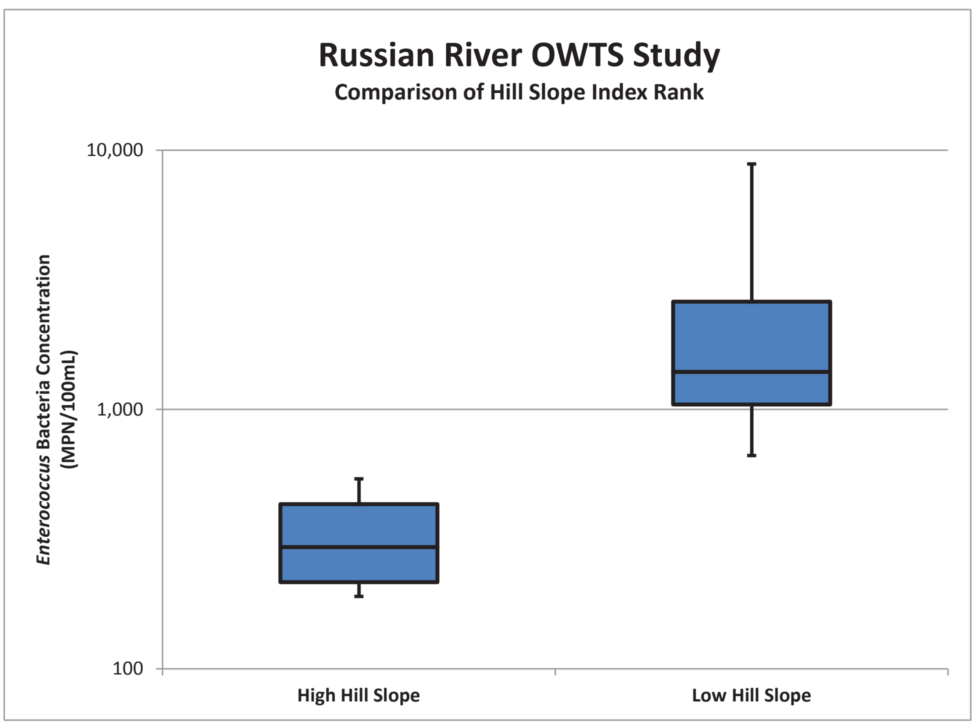

Figure 19. Comparison of *Enterococcus* bacteria concentrations based on catchment hill slope index rank.

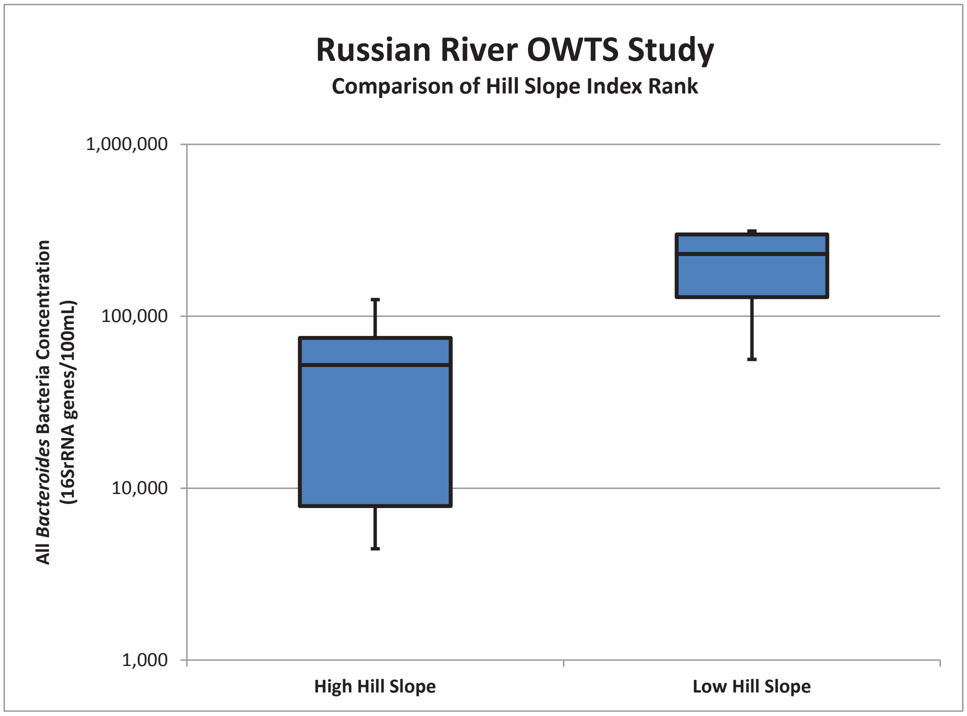

Figure 20. Comparison of All *Bacteroides* bacteria concentrations based on catchment hill slope index rank.

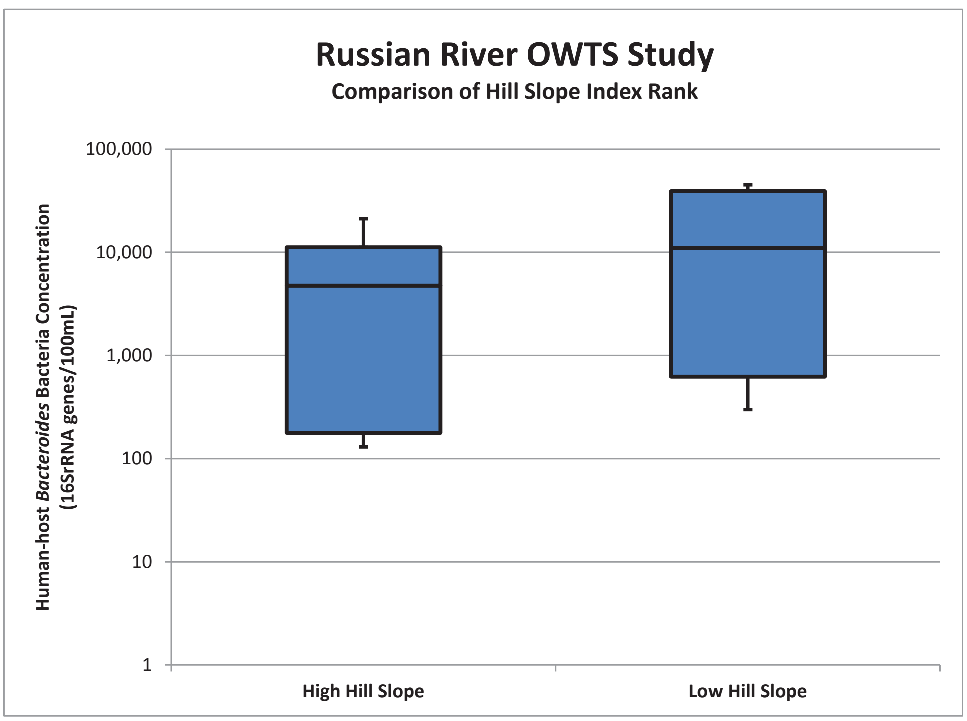

Figure 21. Comparison of Human-host *Bacteroides* bacteria concentrations based on catchment hill slope index rank

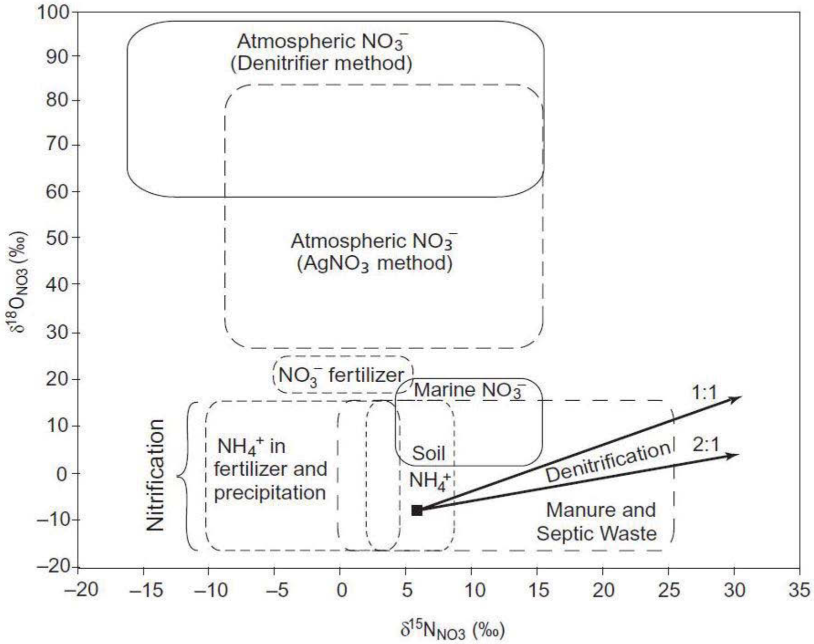

Figure 22. Typical values of the Stable Isotopes of oxygen ($\delta^{18}O$) and nitrogen ($\delta^{15}N$) of nitrate derived from various sources (diagram from Michener and Lajtha, 2007).

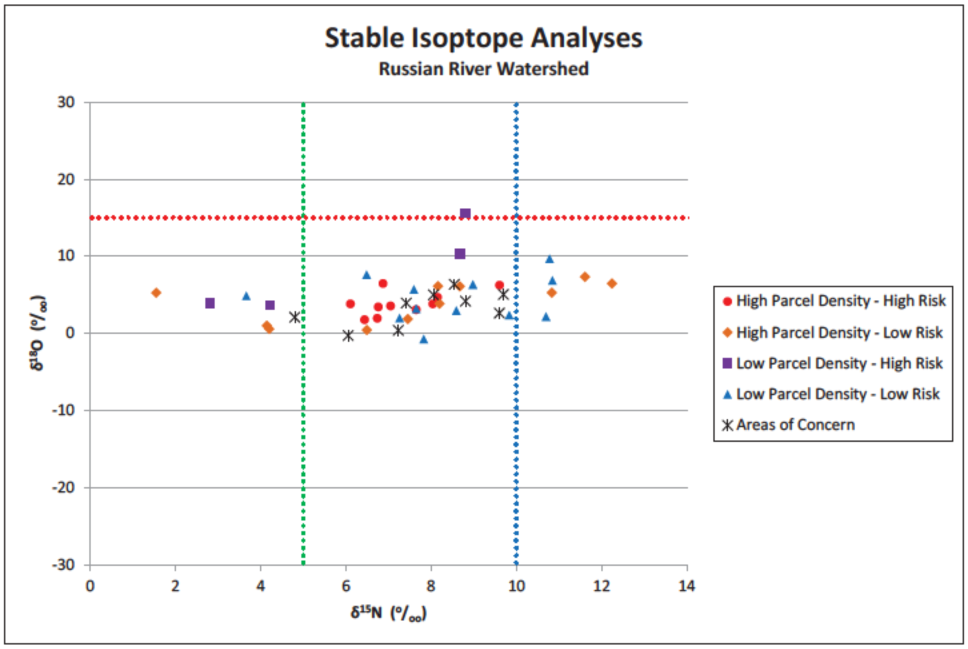

Figure 23. Comparison of the stable isotopes of nitrogen based on catchment category

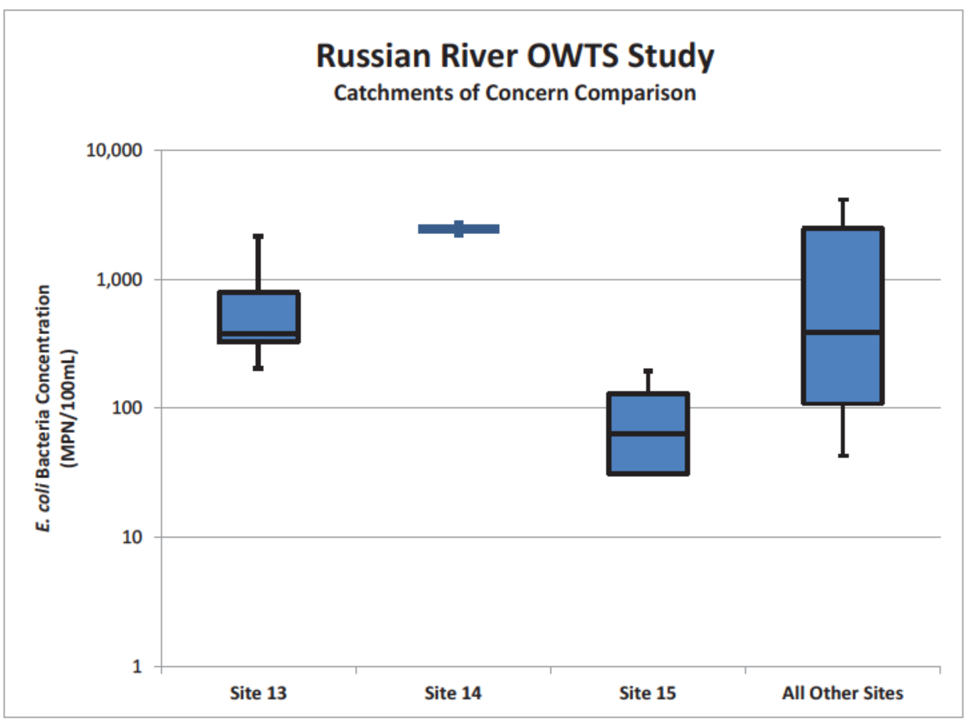

Figure 24. Comparison of *E. coli* bacteria concentrations from the catchments of concern

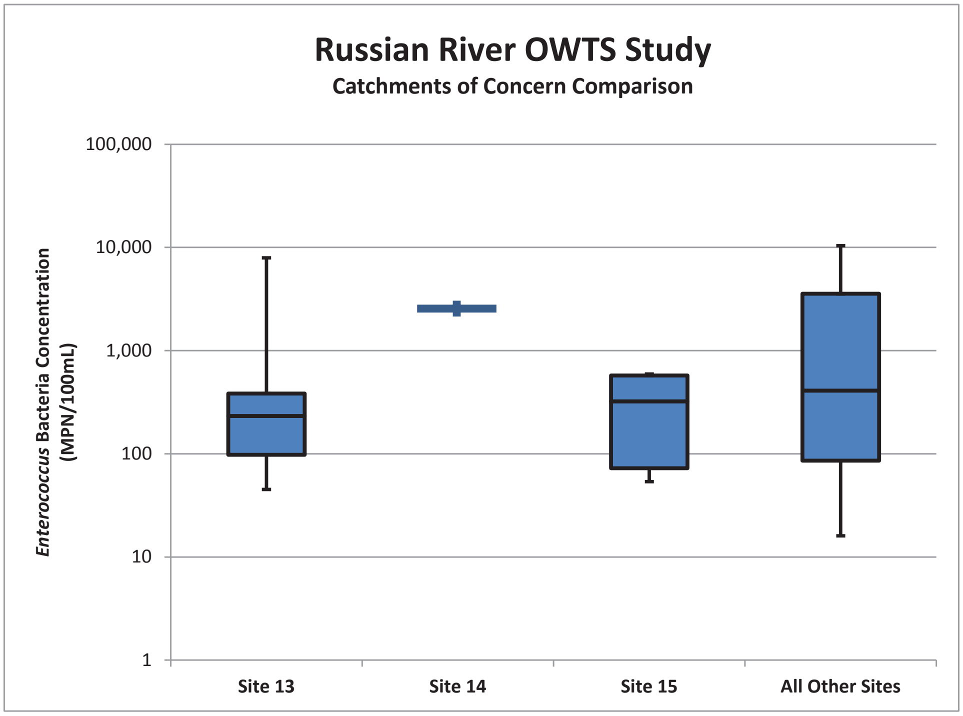

Figure 25. Comparison of *Enterococcus* bacteria concentrations from the catchments of concern

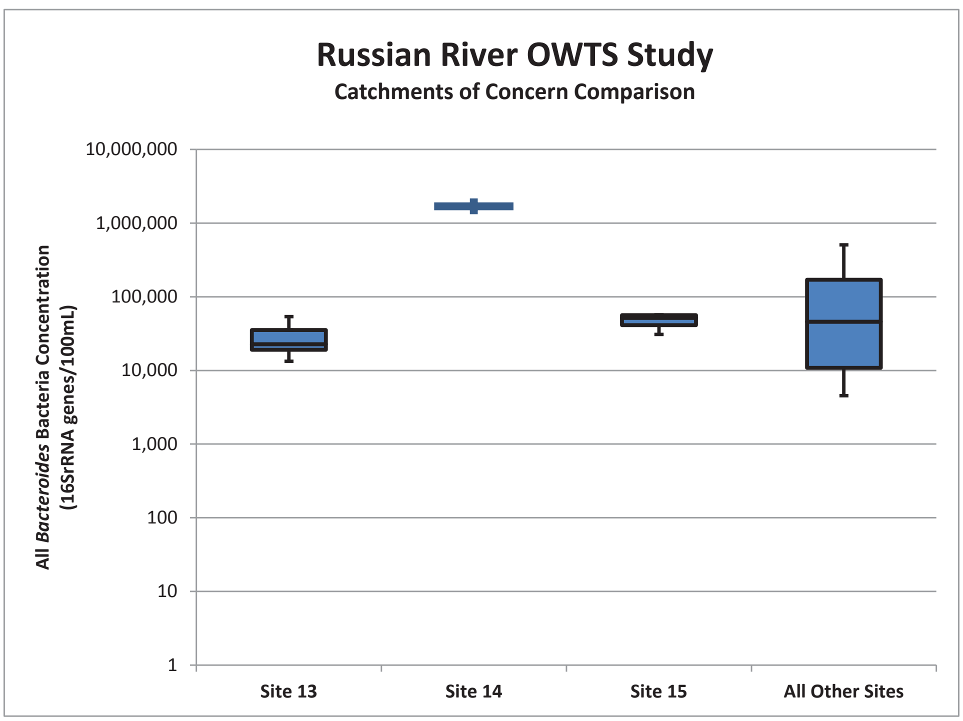

Figure 26. Comparison of All *Bacteroides* bacteria concentrations from the catchments of concern

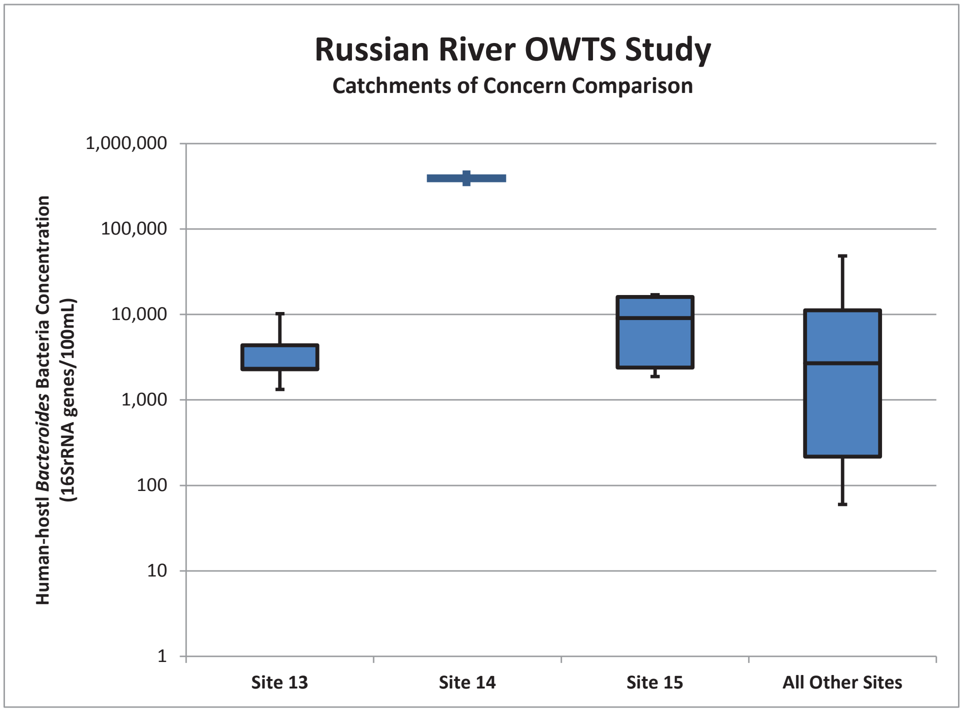

Figure 27. Comparison of Human-host *Bacteroides* bacteria concentrations from the catchments of concern

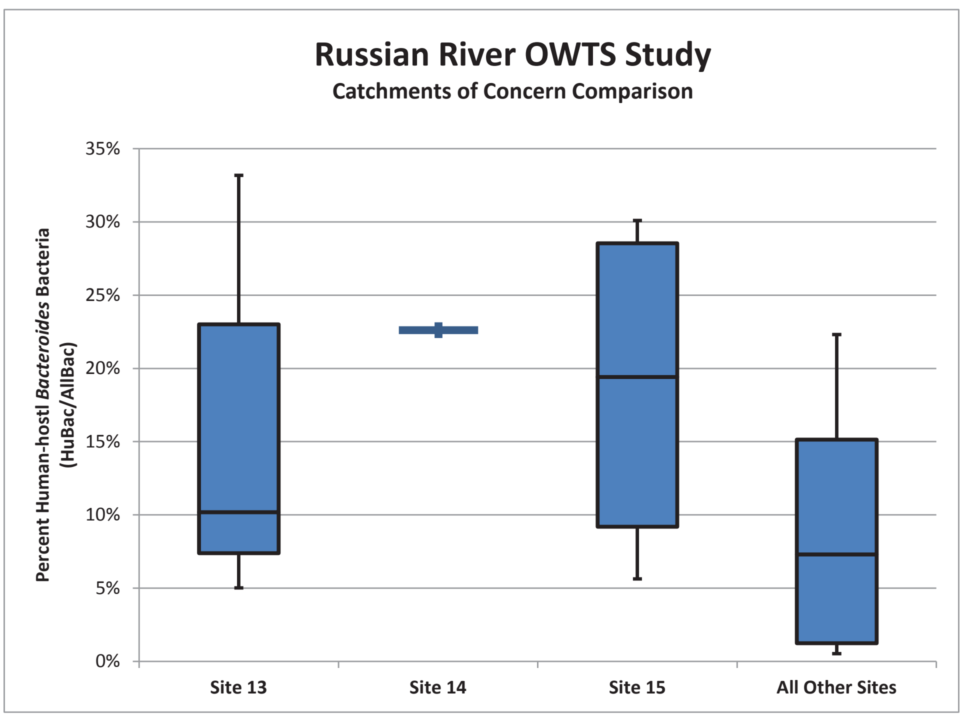

Figure 28. Comparison of the percent of Human-host *Bacteroides* bacteria concentrations from the catchments of concern.

APPENDIX C
EFFECT OF RUSSIAN RIVER DRY SEASON STREAM FLOW MANAGEMENT ON E.COLI BACTERIA CONCENTRATIONS

The Sonoma County Water Agency (Water Agency) is the primary supplier of wholesale drinking water to municipalities and water districts in Sonoma and Marin Counties. The Water Agency controls and coordinates water supply releases from the Coyote Valley Dam and Warm Springs Dam projects in accordance with minimum instream flow requirements specified by the State Water Resources Control Board (State Water Board). These minimum instream flow requirements vary based on water supply conditions. This memorandum evaluates the relationship between measured *E. coli* bacteria concentrations and the management of dry season instream flows in the Russian River.

The State Water Board adopted Decision 1610 on April 17, 1986 that specifies minimum instream flow requirements for the Russian River and Dry Creek. Decision 1610 requires a minimum flow of 25 cubic feet per second (cfs) in the East Fork of the Russian River from Coyote Valley Dam to the confluence with the West Fork of the Russian River under all water supply conditions. From this location to Dry Creek, the Decision 1610 requires minimum Russian River instream flows of 185 cfs from April through August and 150 cfs from September through March during *Normal* water supply condition. Several different minimum instream flow requirements are specified during different water years depending on the combined water storage in Lake Pillsbury and Lake Mendocino.

In addition to being the primary source of drinking water for Sonoma County, the Russian River provides habitat for three salmonid species that are listed as threatened or endangered species under the Federal Endangered Species Act: coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and Chinook salmon (*Oncorhynchus tshawytscha*). Coho salmon is also listed as endangered under the California Endangered Species Act. In September 2008, the National Marine Fisheries Service (NMFS) issued the Russian River Biological Opinion (Biological Opinion) regarding the impacts of the water Agency and U.S. Army Corps of Engineer's water supply and flood control operations in the Russian River Watershed on the survival of these listed fish species (NMFS 2005).

NMFS (2005) concluded that the minimum instream flows required by Decision 1610 are too high for optimal juvenile salmonid habitat in the Upper Russian River and Dry Creek. In addition, NMFS (2005) concluded that the historical practice of breaching the sandbar that builds up and frequently closes the mouth of the Russian River during the summer and fall may adversely affect the listed species. To address these issues, NMFS's Biological Opinion requires the Water Agency and Corps to implement a series of actions to modify existing water supply and flood control activities that are intended to minimize impacts to listed salmon species.

The Biological Opinion requires the Water Agency to request that the minimum flow requirements be changed to the following during *Dry* water supply conditions:

- 70 cfs between May 1 and October 15 at the U.S. Geological Survey (USGS) Gage No. 11467000 (near Guerneville)
- 125 cfs between May 1 and October 15 at the USGS Gage No. 11464000 (near Healdsburg)

Since 2002, the Water Agency has requested several temporary changes to the Decision 1610 minimum instream flow requirements from the State Water Board. The Water Agency filed Temporary Urgency Change Petitions (TUCP) in 2002, 2004, 2007 and 2009 to request reductions in Russian River instream flows to address low storage levels in Lake Mendocino. TUCPs filed from 2010 through 2014 were required by the Biological Opinion to reduce instream flow conditions to improve habitat for the threatened and endangered fish species.

Since 2001, the Regional Water Quality Control Board (Regional Water Board) and the Water Agency have collected water samples to measure *E. coli* bacteria concentrations at several locations in the Russian River to assess impairment to recreational uses. These measured bacteria concentrations were compared to instream flow measurements from the Russian River on the same day. *E. coli* bacteria concentration measurements from Camp Rose Beach and Veteran's Memorial Beach were compared to daily mean stream flows measured near Healdsburg (USGS Gage No 11464000). *E. coli* bacteria concentration measurements from Steelhead Beach, Johnson's Beach and Monte Rio Beach were compared to daily mean stream flows measured near Guerneville (USGS Gage No 11467000).

Correlation between Bacteria Concentration and Stream Flow

E. coli bacteria concentrations in the Russian River were compared to stream flow measurements using Pearson's correlation coefficient. The correlation coefficient is derived by dividing the covariance of two variables by the product of their standard deviations. The correlation coefficient is +1 for a perfect increasing linear relationship and −1 for a perfect decreasing linear relationship. Correlation coefficients between −1 and 1 indicate the degree of linear dependence between the variables. Correlation coefficients closer to zero indicate there is less of a relationship between the variables.

A valid Pearson's correlation coefficient requires that the population distribution follow a linear normal data distribution. Data were log-transformed prior to deriving the coefficient since both stream flow and *E. coli* bacteria concentration data distributions followed a log-normal distribution. A correlation coefficient was considered statistically significant when the resulting probability of rejecting the null hypothesis was equal or lower than 0.05.

Table 1 presents the Pearson's correlation coefficients and associated probabilities of *E. coli* bacteria concentrations compared to daily mean stream flows in the Russian River. None of the Russian River locations evaluated showed any statistically significant correlation between *E. coli* bacteria concentrations and daily mean stream flows. The lack of a correlation can be observed in Figures 1-5 that show a visual comparison between the variables. No relationship between *E. coli* bacteria concentrations and daily mean stream flows is apparent at any of the Russian River locations.

Table 1. Pearson's correlation coefficients of *E. coli* bacteria concentrations and daily mean stream flows

Variables		Pearson's correlation coefficient	Probability
E. coli Bacteria Concentration at Camp Rose Beach	Daily Mean Stream Flow near Healdsburg	-0.009	0.904
E. coli Bacteria Concentration at Veteran's Memorial Beach	Daily Mean Stream Flow near Healdsburg	0.079	0.268
E. coli Bacteria Concentration at Steelhead Beach	Daily Mean Stream Flow near Guerneville	0.173	0.017
E. coli Bacteria Concentration at Johnson's Beach	Daily Mean Stream Flow near Guerneville	0.037	0.604
E. coli Bacteria Concentration at Monte Rio Beach	Daily Mean Stream Flow near Guerneville	0.065	0.335

Evaluation of Reduced Stream Flows on Bacteria Concentrations

Statistical hypothesis tests were made between the measured E. coli bacteria concentrations and different management scenarios of Russian River stream flows. E. coli bacteria concentrations collected during years of reduced stream flow (i.e., years with a TUCP) were compared to E. coli bacteria concentrations collected during years without reduced stream flow (i.e., years without a TUCP).

The Mann-Whitney U statistical hypothesis test was applied to assess the difference between the distributions of E. coli bacteria concentrations and daily mean Russian River stream flows during years with and without a TUCP. The Mann-Whitney U Test is a non-parametric test for assessing whether two samples of observations come from the same distribution (Helsel and Hirsch 2002). The test is similar to performing an ordinary parametric two-sample t test, but is based on ranking the data set. This statistical test is a nonparametric (i.e., distribution-free) inferential statistical method. The test makes no assumption of the frequency distributions. Nonparametric methods are the most appropriate approach for assessing water quality data which can have widely varying frequency distributions. Hypothesis tests were considered statistically significantly different if the resulting probability of rejecting the null hypothesis was equal or lower than 0.05.

Table 2 presents the associated probabilities of the Mann-Whitney U statistical hypothesis tests evaluating *E. coli* bacteria concentrations and daily mean stream flows in the Russian River. Stream flows showed a statistically significant difference between years with a TUCP and years without a TUCP. Most of the Russian River locations evaluated showed no statistically significant difference in *E. coli* bacteria concentrations from reduced stream flows due to the TUCPs. However, *E. coli* bacteria concentrations at Monte Rio Beach did show a difference. The distribution of *E. coli* bacteria concentrations during reduced stream flows were significantly lower that during stream flow years with no TUCP.

Table 2. Associated Probabilities of the Mann-Whitney U Statistical Hypothesis Tests

Variable	Russian River Location	Mann-Whitney U Probability	Statistical Difference
Daily Mean Stream Flow	USGS Gage No. 11464000 near Healdsburg	**<0.001**	**Yes**
	USGS Gage No. 11467000 near Guerneville	**<0.001**	**Yes**
E. coli Bacteria Concentration	Camp Rose Beach	0.730	No
	Veteran's Memorial Beach	0.243	No
	Steelhead Beach	0.228	No
	Johnson's Beach	0.825	No
	Monte Rio Beach	**0.047**	**Yes**

Bold Blue font indicates a statistically significant difference due to reduced stream flow management.

Distributions of the measured E. coli bacteria concentrations between reduced and normal stream flow management were compared visually using box and whisker plots (Figures 6 – 10). The boxes represent the interquartile range of the distribution around the median and the whiskers represent the 10th and 90th percentiles. The figures visually verify the results of the statistical hypothesis tests.

Figures 6 & 7 show statistically significant difference in stream flows between years with a TUCP and years without a TUCP. Figures 8 – 11 show essentially no difference in E. coli bacteria concentrations at most Russian River locations. However, Figure 12 shows significantly lower E. coli bacteria concentrations at Monte Rio Beach during reduced stream flows (with TUCP) as compared to normal stream flow years with no TUCP.

Findings

Based on the evaluation of *E. coli* bacteria concentrations and stream flows in the Russian River presented in this memorandum, Regional Water Board staff can make the following findings:

- None of the Russian River locations evaluated showed any statistically significant correlation between *E. coli* bacteria concentrations and daily mean stream flows.

- Stream flows showed a statistically significant difference between years with a TUCP and years without a TUCP.

- The Russian River at Camp Rose Beach, Veteran's Memorial Beach, Steelhead Beach, and Johnson's Beach showed no statistically significant difference in *E. coli* bacteria concentrations from reduced stream flows due to the TUCPs.

- *E. coli* bacteria concentrations at Monte Rio Beach did show a difference. The distribution of *E. coli* bacteria concentrations during reduced stream flows were significantly lower that during normal stream flow years with no TUCP.

Citations

Butkus, S. 2013. Evaluation of Fecal Indicator Bacteria Types. Memorandum dated October 9, 2013 to the File: Russian River Pathogen TMDL Development and Planning, North Coast Water Quality Control Board. Santa Rosa, CA.

Helsel, D.R. and R. M. Hirsch, 2002. Statistical Methods in Water Resources Techniques of Water Resources Investigations, Book 4, Chapter A3. U.S. Geological Survey, Reston, VA.

National Marine Fisheries Service (NMFS) 2005. Biological opinion for the U.S. Army Corps of Engineers proposed issuance of a section 404 permit to the Sonoma County Water Agency for breaching the Russian River estuary, May 20, 2005.

North Coast Regional Water Quality Control Board (NCRWQCB) 2011. Water Quality Control Plan for the North Coast Region, Santa Rosa, CA.

Figures

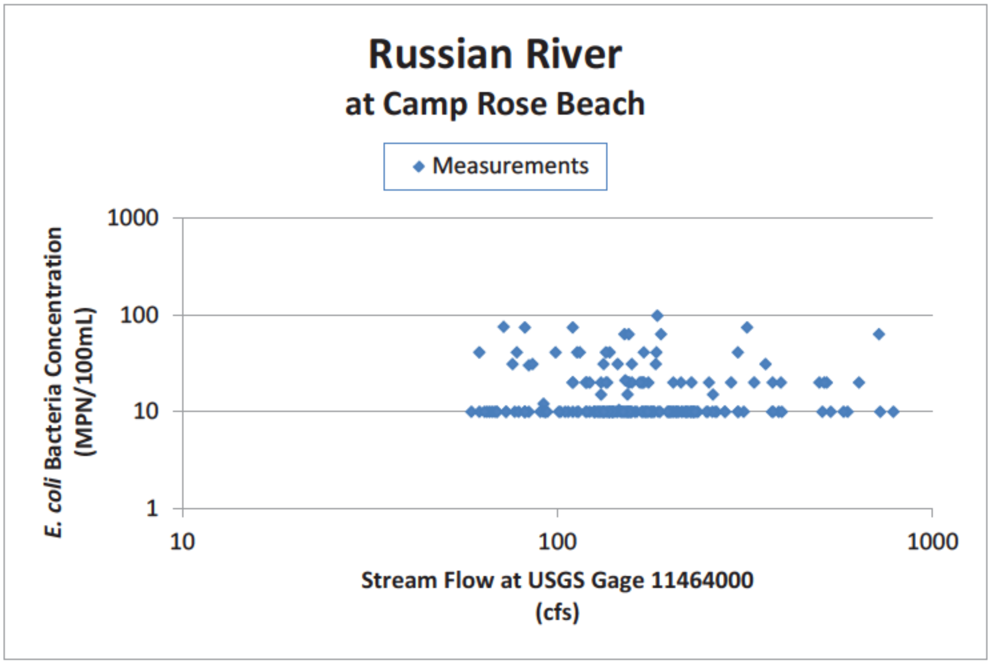

Figure 1. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Camp Rose Beach

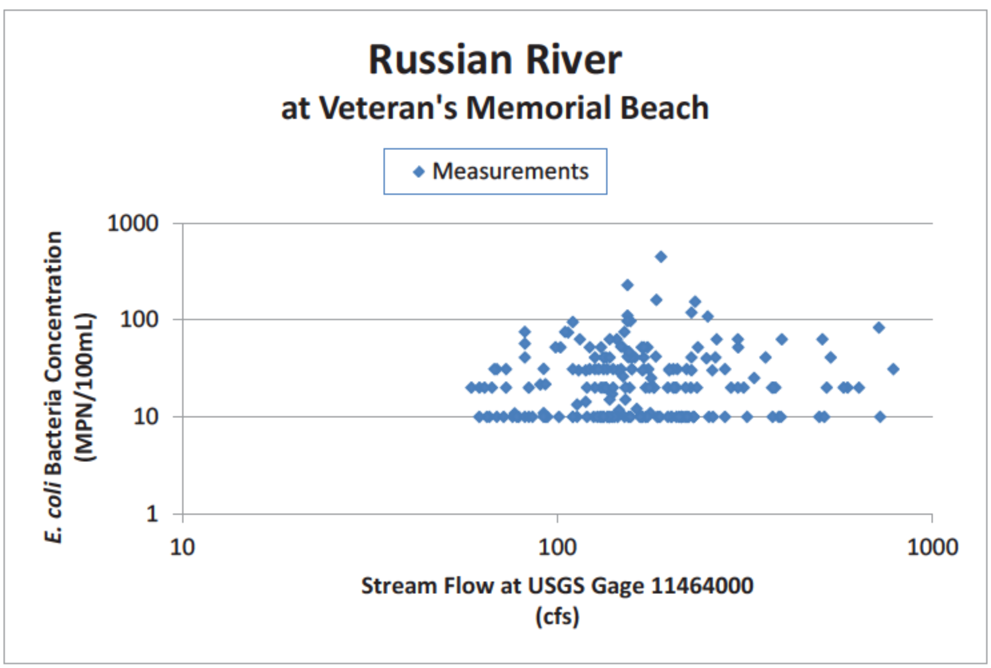

Figure 2. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Veteran's Memorial Beach

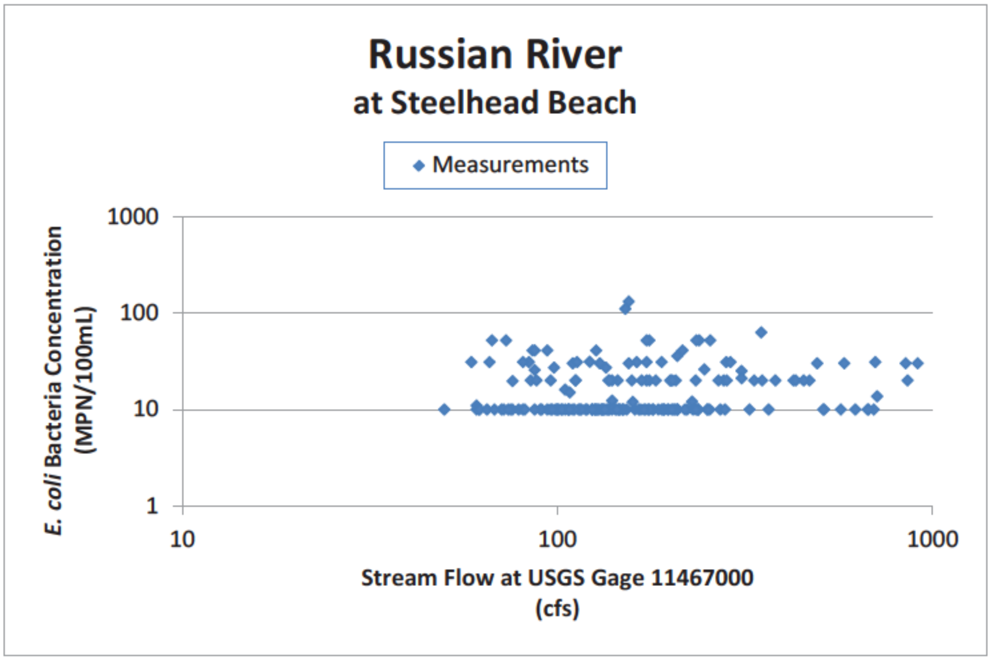

Figure 3. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Steelhead Beach

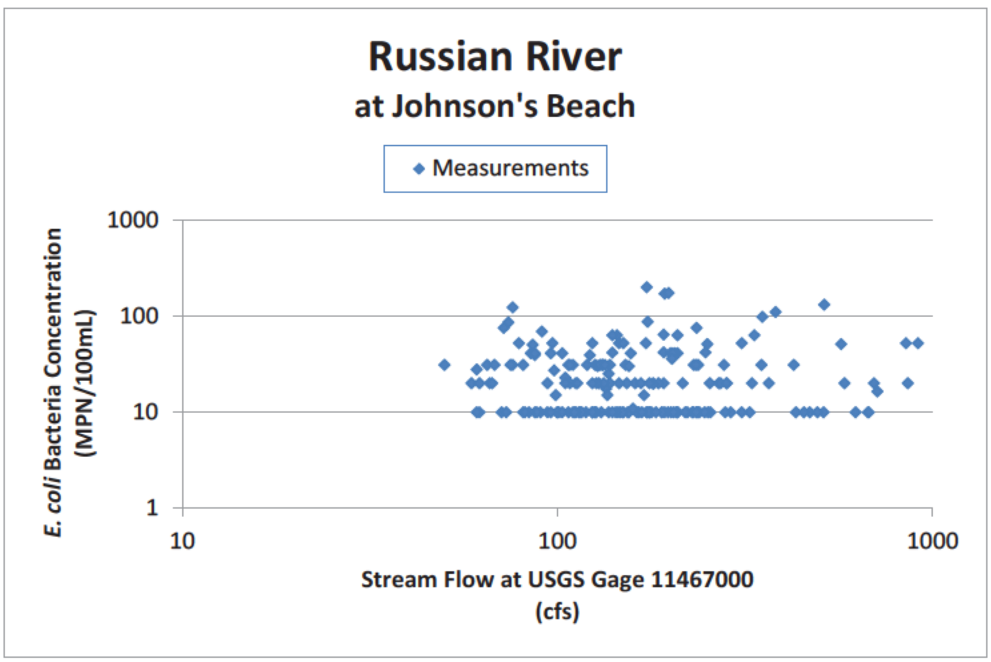

Figure 4. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Johnson's Beach

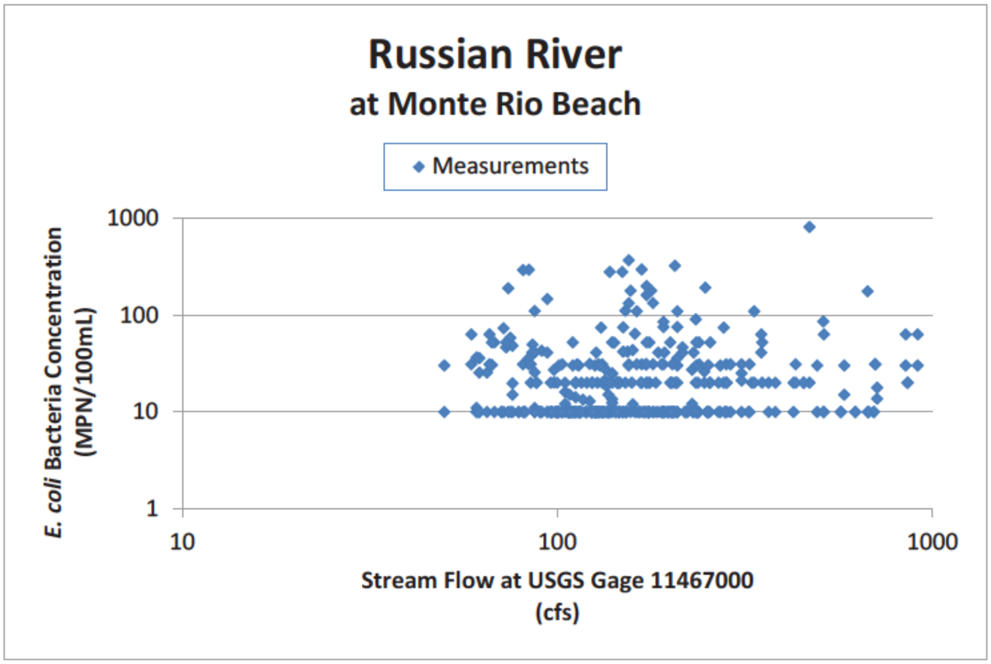

Figure 5. Correlation between E coli Bacteria Concentration and Stream Flow Measurements at Monte Rio Beach

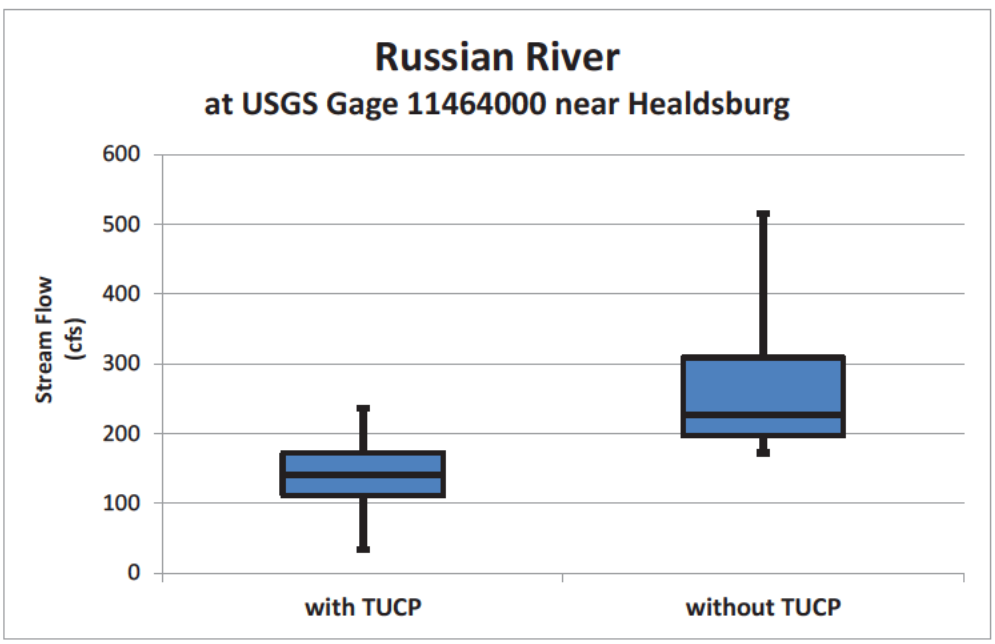

Figure 6. Comparison of Distribution of Stream Flows near Healdsburg during Years With and Without TUCP Reduced Flows

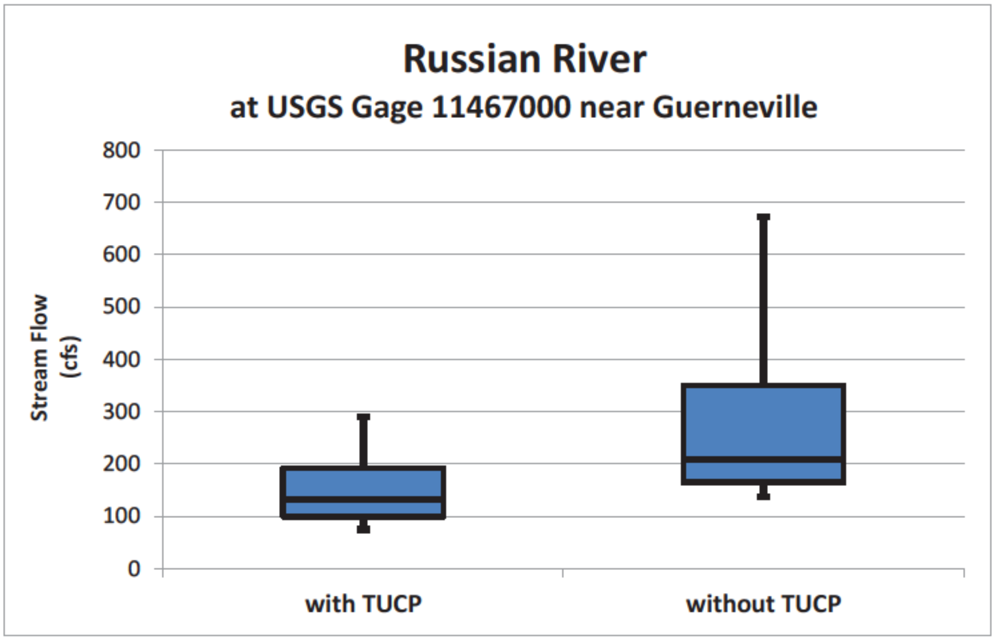

Figure 7. Comparison of Distribution of Stream Flows near Guerneville during Years With and Without TUCP Reduced Flows

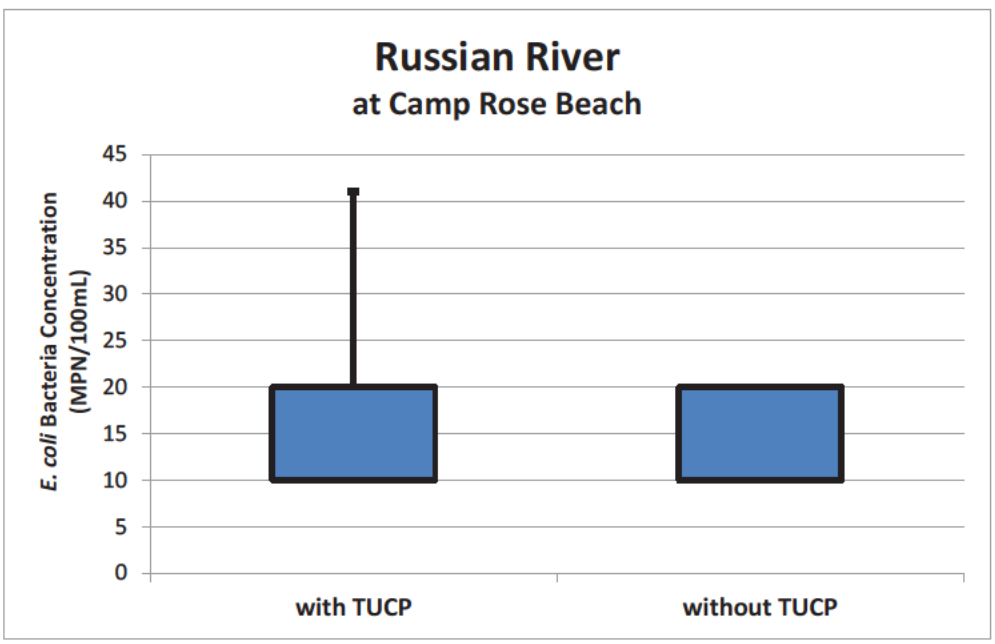

Figure 8. Comparison of Distribution of *E. coli* Bacteria Concentrations at Camp Rose Beach during Years With and Without TUCP Reduced Flows

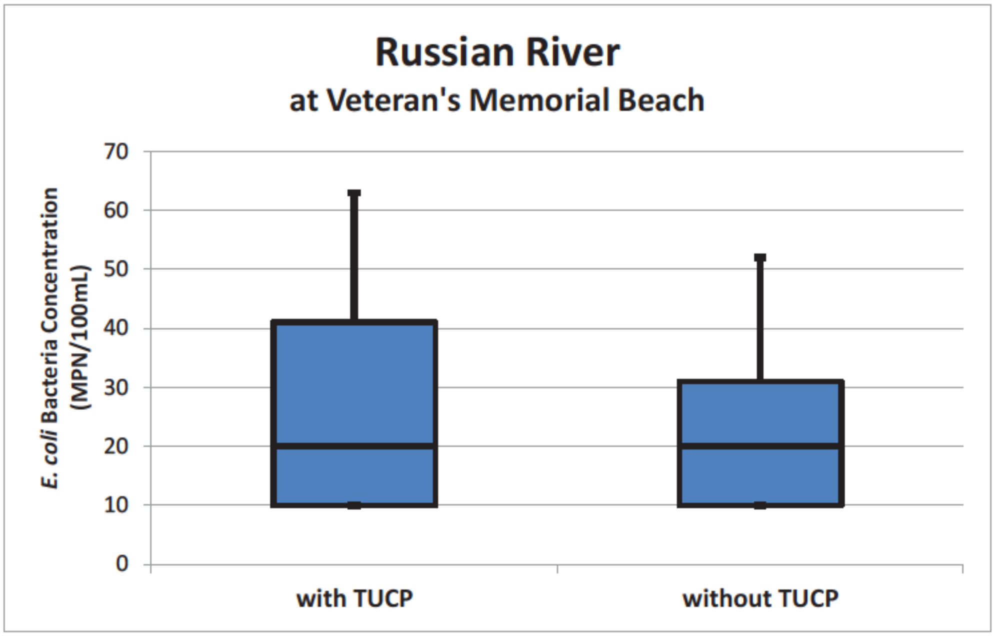

Figure 9. Comparison of Distribution of *E. coli* Bacteria Concentrations at Veteran's Memorial Beach during Years With and Without TUCP Reduced Flows

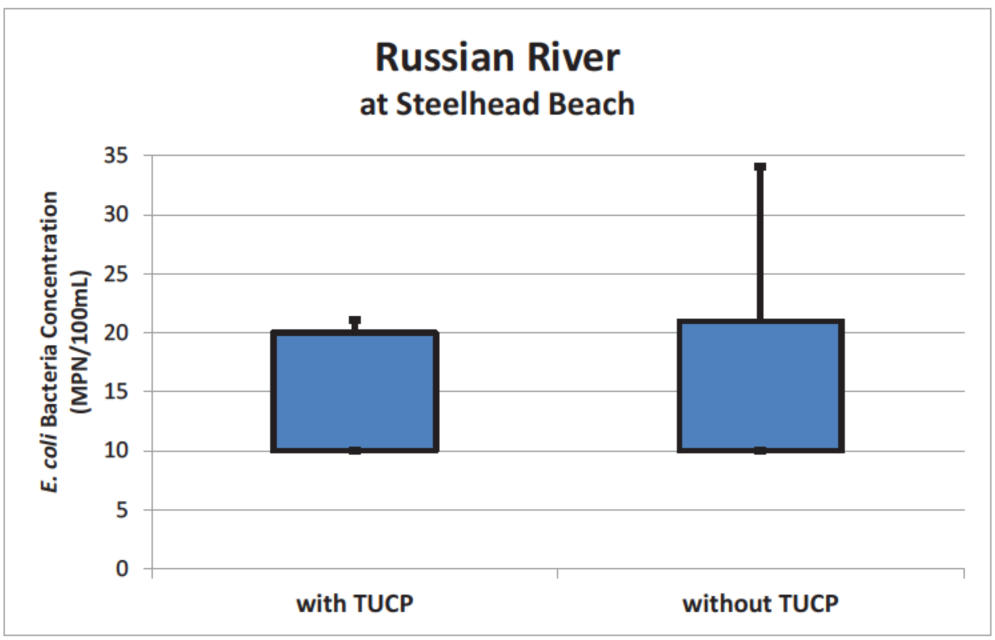

Figure 10. Comparison of Distribution of *E. coli* Bacteria Concentrations at Steelhead Beach during Years With and Without TUCP Reduced Flows

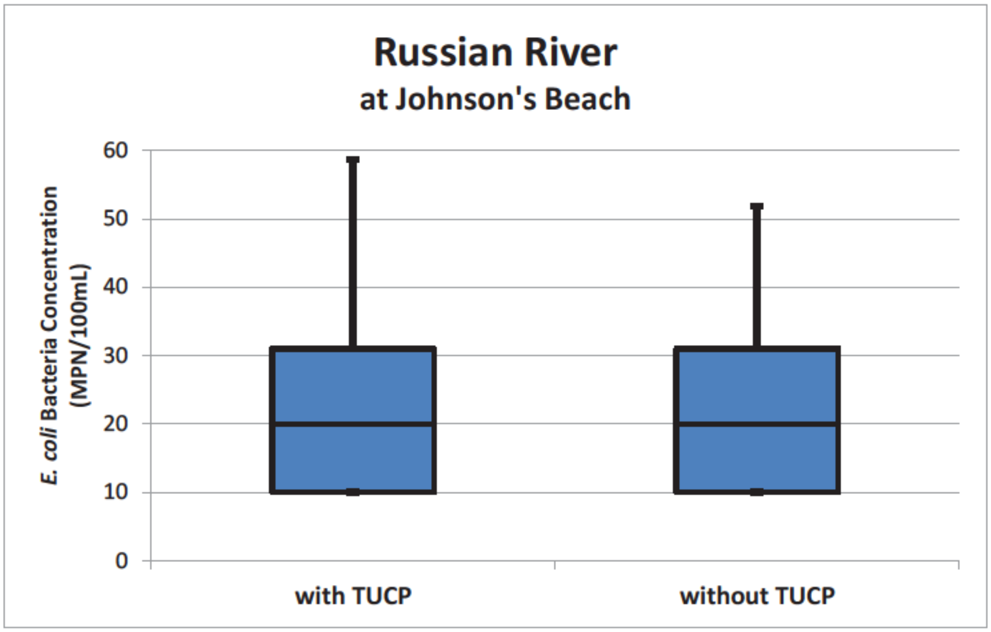

Figure 11. Comparison of Distribution of *E. coli* Bacteria Concentrations at Johnson's Beach during Years With and Without TUCP Reduced Flows

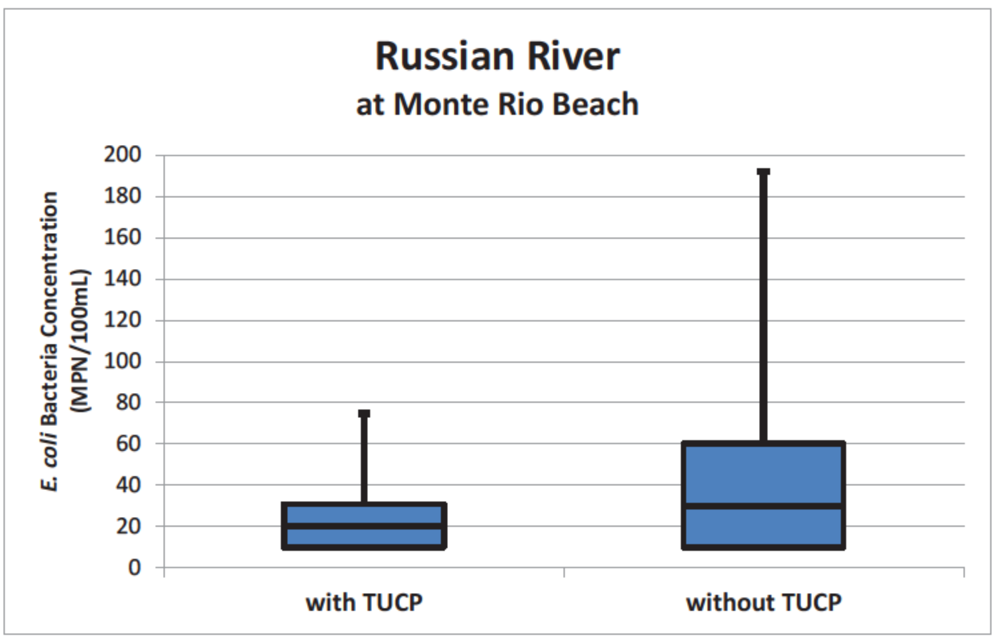

Figure 12. Comparison of Distribution of *E. coli* Bacteria Concentrations at Monte Rio Beach during Years With and Without TUCP Reduced Flows