Pathogens in Tomales Bay Watershed Total Maximum Daily Load (TMDL)

Staff Report

Farhad Ghodrati / Rebecca Tuden

California Regional Water Quality Control Board
San Francisco Bay Region
September 14, 2005; amended December 21, 2005

San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612
Phone: 510-622-2300
Fax: 510-622-2460
www.waterboards.ca.gov/sanfranciscobay/index.htm

CONTENTS

LIST OF FIGURES

LIST OF TABLES

DEFINITION OF ACRONYMS AND ABBREVIATIONS

ABAG:	Association of Bay Area Governments
APA:	Administrative Procedures Act
Basin Plan:	Water Quality Control Plan for the San Francisco Bay
BMP:	Best Management Practice
CAMMPR:	California Management Measures for Polluted Runoff Report
CWA:	Clean Water Act
CWC:	California Water Code
CZARA:	Coastal Zone Act Reauthorization Amendments
DFG:	California Department of Fish and Game
DHS:	California Department of Health Services
EFAP:	Equine Facilities Assistance Program
FC:	Fecal Coliform
FDA:	U.S. Food and Drug Administration
HEV:	Human Enteric Viruses
LA:	Load Allocation
LULC:	Land Use and Land Cover
MCSTOPPP:	Marin County Stormwater Pollution Prevention Program
MOS:	Margin of Safety
MPN:	Most Probable Number
MRCD:	Marin Resource Conservation District
MSD:	Marin Sanitation Device
MST:	Microbial Source Tracking
NRCS:	Natural Resources Conservation Service
NSSP:	National Shellfish Sanitation Program
OAL:	Office of Administrative Law
OSDS:	Onsite Sewage Disposal System
PRNS:	Point Reyes National Seashore
QAPP:	Quality Assurance Project Plan
RCD:	Resource Conservation District
REC I:	Water Contact Recreation Beneficial Use
REC II:	Non-contact Water Recreation Beneficial Use
SHEL:	Shellfish Harvesting Beneficial Use
SWAMP:	Surface Water Ambient Monitoring Program
TBAG:	Tomales Bay Agriculture Group
TBSTAC:	Tomales Bay Shellfish Technical Advisory Committee
TC:	Total Coliform
TMDL:	Total Maximum Daily Load
UCCE:	University of California Cooperative Extension
USEPA:	U.S. Environmental Protection Agency
WDRs:	Waste Discharge Requirements
WLA:	Waste Load Allocation
WMI:	Watershed Management Initiative
WQO:	Water Quality Objective
WQS:	Water Quality Standard

This page intentionally left blank

1. INTRODUCTION

1.1 Overview

This staff report provides the technical background and basis for a proposed amendment to the *Water Quality Control Plan, San Francisco Bay Region* (Basin Plan) (SFBRWQCB, 1995). This staff report contains results of staff analyses of pathogen impairment and sources, recommended pathogen load reduction allocations, and a plan to implement the allocations. If adopted, the Basin Plan amendment would (1) establish a pathogen Total Maximum Daily Load (TMDL) in Tomales Bay Watershed pursuant to Section 303(d) of the Clean Water Act, and (2) establish an implementation strategy to achieve and support the TMDL. If adopted, portions of Basin Plan Chapter 4 (implementation plan) will be revised.

This report provides the scientific basis for the TMDL and associated implementation plan for the Tomales Bay Watershed. It discusses background conditions and current pathogen loads. It also describes how the TMDL ensures attainment of water quality objectives and protects beneficial uses of Tomales Bay Watershed.

1.2 Compliance with the California Environmental Quality Act (CEQA)

This staff report meets the requirements of the California Environmental Quality Act (CEQA) for adopting Basin Plan amendments. CEQA authorizes the California Resources Agency Secretary to exempt a state agency's regulatory program from preparing an Environmental Impact Report or Negative Declaration if certain conditions are met. The Resources Agency has certified the basin planning process to be "functionally equivalent" to the CEQA process. Therefore, this report is a functional equivalent document and fulfills CEQA environmental documentation requirements.

1.3 Next Steps

Staff of the San Francisco Bay Regional Water Quality Control Board (Water Board) have revised this Staff Report and the Basin Plan amendment based on the public comments received on April 20, 2005, and August 8, 2005. Staff will present the revised Basin Plan amendment to the Water Board for consideration and possible adoption (authorized under California Water Code §13240) on September 21, 2005. If adopted, the State Water Resources Control Board (State Board) will consider the Basin Plan amendment for adoption (authorized under California Water Code §13170), and if approved, the California Office of Administrative Law will review the amendment. If the Office of Administrative Law approves the amendment, the U.S. Environmental Protection Agency will consider this TMDL for final approval. Stakeholder comments and concerns will be considered at key milestones throughout the process.

2. BACKGROUND

2.1 Description of TMDL Process

The Tomales Bay estuary (the Bay) is a unique and highly valuable natural resource in the San Francisco Bay Regional Water Quality Control Board's jurisdiction. The State of California establishes and enforces water quality standards in order to protect the beneficial uses of water bodies. When states or local communities identify a water body that has failed to meet water quality standards, a TMDL must be developed to remedy the water quality problem(s). Tomales Bay and its tributaries have been identified as impaired for pathogens. The purpose of this TMDL is twofold: first, to assess the sources of pathogens that are causing water quality impairment in Tomales Bay and its tributaries, and second, to identify appropriate control measures that will lead to the attainment of the water quality standards set for the Bay and its tributaries. The proposed Tomales Bay Watershed TMDL applies to both Tomales Bay and its tributaries.

Section 303(d) of the Federal Clean Water Act (CWA) requires the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) to identify the Region's waters that do not comply with water quality standards (WQS); rank the impaired water bodies by taking into consideration the severity of pollution and the uses made of such waters; and establish TMDLs to ensure that impaired waters attain their beneficial uses. Lists of prioritized impaired water bodies, known as the "303(d) lists," must be submitted to the U.S. Environmental Protection Agency (U.S. EPA) every two years.

A TMDL expresses the total pollutant load a water body can receive and still meet water quality standards. The TMDL can be expressed as pollutant per unit time (load) or a pollutant concentration per unit time. In most cases, a TMDL establishes the allowable pollutant loading capacity and allocates a portion of that load to the various contributors in the watershed as wasteload (for point source discharge) and load (for nonpoint source) allocations. TMDLs must also account for natural background sources and provide a margin of safety (implicit or explicit). A TMDL can be expressed in terms of mass per unit time, toxicity, density, concentration, or other appropriate measures. For this pathogen TMDL we propose using a density-based (number of organisms per unit volume) measure of pathogen-indicator organisms.[1]

[1] The direct detection and measurement of pathogens in ambient waters is not practicable due to high cost, time, equipment, the need for highly skilled laboratory personnel, and other considerations. A class of non-pathogenic indicator organisms (bacteria) called fecal coliforms is therefore commonly used to indicate the presence and assess the magnitude of human fecal pathogenic microorganisms in the environment. Fecal coliforms live and reproduce in the intestinal tracts of all warm-blooded animals (including humans) and are abundantly found in the waste of all warm-blooded animals .The presence of fecal coliform in a water sample indicates the possible presence of pathogens that originate from feces. For more discussion, please refer to Section 3.1.

Tomales Bay and portions of its tributaries have also been identified as impaired for mercury, nutrients, and sediment. A TMDL will be developed for each of these pollutants. Many of the identified pathogen sources (i.e., equestrian facilities, on-site septic systems, dairy facilities, and ranchland activities) can also contribute to sediment and nutrient pollution. The goal of the implementation plan for pathogens is that it will lead to significant reductions in pathogens, nutrients, and sediment. Many of these identified source control actions may also be recommended or required for reduction of sediment and nutrients.

Section 303(d) of the CWA and section 130.0 et seq. of the 40 Code of Federal Regulations (CFR) specify the components and requirements of a TMDL plan. In general, a TMDL plan must:

1. **Develop a strategy to meet applicable Water Quality Standards**: A TMDL must include a plan for the specific waters and pollutants that must be addressed to ensure that applicable water quality standards are attained.

2. **Set quantifiable water quality goals or targets (numeric targets)**: A TMDL must establish specific goals and endpoints for the TMDL, which ensure attainment of applicable water quality standards.

3. **Analyze/account for all sources of pollutants (source assessment)**: A TMDL should describe all significant pollutant sources, including the magnitude and location of sources.

4. **Identify pollution reduction goals (pollutant load allocations)**: A TMDL plan includes pollutant reduction targets for all point and nonpoint sources of pollution. TMDLs, load allocations, and wasteload allocations indicate maximum pollutant loads allowed.

5. **Describe the linkage between water quality targets and pollutants of concern (linkage analysis)**: A TMDL must explain the relationship between the numeric targets and the pollutants of concern. That is, will the recommended pollutant load allocations lead to attainment of the target?

6. **Develop a margin of safety that considers uncertainties, seasonal variations, and critical conditions**: A TMDL must consider any uncertainties regarding the ability of the plan to meet water quality standards. The plan must consider these issues in its recommended pollution reduction goals.

7. **Include an appropriate level of public involvement in the TMDL process**: This is usually achieved by publishing a public notice of the TMDL, circulating the TMDL for public comment, and holding public meetings in local communities.

8. **Identify and implement alternative control measures to rectify impairment of the water body (implementation plan):** A TMDL must recommend specific

nonpoint source Best Management Practices (BMPs), point source controls, and other actions necessary to achieve the desired water quality endpoints.

9. **Include a monitoring and review plan:** A TMDL must include a plan to assess its implementation and effectiveness, and to provide for adjustment as needed.

In addition, the TMDL process involves the public in both the development and implementation stages of the TMDL, as public participation is key to a successful TMDL.

2.2 Regulatory Context

In the San Francisco Bay Region, the CWA is administered by the Water Board under its federally designated authority. The Water Board is one of nine regional water boards in California. The State Water Resources Control Board (State Water Board) establishes statewide policies and serves as the review and appeal body for the decisions of the regional water boards. The State Water Board is made up of five members appointed by the governor.

The San Francisco Bay Regional Water Quality Control Board (Water Board) consists of nine governor-appointed members who serve four-year terms. Scientific information is gathered and policy is developed for the Water Board by its civil service employees (staff). The Water Board has adopted a Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) that contains a list of beneficial uses for waters in the Region and the standards and implementation measures necessary to protect those beneficial uses.

Some measures that go beyond the scope of the current Basin Plan must first be adopted by the Water Board, using a Basin Plan amendment process, before they are implemented. Such measures include the TMDL that is the subject of this report. The process involves presenting the proposed Basin Plan amendment to the Water Board in a publicly noticed hearing. The Water Board receives public comments and at least 45 days later staff presents responses to comments and relevant revisions to the proposed amendment. The Water Board then votes on adoption. If the amendment is adopted, it is sent to the State Water Board for approval. If the State Water Board approves the amendment, it is sent to the Office of Administrative Law (OAL) to determine whether the amendment is consistent with the California Administrative Procedures Act (APA). State TMDL adoption is complete after OAL approval and state transmittal of the TMDL to the U.S. EPA for approval.

2.3 Water Body Description

Tomales Bay is located in western Marin County, California, approximately 50 km northwest of San Francisco (Figure 1). The Bay has a surface area of approximately 28 square kilometers (11 square miles). The mouth of Tomales Bay is at the southern end

of Bodega Bay, and its body extends in a southeasterly direction along the line of the San Andreas Fault. The Bay is about 12 miles in length with an average width of less than one mile. Tomales Bay is characterized by relatively shallow water, with the average depth being less than 20 feet. Hydrographic studies conducted from 1966–1970 (TBSTAC, 2000) indicate that the currents in the Bay are primarily influenced by tidal cycles, not wind. They suggested that the Bay consists of three mixing regimes: 1) significant flushing in the lower Bay from the mouth to approximately Hog Island near the Walker Creek Delta, 2) sluggish mixing in the mid Bay (Pelican Point to Double Point), and 3) even less water exchange in the portion of the upper-Bay (south of Double Point). These studies were conducted in the summer and fall periods and therefore do not reflect the influence of increased inflow from runoff.

Figure 1

Tomales Bay, Marin County, California

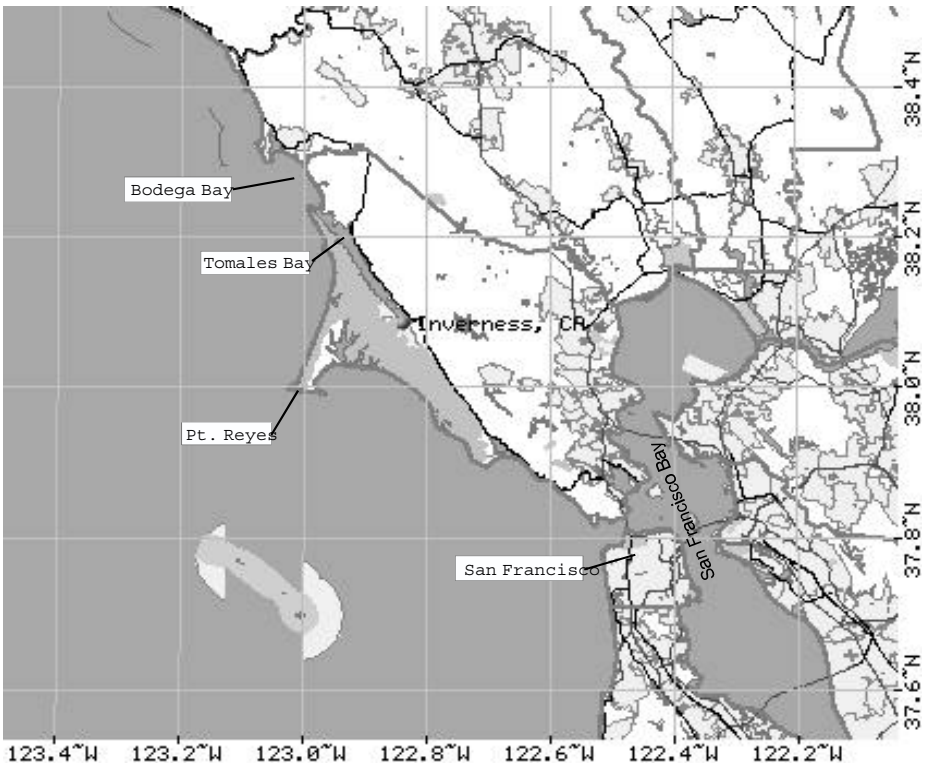


Figure 1. Location of Tomales Bay, Marin County, California (U.S. Census Tiger Map).

2.4 Watershed Description

The Tomales Bay Watershed climate is consistent with the Mediterranean climate of the Central Coast of California, receiving intense rain during the winter months (November through March). Eighty-five percent of the annual rain usually falls during this period.

Another 10% of the annual precipitation falls during October and April, with the remaining 5% during the other five months of the dry season. Average annual rainfall ranges from 26 inches per year in the northern and eastern part of the Watershed to 39 inches per year in the south (TBSTAC, 2000).

The watershed area for Tomales Bay is approximately 561 km^2 (216 square miles) with four major drainage areas: (1) Direct drainage from small tributaries along the west and east shores (73 km^2; 28 mi^2); (2) Lagunitas Creek (241 km^2; 93 mi^2) to the southeast; (3) Olema Creek (50 km^2; 19 mi^2), which flows into Lagunitas Creek close to the head of the Bay; and (4) Walker Creek (196 km^2; 76 mi^2) to the northeast (Table 1 and Figure 2) (TBSTAC, 2000).

The U.S. Geological Survey maintains stream gauges on both Walker and Lagunitas creeks. These gauges measure only a portion of the runoff from their respective watersheds, as well as any water released from catchment reservoirs (Table 2). It has been estimated that about two-thirds of the runoff into Tomales Bay comes through the Lagunitas-Olema Creek drainage even though this area only makes up about half of the Watershed (TBSTAC, 2000) (Tables 1 and 3). The Walker Creek drainage, which includes Chileno, Arroyo Sausal, Salmon, and Keyes creeks, makes up about 35% of the Tomales Bay Watershed area, but produces about 25% of the annual runoff into the Bay (TBSTAC, 2000). The remainder of the flows into the Bay (approximately 10%) comes from small tributaries that drain directly to the Bay, which make up 13% of the total Watershed area.

Table 1
Tomales Bay Watershed Area Estimates, Including Reservoirs

Subwatershed	**Area (KM^2)**	**Area (Percentage)**
Walker	196.35	35%
Lagunitas	241.72	43%
Olema	50.0	9%
Remainder	72.93	13%
Totals	**561**	**100%**

Source: TBSTAC, 2000.

Sediment runoff from the major creeks and tributaries into Tomales Bay may be as high as 48,600 tons/year. Approximately one-third of the sediment is carried into the Bay from the Walker/Keyes Creek drainage (TBSTAC, 2000).

Figure 2

Tomales Bay Watershed

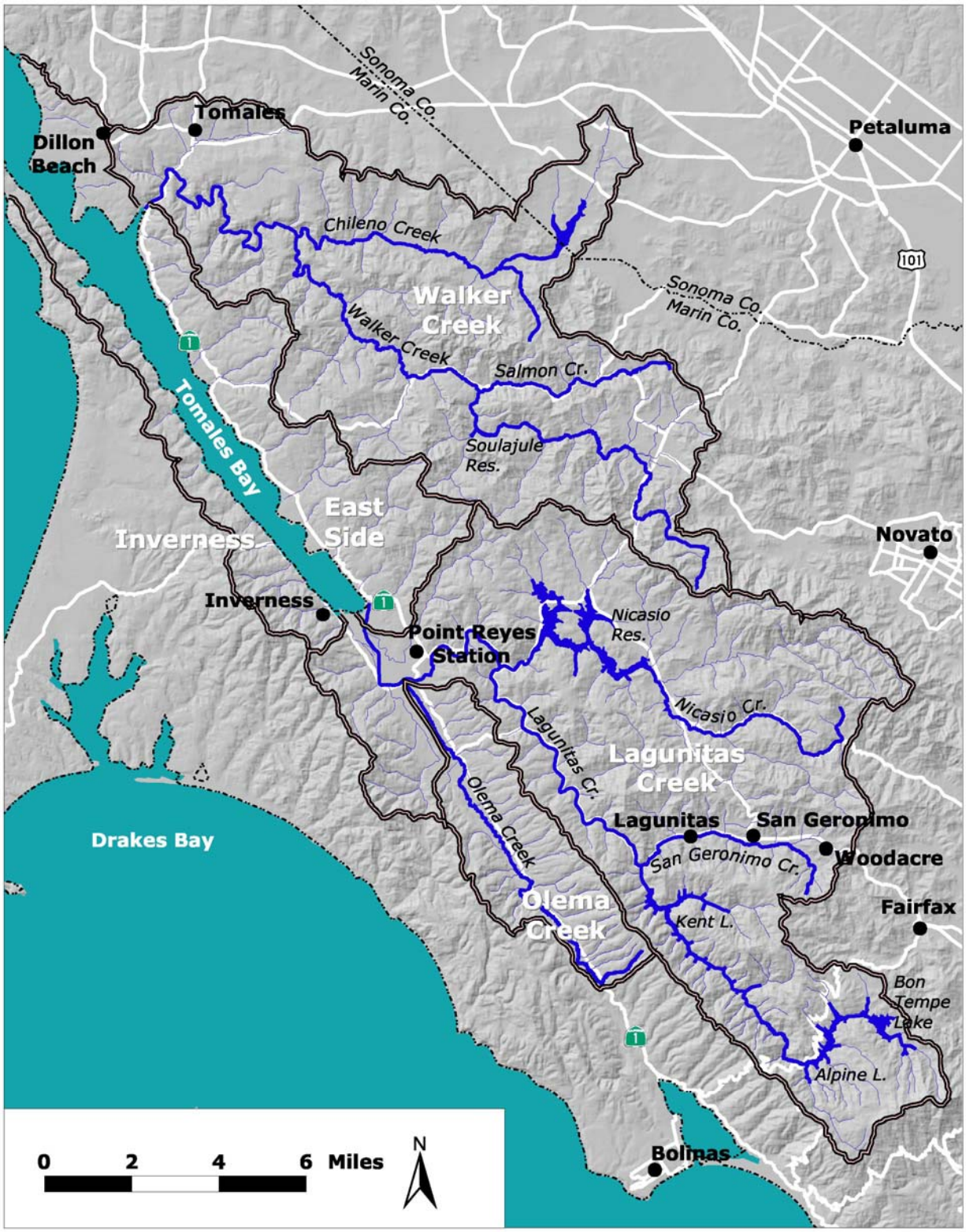


Table 2 **Area Estimates for the Gauged Portions of the Tomales Watershed***		
Watershed	**Area (KM^2)**	**Area (Percent)**
Walker (gauged portion)	78.54	14%
Lagunitas (gauged portion)	213.18	38%
Remainder (not gauged)	269.28	48%
Totals	**561**	**100%**
* Including release and spill from catchment reservoirs and unimpeded flow from the Watershed below the reservoirs. Source: TBSTAC, 2000.		

Table 3 **Estimates of Watershed Contributions to Runoff into Tomales Bay**	
Watershed	**Percentage of Total**
Walker	25%
Lagunitas	66%
Remainder	9%
TOTALS	**100%**
Source: TBSTAC, 2000.	

Marin Municipal Water District (MMWD) maintains five water catchment reservoirs in the Lagunitas Watershed (four on Lagunitas Creek and one on Nicasio Creek) with a total capacity of approximately 69,000 acre feet. MMWD also has a reservoir on a tributary to Walker Creek, with a capacity of 10,572 acre-feet.

2.5 Land and Water Uses

The Tomales Bay Watershed is used for recreational hiking, boating, camping, picnicking, clamming, fishing, and bird watching. The Bay also supports the commercial cultivation and harvesting of shellfish, including oysters, mussels, and clams. Herring and halibut are also harvested commercially from wild populations, and there is a sport fishery for halibut in the Bay.

The major land uses in the Watershed are livestock grazing, dairy farming, equestrian, low-density residential, and parklands. Beef, sheep, and dairy farms have been an important part of the local economy since the mid-1800s, although the number of dairies has been declining. However, since some dairies have switched to raising beef cattle and others have increased the size of their dairy herds, the current total number and type of animals in the Watershed is not known.

There are nine small towns within the Watershed, with limited commercial development and no industry. According to the 2000 census, the west side of Tomales Bay has a population of 1,421, with a total of 707 households. The east side of the Bay (Dillon

Beach, Tomales, Point Reyes Station, Lagunitas-Forest Knolls, San Geronimo, and Woodacre) has a population of 5,011, with 2,047 households. All of the towns are served by onsite sewage disposal system (OSDS) except the town of Tomales, which is served by a centralized wastewater treatment facility. Of the ten small permitted wastewater treatment facilities within the Watershed, only one facility accepts septage waste.

The Water Board prohibits direct discharge from treatment facilities into Tomales Bay or the creeks within the Watershed. A number of the wastewater treatment facilities have holding ponds and are permitted to discharge to irrigation fields during the dry season. A complete list and description of all small wastewater treatment facilities within the Tomales Bay Watershed is provided in Table 16 in Section 5.6.

2.6 Aquaculture

There was at least a minor fishery for native oysters (*Ostera lurida*) from Tomales Bay as early as 1859 (TBSTAC, 2000). Although eastern oysters (*Crassostrea virginica*) were initially transplanted to Tomales Bay near Millerton Station in 1875, these efforts were not successful due to the abundant production of the San Francisco Bay oyster grounds, which were closer to the major markets in San Francisco. Non-native oysters were again introduced into Tomales Bay around 1907 in response to increased pollution of San Francisco Bay and the resultant failure of its oyster industry. The Tomales Bay Oyster Company started operations near Hamlet, and the Consolidated Oyster Company began a short-lived operation at Blakes Landing.

The Tomales Bay Oyster Company was the first to introduce Pacific oysters (*Crassostrea gigas*) to Tomales Bay in 1929 following the earlier successful introduction of this species in the State of Washington. This species now constitutes the majority of oysters currently produced in Tomales Bay.

The vast majority of shellfish harvesting in Tomales Bay is from commercial shellfish growing areas. Currently seven certified active commercial shellfish harvesters and one certified wet storage facility operate in Tomales Bay, with a combined aquaculture lease area of 483 acres (Table 4 and Figures 3a, 3b, and 3c). All active commercial growers in Tomales Bay operate on the eastern shoreline under leases granted by the California Department of Fish and Game (DFG). An inactive grower, the Frank Spenger Company, used to operate on a Point Reyes National Seashore lease on the western shore.

Commercial shellfish production in Tomales Bay is primarily devoted to Pacific oysters (*Crassostrea gigas*) and bay mussels (*Mytilus edulis and M. galloprovincialis*). In addition, there is a small amount of commercial production of Eastern oyster (*Crassostrea virginica*), European oysters (*Ostrea edulis*), Kumomoto oysters (*Crassostrea gigas kumomoto*), and Manila clams (*Tapes semidecussata*). There is a fairly large amount of recreational harvesting for horseneck clams north of the Walker

Creek Delta during the spring and fall. There is also a small bed of cockles and clams used for recreational harvesting near Hamlet, just south of the Walker Creek Delta.

Table 4
Commercial Shellfish Growers and Wet Storage Operators in Tomales Bay

Company	Regulation Number	DFG Lease Number	Number of Acres	Products
Marin Oyster Company	00256	M-430-02 M-430-19	5 25	Pacific Oysters
Charles Friend Oyster Company	00256	M-430-04	87	Pacific Oysters
Cove Mussel Company	00311	M-430-06	10	Bay Mussels, Pacific Oysters
Hog Island Oyster Company, Inc.	00265 00364	M-430-10 M-430-11 M-430-15 M-430-12 Intake	5 5 98 25	Pacific Oysters, Manila Clams, Blue Mussels
Point Reyes Oyster Company	00416	M-430-13 M-430-14 M-430-17	25 5 62	Pacific Oysters, European Oysters, Kumomoto Oysters,
Tomales Bay Shellfish Farms, Inc.	00330	M-430-05	156	Pacific Oysters, Bay Mussels, Manila Clams, European Flat Oysters

Figure 3a.

Location of Commercial Shellfish Growing Area Leases and Prohibited Zones in Tomales Bay (Inner Bay)

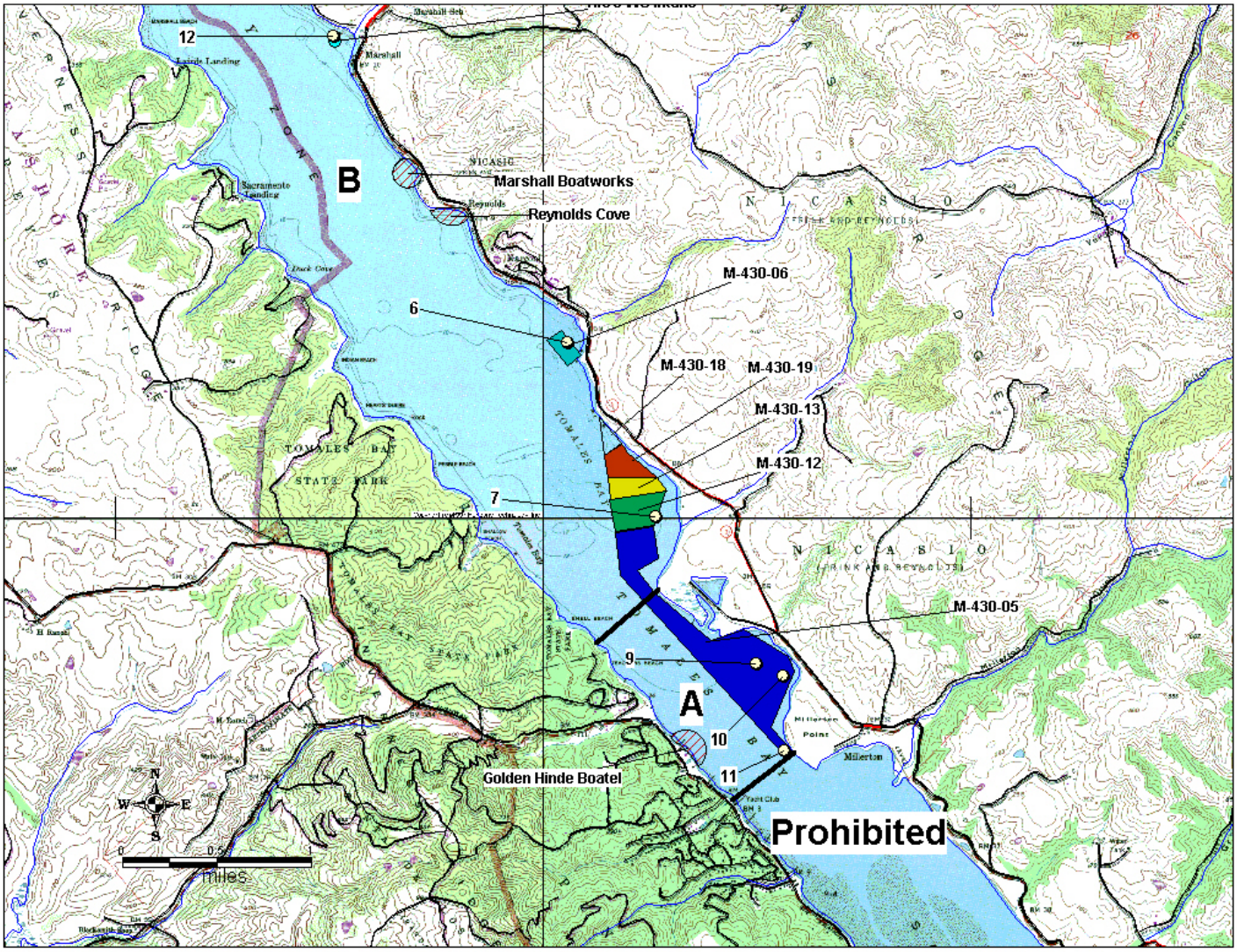


Figure 3b.

Locations of Commercial Shellfish Growing Area Leases and Prohibited Zones in Tomales Bay

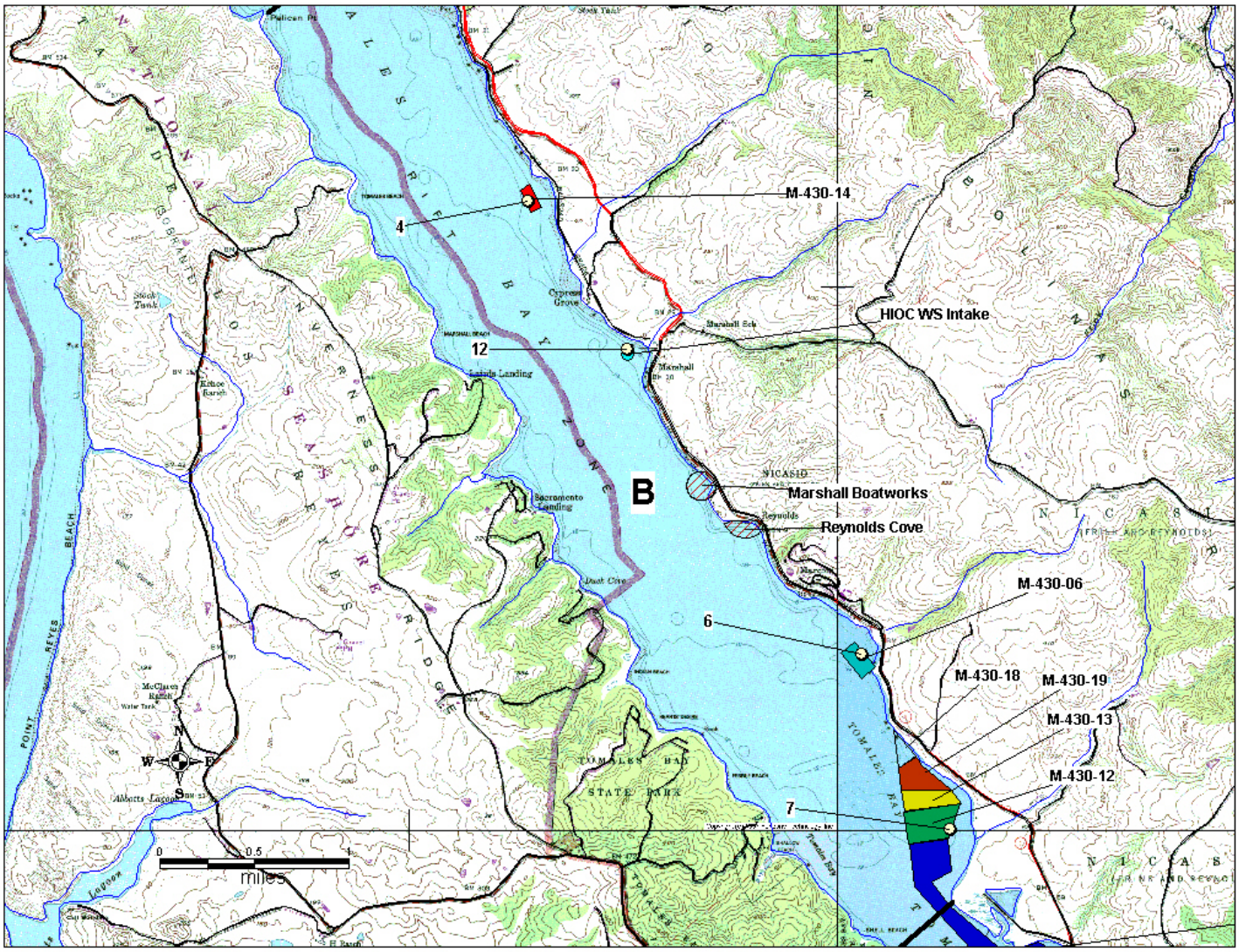
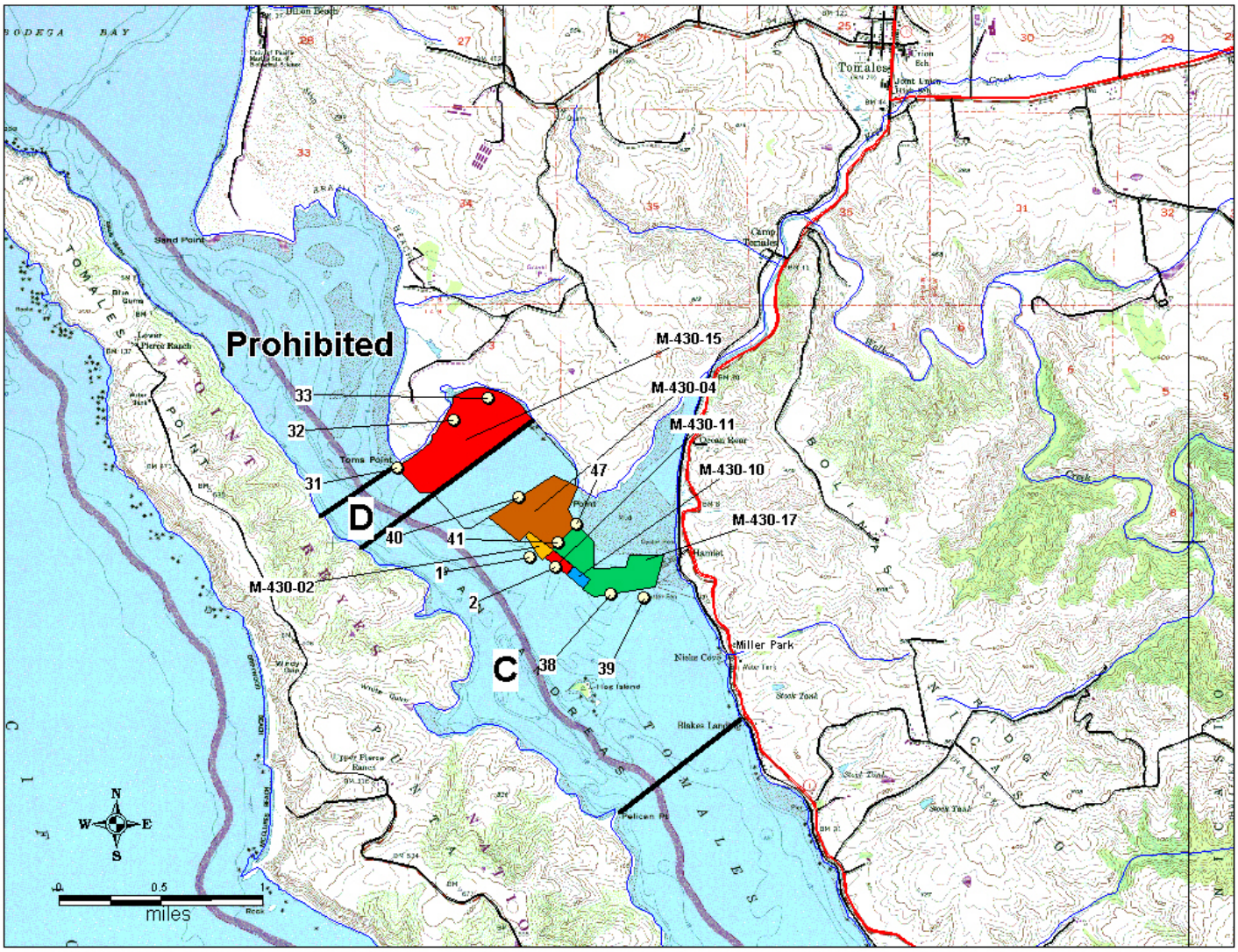


Figure 3c.

Location of Commercial Shellfish Growing Area Leases and Prohibited Zones in Tomales Bay



Source: *Draft Twelve-Year Sanitary Survey Report; Shellfish Growing Area Classification for Tomales Bay* (DHS, 2001).
* HIOC WS: Hog Island Oyster Company Wet Storage

2.7 Tomales Bay Hydrodynamics

Researchers at the University of California, Berkeley developed a three-dimensional hydrodynamic state-of-the-art numerical model of Tomales Bay to evaluate pollutant transport (Brennan and Stacey, 2005a). This model simulates the Bay as a network of over 800,000 cells, which exchange water according to the governing laws of physics,

including the effects of fresh and salt-water density differences. The model inputs include the tidal stage at the mouth of the bay and fresh water flow from the creeks discharging to the bay. Comparison between the model's predictions and direct field observations of currents and salinity show good agreement.

After constructing and validating the model, Brennan and Stacey investigated the transport of pathogens entering the Bay from fresh water creeks. Water entering the Bay was tagged with a tracer—a sort of virtual dye—unique to its source. This tracer then served to quantify how the flows of the Bay transport and dilute pathogens. The distribution of pathogens entering the Bay from Walker Creek was evaluated at the individual shellfish sampling areas located on the Walker Creek delta. The model quantified the temporal and spatial variability of pathogen concentrations in response to different tidal conditions and creek flow rates for a period corresponding to hydrologic conditions from the winter of 2003–04. The results indicate that at times minimal to no dilution of Walker Creek water occurs at a number of the shellfish growing beds. Similarly, at the south end of the Bay (i.e., inner Bay) there is little dilution of tributary flows.

3. PROBLEM DEFINITION

Tomales Bay and its main tributaries: Lagunitas, Walker, and Olema creeks, are impaired by pathogens present in human and animal waste. The presence of pathogens is inferred from high fecal coliform bacteria concentrations. Pathogens pose potential health risks to recreational users and shellfish consumers. In addition to pathogens, animal and human waste contain nutrients that in excess pose a threat to aquatic ecosystem beneficial uses. Tomales Bay, Walker Creek, and Lagunitas Creek are listed as impaired by excess nutrients. Human and animal wastes may also contain other harmful constituents such as steroids and pharmaceuticals. By eliminating the discharge of human waste and controlling the discharge of animal waste this TMDL will have the added benefit of protecting aquatic ecosystem beneficial uses such as Marine Habitat, Estuarine Habitat, Cold and Warm Freshwater Habitat, and Wildlife Habitat.

The listing of Tomales Bay and its tributaries as impaired due to pathogens is based on:

- The exceedance of water quality standards (fecal and total coliform water quality objectives) for shellfish harvesting and water contact recreation;
- The listing of Tomales Bay as threatened under the state's Shellfish Protection Act in 1994;
- The prohibition on commercial shellfish harvesting during rainfall periods, regulated by the California Department of Health Services; and
- A 1998 illness outbreak from the consumption of contaminated Bay shellfish.

Sections below discuss the applicable bacterial water quality standards, results of past bacteriological studies, and the 1998 waterborne illness outbreak.

3.1 Use of Fecal Coliform Bacteria as Indicators of Pathogens

More than 100 types of pathogenic microorganisms can occur in water polluted by fecal matter and cause outbreaks of waterborne disease (Havelaar, 1993). Contaminated or improperly treated drinking water, recreational waters polluted by fecal matter, and shellfish harvested from waters contaminated by human sewage and/or animal wastes can be vectors of pathogenic disease.

The detection and enumeration of all pathogens of concern is impractical in most circumstances due to the potential for many different pathogens to reside in a single water body, lack of readily available and affordable methods, and the variation in likely pathogen concentrations (U.S. EPA, 2002). Due to these shortcomings, indicator organisms are commonly used to assess microbial water quality for both shellfish growing and recreational use waters. Several types of indicator bacteria colonize the intestinal tracts of warm-blooded animals and are routinely shed in their feces. These organisms are not necessarily pathogenic, but are abundant in wastes from warm-blooded animals and are easily detected in the environment. The detection of these

indicator organisms indicates that the environment is contaminated with fecal waste and that pathogenic organisms may be present.

Two of the most commonly used indicators of human pathogenic organisms are total and fecal coliforms. Total coliform are comprised of four genera of bacteria. Fecal coliforms are a subset of total coliform and are specific to wastes from warm-blooded animals, but not necessarily to humans. Although fecal coliform bacteria have historically been the indicator organisms of choice, they do have some shortcomings. These organisms are not human-specific, and therefore do not fully assess the health risk from human enteric viruses.

Even though the scientific community is aware of the shortcomings of fecal coliform indicators, at the present time no other organism serves as perfect indicator. Federal and state standards used to assess water quality in shellfish growing waters and protect public health are all based on fecal coliform concentrations. For these reasons, the Tomales Bay Watershed Pathogen TMDL uses fecal coliforms to indicate and regulate pathogen presence. However, if during the reevaluation of the TMDL, better indicator organisms are available and new standards are put into place for these organisms, the TMDL will be modified accordingly.

3.2 Microbial Source Tracking Techniques (i.e., DNA Fingerprinting)

Microbial Source Tracking (MST) methods have recently been used to help identify nonpoint sources responsible for the fecal pollution of water systems. While these techniques show some promise, much work remains to be done in the evaluation of MST methodologies before they can be applied in a universally acceptable manner. Many of the methods are still in development and most have not been extensively tested.

Most MST studies have relied on matching “fingerprints” from bacterial strains (i.e., *Escherichia coli*) isolated from a water system to those isolated from different hosts (i.e., humans, cows, pigs, raccoons, deer, geese, etc.). The main approaches used to generate fingerprints have depended on phenotypical characteristics of isolates (e.g., antibiotic resistance analysis) or on genotypic methods (e.g., DNA fingerprinting, ribotyping). Both approaches rely on the development of comprehensive libraries (i.e., culture collections) of indicator bacteria.

Accuracy of these approaches in field-study situations has been questioned because of various problems associated with the target bacterial organisms, the level of complexity introduced by spatial (over distance) and temporal (over time) vectors, the stability of markers used, and complexities of sampling design.

A workshop held in February 2002 brought together experts in environmental microbiology, molecular biology, and microbial detection methods to discuss the state of science of MST. The California State Water Resources Control Board, U.S.

Environmental Protection Agency, Southern California Coastal Water Research Project, and the National Water Research Institute sponsored this workshop.

After three days of discussion, the workshop participants concluded that:

- Most MST methods have been tested against a limited number of watersheds and consequently many of them will require further developments before they can be considered appropriate for source tracking of fecal contamination.
- Practically no information is available regarding the population dynamics of the targeted organism on a spatial and temporal basis.
- Variables such as library size, processing costs, and type of professional expertise required for data development and data interpretation will most certainly restrict the use of some methods (e.g., DNA fingerprinting) (Santo Domingo, et al., 2002)

To further investigate the merit of MST techniques for the development of TMDLs, in August 2003 another multiagency academic researcher meeting was organized by U.S. EPA and the U.S. Geological Survey (USGS). The purpose of the meeting was to discuss issues relevant to MST and identify facts about MST tools. The primary goal was to determine the most critical questions that need to be addressed in order to validate the use of current MST methods for TMDL development purposes.

At the conclusion of the meeting, participants arrived at the following:

- MST methods should shift from those that are based on E.coli and fecal enterococci (i.e., DNA fingerprinting, ribotyping) to a better set of fecal indicators or source identifiers for fecal contamination;
- Problems with the current indicators include the possible effects of regrowth in the environment, differential survival of subtypes in the secondary habitat, and nonexclusive distribution of subtypes among hosts;
- Substantial funding and other resources would be needed to properly address these problems;
- The time needed to resolve these issues is not compatible with current TMDL deadlines;
- This approach may not be easy to defend legally in light of the many uncertainties that could be raised; and
- Participants concluded that the use of current library-based methods (i.e., DNA fingerprinting, ribotyping) has limited longevity. Development of library-independent methods has a better likelihood of long-term successful application (Santo Domingo and Stoeckel, 2003).

Due to all the above uncertainties and shortcomings associated with newly developed MST techniques, use of this costly and time-consuming approach was not pursued in developing this TMDL.[2]

[2] A recent MST study performed in Morro Bay took more than three years and $300,000 to complete.

An article by the United States Geological Survey (U.S.GS), published in December of 2004, validates staff's original concerns regarding the accuracy of the MST techniques and position. The article reports that:

> "Seven MST methods using E. coli to identify the sources of fecal contamination were less accurate in field application than previously reported.
>
> The USGS-led study, done in cooperation with state and local government agencies and several universities and affiliated consultants, was among the first to test the accuracy of microbial source tracking methods against samples of known origin, called "challenge isolates." Scientists compared the accuracy of seven source tracking tools in classifying E. coli strains to various sources (humans, dogs, gees, deer, horses, pigs, cows, and chicken).
>
> When researchers sent E.coli challenge isolates for testing, many isolates either remained unclassified or were classified to incorrect sources. In all, fewer than 30 percent of challenge isolates were classified to the correct source-animal species by any method.
>
> Prior source tracking research reports cite accuracy ranges from 60-90 percent for various source tracking methods. The authors of the USGS study attribute the discrepancy between the 60-90 accuracy rates and the 20-30 accuracy rates they reported to a number of factors:
>
> - Different bacteria may be present in animal guts in different seasons; in the USGS study, challenge isolates were collected 9 months after the reference feces were collected;
> - There may be too many strains of E. coli bacteria in each animal species for effective application with small reference libraries, such as the 900 reference strains in the USGS study. At a cost of $10 to $100 to analyze one reference strain, however, building large source libraries gets expensive rather quickly;
> - E. coli strains may not be truly specific to one animal source. Some E. coli strains have been found in more than one animal source, such as when animals live in close proximity with one another, though no evidence to support this premise was found in the U.S.GS study" (U.S.GS, 2004).

3.3 Water Quality Standards

Water quality standards for Tomales Bay and its tributaries are composed of: a) beneficial uses for the Bay, b) water quality objectives (WQOs) to protect those

beneficial uses, and c) the Antidegradation Policy that requires continued maintenance of existing high-quality waters. The Water Board's Basin Plan contains a list of beneficial uses, water bodies in the Region, and the objectives and implementation measures necessary to protect beneficial uses. The overall goal of this TMDL is to protect and restore these beneficial uses by reducing the pathogen levels in Tomales Bay and its tributaries.

Tomales Bay pathogen-impaired beneficial uses are shellfish harvesting, water contact recreation, and non-contact water recreation (Table 5). Tomales Bay tributary pathogen-impaired beneficial uses are water contact recreation and non-contact water recreation (Table 5). Table 6 shows the Water Board Basin Plan's numerical water quality objectives for fecal and total coliforms for each of the beneficial uses listed in Table 5. In the Bay, the shellfish harvesting beneficial use is the most sensitive to elevated pathogen levels, and therefore this TMDL protects all three Bay beneficial uses by requiring actions to attain the shellfish harvesting WQO. In the tributaries, the water contact recreation objectives must be attained and in addition, bacteria concentrations in the tributaries must be reduced to levels necessary to assure that the Bay objectives are met.

Table 5
Beneficial Uses of Tomales Bay and its Tributaries Relevant to Pathogen TMDL

Designated Beneficial Uses	Description
Shellfish Harvesting (SHEL)[a]	Uses of water that support habitats suitable for the collection of crustaceans and filter feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes.[3]
Water Contact Recreation (REC-I)	Uses of water for recreational activities involving body contact with water such that ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, and fishing.
Non-contact Water Recreation (REC-II)	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water such that water ingestion is reasonably possible. These uses include, but are not limited to, boating, kayaking, sailing, picnicking, sunbathing, hiking, beachcombing, camping, bathing, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

a. Exists only in the Bay.

[3] Since sport shellfish harvesting could take place at any spot within the Bay, the SHEL water quality standards must be met at the entire Bay and not just at the designated lease areas for commercial shellfish farming.

Table 6 **Current Basin Plan's Water Quality Objectives for Coliform Bacteria [a]**		
Beneficial Use	**Fecal Coliform (MPN[b]/100 mL)**	**Total Coliform (MPN/100 mL)**
Water Contact Recreation (REC I)	Log mean<200 90th percentile<400	Median< 240 No sample> 10,000
Shellfish Harvesting (SHEL)	Median<14 90th percentile <43	Median< 70 90th percentile< 230
Non-contact Water Recreation (REC II)	Mean<2000 90th percentile<4000	N/A
a. Based on a minimum of five consecutive samples equally spaced over a 30-day period. b. Most Probable Number (MPN) is a statistical representation of the results of the standard coliform test.		

3.4 Other Regulatory Authorities/Water Quality Standards

California Department of Health Services Standards

The California Department of Health Services (DHS) has separate authority and standards to regulate commercial shellfish growing areas, which supersede the water quality objectives for shellfish harvesting contained in Water Board's Basin Plan. In the San Francisco Bay Region, Basin Plan standards for fecal coliforms in shellfish-growing waters state that the concentration of fecal coliforms in the ambient water cannot exceed a median of 14 MPN/100 mL, or the 90th percentile cannot exceed 43 MPN/100 mL. Although DHS used a median value in the past, they now use a geometric mean of 14 MPN/100 mL. DHS standards follow criteria developed by the National Shellfish Sanitation Program (NSSP), which is administered by the U.S. Food and Drug Administration (FDA) (TBSTAC, 2000). These standards allow for either a median or a geometric mean to be used. The NSSP standards are based on acceptable levels of fecal coliforms in shellfish and shellfish growing waters.

New U.S. EPA Enterococci Standards

On November 16, 2004, EPA promulgated a rule entitled, "Water Quality Standards for Coastal and Great Lakes Recreation Waters" (69 FR 67217 et seq.). This rule became effective December 16, 2004, and requires marine coastal waters (including estuarine waters) of California (except those covered by Los Angeles Basin Regional Water Quality Control Board) to achieve certain bacteria standards. This rule applies to Tomales Bay based on the designated water contact recreation beneficial uses in effect.

Based on this rule, designated Bathing Beach Waters must meet an enterococci concentration of no more than 35 / 100 mL (geometric mean, using analytical methods 1106.1 or 1600 or equivalent method) and a single sample maximum of no more than 104 / 100 mL (75% confidence level). These values explicitly apply to enterococci

regardless of origin unless a sanitary survey shows that the source of the indicator bacteria are non-human and epidemiological study shows that the indicator densities are not indicative of human health risk.

This TMDL does not specifically address these recently promulgated and applicable water quality standards. However, we believe that the current fecal coliform targets for protecting the beneficial uses of shellfish harvesting in the Bay and water contact recreation in the tributaries are sufficient to achieve these federal standards because the fecal coliform standards for shellfish harvesting protection are roughly an order of magnitude more stringent than the standards set to protect water contact recreation. Therefore, staff concludes that the fecal coliform standards are sufficiently stringent to result in attainment of the enterococci standards and there would be no need to set a separate enterococci TMDL for Tomales Bay.

3.5 Rainfall Closure Rules

To ensure public safety, DHS has developed rainfall-based shellfish harvesting prohibition rules for different areas of the Bay. These area-specific rules are based on analysis of the influence of runoff events on tissue and water column fecal coliform concentrations (Table 7). As the volume of collected data has increased and the data analysis has become more refined, rainfall closure rules have also become more stringent. This has significantly impaired the economic viability of the commercial shellfishing industry. The latest and most stringent rules were issued in 1999.

Table 7
Summary of Closure Rules for Shellfish Growing Areas in Tomales Bay

Area	Area Description	24-Hour Rainfall Threshold	Closure Length (Days)	Secondary Rainfall Threshold	Closure Length (Days)	10-Day Rainfall Threshold	Closure Length (Days)
A	Inner Bay excluding area of Lease M-430-05 south of Tomasini Point	0.40 inch	4	0.67 inch	5	> 2.00 inch	6
B	Area of Lease M-430-05 south of Tomasini Point	0.50 inch	4	0.67 inch	5	N/A	N/A
C	Outer-Bay[a] excluding Lease M-430-15	0.50 inch	5	0.67 inch	6	N/A	N/A
D	Lease M-430-15 in Outer-Bay [b]	0.40 inch	6	0.67 inch	7	> 2.00 inch	8

a. The area closer to the mouth of the Bay.
b. Lease M-430 shall be closed one additional day when the 10-day cumulative rainfall exceeds 2.0 inches. This does not include the portion of this lease that is subject to seasonal rainfall closure.
Source: Adopted from *Draft Twelve-Year Sanitary Survey Report; Shellfish Growing Area Classification for Tomales Bay* (DHS, 2001).

The commercial shellfish growing industry is regulated by DHS using fecal coliform standards. Therefore, the required endpoints (i.e., numeric targets, TMDL, and load allocations) of this TMDL are based upon fecal coliform standards as well.

3.6 The Shellfish Protection Act and the Listing of Tomales Bay as Impaired

On October 10, 1993, the California legislature passed legislation that enacted the Shellfish Protection Act. This legislation is incorporated in the Porter Cologne Water Quality Control Act (California Water Code, Division 7, Chapter 24, Section 14950–14958). Under this law, the Water Board is required to form a technical advisory committee for any commercial shellfish growing area determined to be threatened. One of the criteria for a "threatened" area is the number of days the area is closed to shellfish harvesting due to pollution threats. The Shellfish Protection Act states that a shellfish area shall be designated as threatened if it is closed to harvesting for more than thirty days in each of three consecutive calendar years. Based on the January 5, 1994 California Department of Health Services' (DHS) letter notifying the Water Board that Tomales Bay met the threatened designation, the Water Board passed a resolution on January 19, 1994 authorizing formation of the Tomales Bay Shellfish Technical Advisory Committee (TBSTAC). Water Board staff organized TBSTAC and held its first meeting on February 15, 1994. According to the Shellfish Act, the purpose of TBSTAC is to advise and assist Water Board in developing an investigation and remediation strategy to reduce pollution affecting the shellfish growing areas.

3.7 Summary of Past Bacteriological Water Quality Studies

In Tomales Bay, Shellfish growers, under the direction of DHS, conduct monthly fecal coliform water quality monitoring. In addition, several intensive studies on bacteriological water quality of the Bay and its tributaries have been conducted over the past 28 years. These studies include:

- a 1974 shellfish and water quality study by DHS;
- a shoreline and Watershed water quality survey carried out in 1976–77 and 1977–78 by the Water Board;
- a sanitary survey conducted by the Department of Health and Human Services of FDA;
- a pilot study conducted by DHS in the winter of 1994–95 to test sampling methods and locations for the 1995–96 study;
- a State Water Board funded study conducted in 1995–96 by DHS and the Water Board, under the auspices of TBSTAC; and
- a second State Water Board funded study conducted in 2001 by the Water Board and TBSTAC.

These studies indicate that Tomales Bay and its tributaries have exceeded shellfish and water quality standards over the last three decades. The results of these studies are briefly discussed below.

1974 Study: California Department of Health Services
In 1974, DHS designed a study (TBSTAC, 2000) to determine the water quality of Tomales Bay and tributary streams during wet weather conditions and relate the results to the bacteriological quality of the shellfish grown in the Bay. The study also included a sanitary survey for potential pollutant sources, with a detailed description of the potential of contamination from land uses and recreational uses in and along Tomales Bay. DHS staff collected water samples at 17 Bay sampling stations, 19 shoreline stations and 49 tributary stream stations for 12 days in December, following a three-day rain event totaling 1.98 inches. They analyzed all samples for total and fecal coliforms. They also sampled the shellfish from six locations and analyzed them for coliforms and heavy metals.

Results from the Bay samples generally showed that the Bay waters did not exceed the median standard of 14 MPN/100 mL for shellfish harvesting waters but some stations did exceed the requirement that the 90th percentile of samples may not exceed 43 MPN/100mL. Shoreline samples showed elevated total and fecal coliform levels at numerous stations, which were attributed to the possibility of shoreline drainage, tributary streams entering the Bay, and possible failing septic systems. Shellfish samples were also elevated in most instances. In spite of fairly low runoff because of dry conditions in the Watershed, results from tributary samples showed high total and fecal coliform counts. The streams were considered the major source of pollutants to the Bay. The study concluded that the high coliform counts were due to contribution of wastes by upstream dairies and, in lower Keyes Creek, from raw sewage discharges from the town of Tomales. This study was conducted before the adoption of the Water Board requirements to improve handling of animal waste on dairy farms and the construction of the Tomales sewage treatment plant.

1976–78 Study: Regional Water Quality Control Board
The Water Board conducted a shoreline and tributary sampling survey during the winters of 1976–77 and 1977–78 (TBSTAC, 2000), to evaluate the effectiveness of the Water Board's recent requirements for dairy waste practices. The Water Board adopted "Minimum Guidelines for Protection of Water Quality from Animal Wastes" in 1973 and required dairies to be in compliance with manure handling practices by September 1, 1976. Samples were taken from 20 stream stations and six shoreline stations (not every station was sampled during each survey nor during both years). Samples were analyzed for total and fecal coliforms, total organic carbon, and ammonia. Samples were only taken during the rainy season (November through March in 1976–77 and November through January in 1977–78).

Stream conditions improved for areas in which dairies had come into compliance with the minimum guidelines, although none of the shoreline or stream stations sampled met coliform objectives for water contact and non-contact recreation following periods of rainfall. The 1976–77 season had very light rainfall and the January 3, 1977 sampling event was the first major rain (approximately two inches in three days). The January 14, 1978 sampling event followed a 2.5-inch rain event in three days; however, there was

significant rainfall in November and December, so that the runoff from the Watershed was greater than it had been the previous year. There were much higher coliform levels along the shoreline in the 1977–78 season as compared with the previous year; this was attributed to greater freshwater inflows into the Bay during 1977–78. Stream stations showed decreases in coliform between 1976–77 and 1977–78 following implementation of the minimum guidelines. The report also concluded that sewering of the town of Tomales in June 1977 resulted in decreased levels of coliform in Keyes Creek below the town.

1980 Study: U.S. Food and Drug Administration

In 1980, FDA, to determine the degree of pollution and the recovery rate of the Bay during periods of rainfall, conducted a sanitary survey from February 24 through March 12 (TBSTAC, 2000). Samples were taken from 45 stations in the Bay and on tributary stations close to the Bay. A total of 393 samples were collected and analyzed for total and fecal coliforms, and fecal streptococci. Shellfish samples were taken from two sites in the Bay and analyzed for total and fecal coliforms.

The results of this study showed that the shellfish market standard for fecal coliform is exceeded in all Bay water quality stations during wet periods. The dry period samples met the standard, with the exception of stations at the head of the Bay and near the mouth of Walker Creek. Seven out of eight shellfish samples exceeded the market standard. Tributary samples ranged from low fecal coliform densities during the dry periods to high densities during rainfall events. In order to quantify the numbers of bacteria entering the Bay, daily estimates of stream flow were made on major streams (Walker, Keyes, Lagunitas, Olema, and Bear Valley creeks) and several east shore tributaries to the Bay (Millerton Gulch, Tomasini Creek, Grand Canyon Creek, and Cypress Grove). Fecal coliform densities in the streams during dry weather were equal to sewage from about 150 to 200 people. During wet weather, fecal coliform densities increased to the equivalent of sewage from 1,500 to 2,000 people or 500 to 700 cows. The highest loadings following rains revealed a bacterial equivalent of 40,000 to 50,000 people or 15,000 to 20,000 cows.

The 1980 study concluded that the portions of the Bay most seriously affected by pollution from rainfall and runoff were the head of the Bay (Millerton Point south) and the Walker Creek delta. Rural and livestock sources of nonpoint pollution were considered to be the most likely cause of high fecal coliform densities in the Bay.

1994–95 Pilot Study: Department of Health Services

The pilot study conducted by DHS in the winter of 1994–95 was a prelude to the study during 1995–96 (TBSTAC, 2000). Both of these studies were initiated as a result of Tomales Bay being listed as threatened under the Shellfish Protection Act and the formation of TBSTAC. This study was designed to evaluate indicator species, test sampling methods and laboratory analyses, and finalize site selection of Watershed sampling stations for the 1995–96 study. A total of 352 samples were collected from 12 stations in the Bay and from 35 Watershed stations on nine different sampling dates during both closed and open harvesting periods. Samples were analyzed for total and

fecal coliforms, Enterococci, anaerobic bacterial indicators, and Methylene Blue-Active Substances (MBAS), which are common surfactants in detergent. A total of 26 shellfish samples were collected for total and fecal coliform analysis.

The results of this study show the impact of rainfall on the water quality of the tributaries entering Tomales Bay and on the water quality of the Bay itself following runoff events. These data support the study's theory that the major source of fecal contamination to the Bay is rainfall-related runoff from the tributaries. Two seasonal patterns of fecal coliform densities were observed: 1) sites that showed declining fecal coliform densities throughout the winter, suggesting a nonrenewable source of coliforms, and 2) sites that exhibited high fecal coliform densities throughout the season, suggesting a renewable source. The results of this pilot study were used to determine what types of analyses would be used for the full-scale study during the 1995–96 winter season and which stations should be added or deleted from the sampling design.

1995–96 Study: TBSTAC, State Water Board, DHS, Water Board

Through TBSTAC, the Water Board and DHS conducted an intensive State Water Board-funded study of bacteriological and pathogen levels in the water of Tomales Bay and its Watershed (TBSTAC, 2000). Researchers measured the concentrations of fecal coliforms in oyster tissue. They collected samples before and after the wet season and throughout rainfall events, including the day the Bay would normally be opened for shellfish harvesting (day X [i.e., 4 to 5 days after the rainfall event]). Forty sampling stations throughout the Bay and its Watersheds were sampled during two dry season periods and during four rainfall events. All samples were analyzed for four standard indicators of microbiological water quality: total coliform, fecal coliform, enterococcus, and *Escherichia coli* (E. coli). In addition, several sites were analyzed for coliphage and the anaerobic bacterium *Bacteriodes vulgatus*, indicators that were thought to be more specific for human fecal sources than the standard indicator organisms. A limited number of analyses were performed to detect the presence of pathogenic bacteria. *Salmonella typhirium* and *E. coli*:0157 were identified in separate Watershed samples (TBSTAC, 2000).

Watershed Results

Bacterial densities usually exceeded the standards within the first one or two days of each rainfall event, then typically decreased to acceptable levels by the last day of sampling. Consistently high bacterial levels were detected during most of the study at sites within the Walker/Keyes/Chileno Watershed and along the eastern shoreline watershed. Slightly lower concentrations of fecal coliforms were detected throughout the Lagunitas/Olema Subwatershed. In contrast, bacterial levels at the western shoreline Watershed stations were generally 10 to 100 times lower than those from all other Subwatersheds.

Fecal coliform loadings were calculated to estimate the amount of fecal coliforms contributed by each Subwatershed on a daily basis. The highest loadings estimated were within the Walker/Keyes/Chileno and the Lagunitas/Olema Subwatersheds. The former region is primarily dairy and livestock grazing with some residential dwellings,

while the latter contains a mix of agriculture, commercial, and residential uses. Within the Walker/Keyes/Chileno Watershed, the highest fecal coliform loadings estimated were in the Chileno Creek Subwatershed. Within the eastern shoreline Watershed, the highest fecal coliform loadings generally estimated were in the Subwatersheds represented by stations Milepost 40.35, Milepost 34.95, Millerton Creek, Milepost 32.12, Grand Canyon Creek, and Tomasini Creek. Within the Lagunitas/Olema Watershed, Lagunitas Creek contributed the largest share of the fecal load, followed by Olema Creek. The Bear Valley drainage contributed the lowest loadings for this Subwatershed. Fecal coliform loadings from the western Subwatershed were less than those contributed by the other Subwatersheds.

Bay Results

Outer-Bay (the area closer to the mouth of the Bay) sampling stations were adversely affected within the first two days following significant rainfall. Fecal coliform concentrations often remained elevated three days after a rainfall event and did not always return to acceptable levels by the day shellfish growing waters were reopened for harvest (day X). This indicates either a long residence time in the outer bay or a prolonged source of contamination. The highest fecal coliform concentrations were observed at station 34, which is in the direct influence of the branch of Walker/Keyes Creek that flows around Preston Point. Fecal coliform levels at Mid-Bay stations were generally lower than either the outer- or inner-bay regions, although all Bay stations experienced elevated concentrations of fecal coliforms immediately following rainfall. Fecal coliform levels at the inner-bay monitoring stations were slightly greater than those of the mid-Bay, and did not always return to acceptable levels by the day shellfish growing waters were reopened for harvest (day X). During rainfall event three, both inner-bay monitoring stations showed an obvious spike of fecal coliform on day X that greatly exceeded the concentrations detected within the first three days of rainfall. A possible explanation for this sharp increase would be a pulse of contamination from the Watershed or nearshore area.

Shellfish Results

The fecal coliform concentrations in oysters in the outer Bay typically reached extremely high levels following significant rainfall. These data suggest a pattern of increasing concentration throughout the winter, perhaps as a result of the continuous high fecal concentrations contributed by the Watershed. In addition, lower water temperatures in winter may result in a reduced metabolic rate in the oysters, which in turn would lengthen the time necessary for satisfactory cleansing of contaminated shellfish. Consequently, oysters in the outer Bay did not always return to the National Shellfish Sanitation Program (NSSP) market standard by the time the outer Bay was reopened for harvesting.

Within the outer Bay stations, samples were collected from sites representing two different culture techniques: top-culture (i.e., floating bags) and bottom-culture (i.e., rack and bag). The top-culture station was significantly higher than the NSSP market standard during the first dry season sampling. It is likely that these elevated levels of

fecal coliforms are the result of localized contamination, possibly from birds roosting and defecating on the floating bags.

Oysters from the Mid-Bay were found to exceed the NSSP standard following significant rainfall, but generally returned to acceptable levels for fecal coliforms by day X. Oysters from the inner-bay typically exceed the NSSP market standard after significant rainfall, and the magnitude of contamination was generally equivalent to the observed levels in the outer-bay oysters.

As a result of this study and previous supporting data, the rainfall closure requirements that DHS applies to harvesting shellfish in Tomales Bay are now more stringent (TBSTAC, 2000).

In the winter of 2000–2001, the Water Board, in conjunction with TBSTAC, designed and conducted a study with the purpose of implementing some TBSTAC recommendations from the 1995–96 study. The specific goals of the study were to: 1) verify the findings of previous studies regarding potential sources of fecal contamination to Tomales Bay and its tributaries, 2) collect fecal coliform data from some additional stations (points of interest) within the Watershed, and 3) characterize and assess the loadings of fecal coliforms to Tomales Bay during storm or “worst case scenario” conditions.

Sampling Frequency
The study consisted of five sampling events. Two dry-weather sampling events were conducted, both prior to and following the wet season. Samples for each of the three wet-season events were collected over a two-day period (with the exception of the first wet-season sampling event, which lasted only one day) that coincided with the first two days of a rainfall harvest closure (defined as 0.5 inch of rain within a 24-hour period).

Sampling Stations
A total of 20 sampling stations were selected throughout the Watershed and the Bay: three inner-Bay stations, three outer-Bay stations, and fourteen Watershed stations (Table 8 and Figure 4). Station locations were selected on the basis of their i) proximity to potential sources of fecal contamination, ii) past history of contamination, iii) areas of regulatory compliance (i.e., shellfish beds), and iv) site accessibility.

During each sampling event, fecal coliform samples were collected and analyzed for each of the 20 stations. Bay stations were sampled three times daily, whereas the Watershed stations were sampled only once in any given sampling day.

Flow/Discharge Measurements
Utilizing calibrated rating curves provided by USGS and the Point Reyes National Park Service, stream flow data in 15-minute increments were obtained for Lagunitas, Walker, and Olema Creeks from gauging stations. For the remaining streams for which no

automated gauging station and/or accurate rating curves were available, manual discharge measurements were conducted.

Table 8
List of Sampling Sites for the 2001Tomales Bay Bacterial Monitoring Study

Station Number	Station Name	Bay/Watershed
1	Tomales Bay Oyster Co. Lease (TBOC), South	Bay
2	Tomales Bay Oyster Co. Lease (TBOC), Central	Bay
3	Tomales Bay Oyster Co. Lease (TBOC), North	Bay
4	Hog Island Oyster Co. Lease (HIOC), South	Bay
5	Hog Island Oyster Co. Lease (HIOC), Central	Bay
6	Hog Island Oyster Co. Lease (HIOC), North	Bay
7	Mid Chileno Creek	Watershed
8	Walker Creek @ Walker Creek Ranch	Watershed
9	Keyes Creek @ Tomales Village	Watershed
10	Keyes Creek @ Walker Creek Confluence	Watershed
11	Walker Creek @ Highway 1 Bridge	Watershed
12	Olema Creek @ Bear Valley Road	Watershed
13	San Geronimo Creek @ White Horse Bridge	Watershed
14	San Geronimo Creek @ Roy's Pool	Watershed
15	Lagunitas Creek @ Samuel P. Taylor Park	Watershed
16	Lagunitas Creek @ Gallagher Ranch	Watershed
17	Nicasio Creek @ Platform Bridge	Watershed
18	Giacomini Levee @ Giacomini Ranch	Watershed
19	Point Reyes Station @ 3rd Street	Watershed
20	Point Reyes Station @ Mesa Road	Watershed

Watershed Results

Throughout the three wet-weather sampling events, the fecal coliform levels for all Watershed and Bay station samples significantly exceeded the designated water quality objectives for shellfish harvesting waters and, in most cases, for contact and non-contact water recreation (Table 9 and Figure 5). In general, fecal coliform levels increased during the second day of each wet-weather sampling event (with the exception of the first wet-weather sampling event, which lasted only one day).

Figure 4

Location of Sampling Stations for the 2001
Tomales Bay Bacterial Monitoring Study

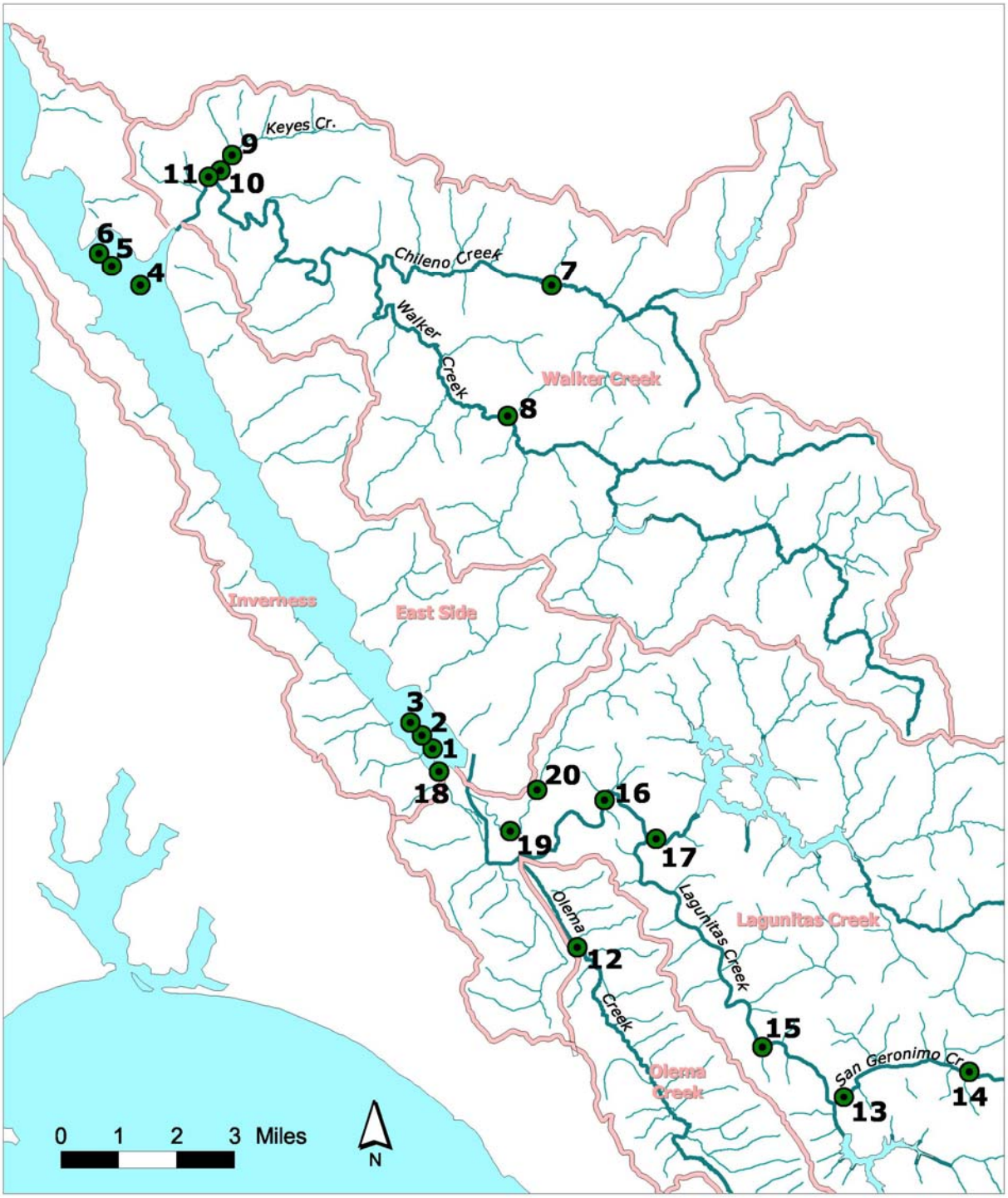


Table 9

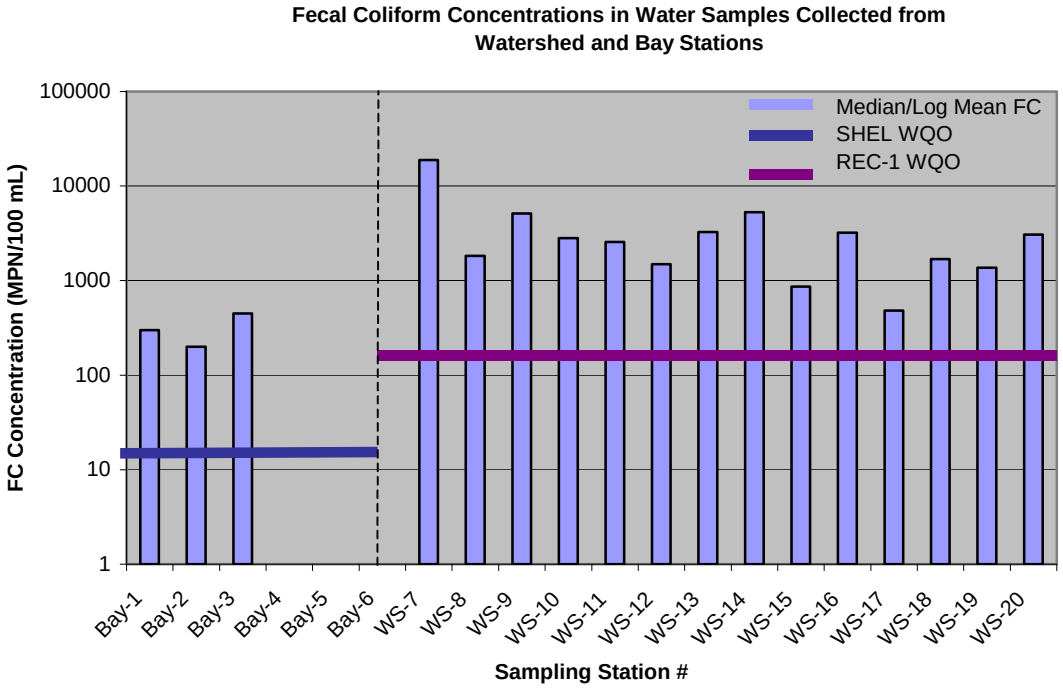
SUMMARY OF 2001 TOMALES BAY BACTERIAL MONITORING RESULTS

Station #	Station ID	Fecal Coliforms (MPN/100 mL)						
		1st Wet Event	2nd Wet Event		3rd Wet Event		Median	Log Mean
		Jan-11-01	Jan-25-01	Jan-26-01	Feb-9-01	Feb-10-01		
Bay-1	STBOC	750	300	4650	<200*	<200	**300**	
Bay-2	CTBOC	200	200	1367	<200	<200	**200**	
Bay-3	NTBOC	450	450	1700	<200	200	**450**	
Bay-4	SHIOC	NS	NS	NS	<200	NS	**NA**	
Bay-5	CHIOC	NS	NS	NS	<200	NS	**NA**	
Bay-6	NHIOC	NS	NS	NS	<200	NS	**NA**	
WS-7	CHG	126,667	11,667	32,000	800	63,333		**18,876**
WS-8	WCR	10,333	200	2,133	7,000	667		**1,831**
WS-9	KYT	9,000	1,770	7,000	6,667	4,667		**5,106**
WS-10	KYW	5,000	2,200	13,000	400	3,000		**2,798**
WS-11	WK1	3,033	500	94,333	NS	300		**2,560**
WS-12	OLC	1,000	2,100	3,033	2,550	450		**1,489**
WS-13	SGW	4,333	467	15,667	3,667	3,100		**3,246**
WS-14	SGR	3,000	3,000	24,000	11,000	1,700		**5,263**
WS-15	LCS	2,200	200	7,000	200	800		**868**
WS-16	LCG	6,533	6,667	7,667	1,200	850		**3,210**
WS-17	NIC	400	400	700	<200	<200		**339**
WS-18	GIL	2,600	700	2,200	700	5,000		**1,696**
WS-19	PR3	4,100	1,900	333	NS	NS		**1,374**
WS-20	PRM	8,000	800	5,000	5,000	1,700		**3,068**

*<200 = Since the detection limit for this analyses was 200 MPN/100mL, concentrations below this limit are listed as <200.
NS = Not Sampled.
ND = Not Available.

Figure 5

Summary of 2001 Tomales Bay Bacterial Monitoring Results



Bay Results

Due to the unavailability of a sampling boat, only one set of samples from outer-Bay Stations 4–6 was collected during this study. For the remaining inner-Bay sampling locations, Day 1 fecal coliform levels did not change between Rainfall Event No. 1 and Rainfall Event No. 2 but increased significantly on Day 2 Rainfall Event No. 2. Of the inner-Bay station samples, over all of the sampling events, the highest fecal coliform levels were consistently detected at the inner-Bay Station 1 (located south of the Tomales Bay Oyster Company lease area), which is closer to the inlet of Lagunitas and Olema Creeks than the other two inner-Bay stations.

Overall Fecal Coliform Contributions

Table 10a contains the overall ranking of all Subwatersheds according to the total number of fecal coliforms they each contributed over the span of the three rainfall sampling events. Table 10b contains the flow measurement data for all subwatersheds and monitoring dates listed in Table 10a.The lower Walker Creek Subwatershed contributed the highest one-time and highest overall fecal coliform loadings. Lower and upper San Geronimo Creek subwatersheds rank as the second- and third-largest contributors of fecal coliforms. The Keyes Creek and Olema Creek subwatersheds recorded the lowest fecal coliform loadings (Water Board, 2001).

Table 10a
Ranking of Tomales Bay Subwatersheds*

Subwatershed	FC/Day** 1/11/01	FC/Day 1/25/01	FC/Day 1/26/01	FC/Day 2/9/01	FC/Day 2/10/01	Total FC/ 5 Days
1. Lower Walker Creek (Station # 11)	9.21×10^{13}	3.78×10^{12}	1.69×10^{15}	N/A	6.67×10^{12}	**1.79×10^{15}**
2. Lower San Geronimo (Station # 13)	9.40×10^{12}	4.86×10^{11}	1.69×10^{14}	7.20×10^{12}	4.15×10^{12}	**1.90×10^{14}**
3. Upper San Geronimo (Station # 14)	4.22×10^{12}	3.22×10^{12}	9.93×10^{13}	1.42×10^{13}	1.96×10^{12}	**1.23×10^{14}**
4. Chileno Creek (Station # 7)	5.58×10^{13}	1.61×10^{12}	1.92×10^{13}	1.18×10^{11}	6.57×10^{12}	**8.33×10^{13}**
5. Lower Lagunitas Creek (Station # 16)	9.36×10^{12}	9.55×10^{12}	5.40×10^{13}	9.04×10^{11}	7.95×10^{11}	**7.46×10^{13}**
6. Upper Lagunitas Creek (Station # 15)	2.74×10^{12}	1.71×10^{11}	4.72×10^{13}	2.28×10^{11}	9.68×10^{11}	**5.13×10^{13}**
7. Upper Walker Creek (Station # 8)	7.80×10^{12}	8.12×10^{10}	3.04×10^{12}	3.81×10^{12}	3.63×10^{11}	**1.51×10^{13}**
8. Olema Creek (Station # 12)	3.47×10^{11}	1.36×10^{12}	5.73×10^{12}	1.09×10^{12}	1.44×10^{11}	**8.67×10^{12}**
9. Keyes Creek (Station # 10)	N/A	2.25×10^{11}	5.35×10^{12}	N/A	N/A	**5.57×10^{12}**

* Ranking is based on the overall fecal coliform contributions over the span of 2001 monitoring study.
** Total daily loadings were calculated by extrapolating single fecal coliform and associated flow measurements from each monitoring day over the entire 24-hour daily time period.

Table 10b
Discharge Data for Subwatersheds and Monitoring Dates Listed in Table 10a

Sub watershed	Date	Time	Discharge (m^3/s)	F.C. (FC/100 cm^3)	F.C. (FC/s)	Loading (FC/Day)
Chileno	1/11/01	13:00	0.51	1.27E+05	6.46E+08	5.58E+13
Upper-Walker	1/11/01	12:25	0.87	1.03E+04	9.03E+07	7.80E+12
Keyes	1/11/01	13:35	0.00	9.00E+03	0.00E+00	0.00E+00
Lower-Walker	1/11/01	13:50	35.15	3.03E+03	1.07E+09	9.21E+13
Olema	1/11/01	9:30	0.40	1.00E+03	4.02E+06	3.47E+11
Lower-S.G.	1/11/01	10:30	2.51	4.33E+03	1.09E+08	9.40E+12
Upper-S.G.	1/11/01	11:00	1.63	3.00E+03	4.89E+07	4.22E+12
Upper-Lagunitas	1/11/01	10:10	1.44	2.20E+03	3.17E+07	2.74E+12
Lower-Lagunitas	1/11/01	10:00	1.66	6.53E+03	1.08E+08	9.36E+12
Chileno	1/25/01	12:10	0.16	1.17E+04	1.87E+07	1.61E+12
Upper-Walker	1/25/01	11:25	0.47	2.00E+02	9.40E+05	8.12E+10
Keyes	1/25/01	13:00	0.15	1.77E+03	2.60E+06	2.25E+11
Lower-Walker	1/25/01	9:30	10.93	4.00E+02	4.37E+07	3.78E+12
Olema	1/25/01	13:30	0.75	2.10E+03	1.58E+07	1.36E+12
Lower-S.G.	1/25/01	9:20	1.20	4.67E+02	5.62E+06	4.86E+11
Upper-S.G.	1/25/01	8:50	1.24	3.00E+03	3.73E+07	3.22E+12
Upper-Lagunitas	1/25/01	9:50	0.99	2.00E+02	1.98E+06	1.71E+11
Lower-Lagunitas	1/25/01	2:00	1.66	6.67E+03	1.11E+08	9.55E+12
Chileno	1/26/01	12:15	0.69	3.20E+04	2.22E+08	1.92E+13
Upper-Walker	1/26/01	11:40	1.65	2.13E+03	3.52E+07	3.04E+12
Keyes	1/26/01	12:50	0.88	7.00E+03	6.19E+07	5.35E+12
Lower-Walker	1/26/01	1:25	20.72	9.43E+04	1.95E+10	1.69E+15
Olema	1/26/01	14:30	2.19	3.03E+03	6.63E+07	5.73E+12
Lower-S.G.	1/26/01	9:35	12.46	1.57E+04	1.95E+09	1.69E+14
Upper-S.G.	1/26/01	9:05	4.79	2.40E+04	1.15E+09	9.93E+13
Upper-Lagunitas	1/26/01	10:00	7.80	7.00E+03	5.46E+08	4.72E+13
Lower-Lagunitas	1/26/01	14:50	8.15	7.67E+03	6.25E+08	5.40E+13
Chileno	2/9/01	12:55	0.17	8.00E+02	1.36E+06	1.18E+11
Upper-Walker	2/9/01	12:15	0.63	7.00E+03	4.41E+07	3.81E+12
Keyes	2/9/01	13:25	0.00	6.67E+03	0.00E+00	0.00E+00
Lower-Walker	2/9/01	13:40	na*	na	na	na
Olema	2/9/01	13:50	0.49	2.55E+03	1.26E+07	1.09E+12
Lower-S.G.	2/9/01	10:35	2.27	3.67E+03	8.33E+07	7.20E+12
Upper-S.G.	2/9/01	10:00	1.53	1.10E+04	1.69E+08	1.46E+13
Upper-Lagunitas	2/9/01	10:55	1.32	2.00E+02	2.64E+06	2.28E+11
Lower-Lagunitas	2/9/01	14:15	1.21	8.67E+02	1.05E+07	9.04E+11

Table 10b (continued)
Discharge Data for Subwatersheds and Monitoring Dates Listed in Table 10a

Subwatershed	Date	Time	Discharge (m^3/s)	F.C. (FC/100 cm^3)	F.C. (FC/s)	Loading (FC/Day)
Chileno	2/10/01	13:00	0.12	6.33E+04	7.60E+07	6.57E+12
Upper-Walker	2/10/01	12:15	0.63	6.67E+02	4.20E+06	3.63E+11
Keyes	2/10/01	13:30	0.00	4.67E+03	0.00E+00	0.00E+00
Lower-Walker	2/10/01	14:00	28.96	2.67E+02	7.72E+07	6.67E+12
Olema	2/10/01	9:45	0.46	3.67E+02	1.67E+06	1.44E+11
Lower-S.G.	2/10/01	10:10	1.55	3.10E+03	4.80E+07	4.15E+12
Upper-S.G.	2/10/01	9:40	1.34	1.70E+03	2.27E+07	1.96E+12
Upper-Lagunitas	2/10/01	10:35	1.40	8.00E+02	1.12E+07	9.68E+11
Lower-Lagunitas	2/10/01	10:10	1.45	6.33E+02	9.20E+06	7.95E+11

* Data not available

Conclusions

The data from this study verify previous findings, demonstrating that rainfall-induced runoff has a deleterious effect on the water quality of the Bay. During the rain events monitored in this study, fecal coliform levels increased in samples taken from tributaries in the Tomales Bay Watershed, as well as in samples taken from shellfish growing waters within the Bay.

Throughout the three rainfall-sampling events, the fecal coliform concentrations for all Watershed and Bay station samples significantly exceeded the designated water quality objective of 14 MPN for Shellfish Harvesting Waters, and in most cases, even the much higher value set by the water quality objective for non-contact water recreation (mean < 2000 MPN).

The fecal coliform concentrations and loadings remained high during all rainfall events sampled in all watersheds. This suggests either the presence of a renewable source or the introduction of new sources of fecal coliform throughout portions of the Watershed. Failing onsite sewage disposal systems or runoff from animal pastures (containing manure) could be some of the potential new or renewable sources of fecal coliform.

The lower Walker Creek Subwatershed contributed the highest one-time and highest overall fecal coliform loadings. Lower and upper San Geronimo Creek subwatersheds rank as second- and third-largest fecal coliform contributors. The Keyes Creek and Olema Creek subwatersheds had the lowest fecal coliform loadings.

Several past studies suggest that runoff from dairies and livestock-grazed land are the primary source of fecal coliforms to Tomales Bay (TBSTAC, 2000). Results of the 2001 study are consistent with past findings and are summarized as follows:

- The highest fecal coliform concentrations and/or loadings are observed in the Chileno Creek and Walker Creek watersheds. Land use in these areas consists primarily of grazing lands and dairies.

- High fecal coliform levels detected in the storm drains of the town of Point Reyes Station indicate that another likely source of fecal contamination to the Bay is residential runoff.

- While livestock and domestic animals provide significant loadings of fecal coliforms to the Bay, failing residential septic systems cannot be discounted as a loading source.

- Given that the predominant land uses in the monitored segment of the San Geronimo Creek Watershed are residential housing and horse farming, we conclude that the high fecal coliform concentrations/loadings observed there are most likely due to failing/substandard residential septic systems, urban runoff containing waste from pets, and runoff containing waste from the equestrian facilities.

3.8 Recent Bacterial Monitoring Data (2004 & 2005)

In January of 2004 Water Board staff started a long-term bacterial monitoring program for the Tomales Bay Watershed. The fecal coliform data collected from this monitoring effort are presented in table 11a-c below.

Table 11a

Tomales Bay/Watershed Fecal Coliform (FC) Monitoring Results from Winter 2004

Sampling Station	Station No.	Sampling Date					Median FC/100 mL	Log Mean FC/100 mL
		1/6/04	1/13/04	1/20/04	1/27/04	2/3/04		
Bay 2	Bay-1	14	NS	2	5	2	**3.5**	**N/A**
Bay 7	Bay-2	7	8	5	7	3500	**7.0**	**N/A**
Bay 11	Bay-3	350	350	33	23	16000	**350.0**	**N/A**
Bay 39	Bay-4	11	NS	0	5	0	**2.5**	**N/A**
Bay 47	Bay-5	8	NS	0	13	2	**5.0**	**N/A**
Inverness 1st Valley	WS-1	49	950	33	240	130	**N/A**	**137**
Inverness 2nd Valley	WS-2	23	5400	49	240	350	**N/A**	**220**
Inverness 3rd Valley*	WS-3	12	23	49	240	5	**N/A**	**28**
Lagunitas Creek @ Gallagher Ranch	WS-4	60	49	350	49	350	**N/A**	**112**
Millerton Creek @ HWY One	WS-5	130	700	285	16000	2400	**N/A**	**999**
East Shore Drainage @ MP 36.16	WS-6	33	110	79	240	350	**N/A**	**119**
Walker Creek @ Walker Creek Ranch	WS-7	700	46	70	2550	700	**N/A**	**332**
Upper Keys Creek @ Tomales	WS-8	8	220	350	9200	7300	**N/A**	**529**
Walker Creek @ HWY One	WS-9	540	87	130	350	2400	**N/A**	**348**
Upper Chileno Creek (below Laguna Lake)	WS-10	110	23	70	540	2400	**N/A**	**187**
Olema-Mainstem above Randall Gulch	WS-11	70	130	240	900	140	**N/A**	**194**
Olema-John West Fork	WS-12	20	70	8	900	170	**N/A**	**70**

Table 11a (continued)

Tomales Bay/Watershed Fecal Coliform (FC) Monitoring Results from Winter 2004

Olema-Mainstem @ Five Brooks	WS-13	20	40	300	1600	300	**N/A**	**163**
Olema-Davis Boucher tributary	WS-14	20	20	30	500	8	**N/A**	**34**
Olema-Downstream of Olema pasture flow	WS-15	200	220	130	2400	500	**N/A**	**369**
Olema-Bear Valley Rd. bridge	WS-16	2000	40	20	1300	50	**N/A**	**160**
East Fork Woodacre Creek	WS-17	79	1700	49	1100	5400	**N/A**	**523**
West Fork Woodacre Creek	WS-18	110	260	700	1400	700	**N/A**	**456**
Woodacre Creek	WS-19	1600	540	79	5400	2400	**N/A**	**976**
San Geronimo Creek @ Roy's Pool	WS-20	350	170	700	5400	9200	**N/A**	**1157**
Montezuma Creek	WS-21	540	130	3500	220	1700	**N/A**	**620**
Arroyo Creek	WS-22	110	33	240	2200	540	**N/A**	**253**
San Geronimo Creek @ Inkwells	WS-23	210	140	350	3500	920	**N/A**	**506**
Lagunitas Creek below Devils Gulch	WS-24	110	180	240	1600	1600	**N/A**	**414**
Lagunitas Creek below Cheda	WS-25	49	79	240	2100	9200	**N/A**	**448**
Lagunitas Creek below Jewell	WS-26	110	70	49	390	5400	**N/A**	**240**

* Inverness 3rd Valley is considered a watershed with minimal anthropogenic influences.
NS = Not Sampled
NA = Not Applicable

Table 11b

Tomales Bay Watershed Fecal Coliform (FC) Monitoring Result From Summer 2004

Sampling Station	**Station No.**	**Sampling Date**					**Log Mean FC/100 mL**
		6/1/04	**6/8/04**	**6/15/04**	**6/24/04**	**6/29/04**	
Inverness 1st Valley	WS-1	170	350	350	110	350	**240**
Inverness 2nd Valley	WS-2	220	79	350	350	350	**237**
Inverness 3rd Valley*	WS-3	49	9	33	23	350	**41**
Lagunitas Creek @ Gallagher Ranch	WS-4	130	110	140	140	70	**114**
Millerton Creek @ HWY One	WS-5	33	8	33	7	2	**10**
East Shore Drainage @ MP 36.16	WS-6	220	240	295	9200	1100	**691**
Walker Creek @ Walker Creek Ranch	WS-7	170	120	110	200	540	**189**
Upper Keys Creek @ Tomales	WS-8	16000	16000	920	16000	180	**3684**
Walker Creek @ HWY one	WS-9	170	130	79	130	70	**110**
Upper Chileno Creek (below Laguna Lake)	WS-10	540	23	920	3500	920	**517**

* Inverness 3rd Valley is considered a watershed with minimal anthropogenic influences.

Table 11c

Tomales Bay Watershed Fecal Coliform (FC) Monitoring Result from Winter 2005

Sampling Station	Station #	Date					Log Mean FC/100 mL
		2/1/05	2/8/05	2/15/05	2/22/05	3/1/05	
Inverness 1st Valley	WS-1	300	170	1700	80	110	**238**
Inverness 2nd Valley	WS-2	130	70	800	70	40	**115**
Inverness 3rd Valley*	WS-3	130	20	240	17	23	**48**
Lagunitas Creek @ Gallagher	WS-4	80	13	170	130	110	**76**
Millerton Creek @ HWY One	WS-5	105	170	16000	300	300	**481**
East Shore Drainage @ MP 36.16	WS-6	20	17	170	130	70	**55**
Walker Creek @ Walker Creek Ranch	WS-7	50	110	2600	110	230	**205**
Upper Keys Creek @ Tomales	WS-8	300	800	16000	500	500	**992**
Walker Creek @ HWY one	WS-9	110	140	1700	500	400	**350**
Upper Chileno Creek (below Laguna Lake)	WS-10	30	13	1300	17	80	**59**
Olema-Mainstem above Randall Gulch	WS-11	800	80	1300	110	1100	**399**
Olema-John West Fork	WS-12	130	40	2200	170	800	**274**
Olema-Mainstem @ Five Brooks	WS-13	800	20	800	500	800	**348**
Olema-Davis Boucher tributary	WS-14	220	300	300	240	130	**228**
Olema-at Caltrans	WS-15	200	70	500	50	300	**160**
Olema-Bear Valley Rd. bridge	WS-16	400	80	9000	130	800	**496**
East Fork Woodacre Creek	WS-17	40	130	16000	300	50	**263**
West Fork Woodacre Creek	WS-18	50	170	9000	30	30	**147**
Woodacre Creek	WS-19	170	140	5000	500	500	**495**
San Geronimo Creek @ Roy's Pool	WS-20	23	80	16000	500	220	**318**
Montezuma Creek	WS-21	23	700	1600	130	230	**238**
Arroyo Creek	WS-22	50	130	900	130	80	**143**
San Geronimo Creek @ Inkwells	WS-23	110	210	5000	170	130	**303**
Lagunitas Creek Below Devil's Gulch	WS-24	300	40	300	300	50	**140**
Lagunitas Creek Below Cheda Creek	WS-25	8	80	220	170	50	**65**

* Inverness 3rd Valley is considered a watershed with minimal anthropogenic influences.

3.9 Illness Outbreak

On May 13, 1998, DHS was notified of a food-borne illness outbreak associated with the consumption of Tomales Bay oysters. DHS closed the Bay to shellfish harvesting and launched an investigation, which included several divisions at DHS, FDA, the Centers for Disease Control and Prevention, and several local county health departments. This illness affected 171 people and was caused by a virus of human fecal origin. An investigation determined that the oysters causing the illness were harvested from mid- and outer-Bay locations. DHS had collected water and shellfish samples on the earliest dates that the contaminated shellfish could have been harvested. This was after a rainfall closure and there was no additional rainfall after this time. Data showed that both water and shellfish met fecal coliform standards. After subsequent studies, DHS opened the mid- and outer-bay leases to shellfish harvesting on August 4, 1998.

3.10 Problem Statement

To summarize, the following arguments form the basis for designating Tomales Bay and its tributaries as impaired due to pathogens:

1. Tomales Bay exceeds water quality objectives set by (a) Water Board in the Basin Plan; (b) DHS; and (c) FDA through the National Shellfish Sanitation Program. Since DHS rainfall closure rules are based on fecal coliform concentrations in water and shellfish, the number of days Tomales Bay is closed for harvesting is a conservative estimate of the number of days fecal coliform concentrations exceed standards. In recent years, on average, Tomales Bay has been closed to harvesting approximately 70 days per year, and therefore it is assumed that fecal coliform standards are exceeded for approximately 70 days per year.

2. Under the Porter Cologne Water Quality Control Act (California Water Code, Division 7, Chapter 24, Section 14950–14958), the Shellfish Protection Act, Tomales Bay is considered threatened due to the conditions listed above.

3. DHS prohibits shellfish harvesting during periods of rainfall based on the results of bacteriological studies. The Bay is closed to harvesting approximately 70 days per year. Therefore, the beneficial use of shellfish harvesting is not currently being protected during the wet season.

4. A major human illness outbreak caused by the consumption of Tomales Bay oysters contaminated with a pathogenic human virus occurred during a dry weather period in May 1998. This suggests that the beneficial uses of the Bay are not adequately protected even in the absence of wet weather conditions.

4. NUMERIC TARGETS

4.1 Numeric Targets

In order to develop a TMDL, a desired or target condition must be established to provide measurable environmental management goals and a clear linkage to attaining the applicable water quality objectives.

The numeric targets (desired future conditions for the Bay and its tributaries) proposed for this TMDL are as follows:

1. Water Board Basin Plan's water quality objective (WQO) for Tomales Bay shellfish growing waters;
2. Water Board's Basin Plan WQO for water contact recreation for all the major tributaries to Tomales Bay;
3. A shellfish harvesting closure target of <30 days per year; and,
4. A zero discharge of human waste for the Bay and all its tributaries.

The first target is the fecal coliform water quality objective as contained in the Basin Plan (Table 12). The Basin Plan also lists a total coliform objective to protect the beneficial use of shellfish harvesting. Fecal coliforms are proposed as targets and not total coliforms because fecal coliforms are a better indicator of fecal contamination and their use as an indicator is consistent with how DHS regulates the shellfish growing industry.

Table 12
Numeric Targets for Fecal Coliforms for Tomales Bay and its Tributaries [b]

Water Body	Fecal Coliform
Tomales Bay (SHEL WQO)[c]	Median<14 (MPN[a]/100 mL) 90th percentile <43(MPN/100 mL)
Tomales Bay Tributaries[c]	Log mean<200 (MPN/100mL) 90th percentile<400 (MPN/100mL)

a. Most Probable Number (MPN) is a statistical representation of the standard coliform test results.[4]
b. Based on a minimum of five consecutive samples equally spaced over a 30-day period.
c. All samples should be collected at the knee-high depth.

Water contact recreation (REC-I) and non-contact recreation (REC-II) are two other beneficial uses of the Bay that have fecal and total coliform objectives that are designed

[4] The Most Probable Number (MPN) is a statistical reduction of the data generated by the assay of interest. For example, in the Multiple Tube Fermentation assay—a multistep assay consisting of presumptive, confirmed, and complete phases—serial dilutions of a sample are inoculated into broth media. Analysts will then score the number of gas producing tubes, from which the other two phases of the assay are performed, then use the combinations of positive results to consult a statistical table to estimate the number of organisms present.

to protect against the transmission of pathogens. The fecal coliform objectives to protect these uses (REC-I log mean <200MPN/100mL and 90%<400 MPN/100mL, REC-II mean<2000 MPN/100mL and 90%<4000 MPN/100mL) are much higher (i.e., allow a larger concentration of bacteria) than the objectives used to protect shellfish harvesting. By requiring water quality in the entire Bay to meet the shellfish harvesting fecal coliform objective, the (less stringent) objectives assigned to the other beneficial uses in the Bay will also be met.

The second target is the Basin Plan's fecal coliform objective for water contact recreation. This target applies to Tomales Bay's main tributaries, Lagunitas, Walker, and Olema Creeks (Table 12). Considering that the main sources of pathogens to the Bay are located within the watersheds of these tributaries and that some of these tributaries are also impaired due to pathogens, this target is proposed to fully protect the beneficial uses of the tributaries.

The third target for Tomales Bay is expressed in terms of the number of days commercial shellfish growing areas are subjected to harvest closures due to elevated water column bacteria densities. Consistent with the definition of "threatened conditions" under Section 14954 of the California Shellfish Protection Act of 1993, Tomales Bay shellfish growing areas shall not be closed for harvest for more than 30 days per calendar year.

The fourth target is zero discharge of human waste to the waters of Tomales Bay and its tributaries. This target is based on the knowledge that human waste can be a significant source of pathogenic organisms, including viruses, and attainment of fecal coliform objectives is not sufficient to fully protect human health. Human waste can contain both bacterial and viral pathogens and is the greatest concern to human health. Fecal coliforms are bacterial indicators, which may not fully confirm a presence or lack of human viruses. The 1998 illness outbreak is evidence that compliance with fecal coliform objectives alone may not sufficiently protect human health. Because the list of existing viruses is exhaustive and ever changing, a virus-specific target is not feasible and a prohibition of human waste discharge is proposed.

A target of no discharge of human waste into Tomales Bay or its tributaries is consistent with existing water quality plans and policies. The Basin Plan prohibits discharge of raw sewage or inadequately treated waste into Tomales Bay and its tributaries based on two existing prohibitions in the Basin Plan in Table 4-1 (prohibition # 5 and #15). Prohibition #15 states: "It shall be prohibited to discharge any raw sewage or any waste failing to meet waste discharge requirements to any waters of the Basin." Prohibition #5 states: "It shall be prohibited to discharge any wastewater which has particular characteristics of concern to beneficial uses to Tomales Bay…". These prohibitions are applicable to all discharges of human waste whether associated with recreational use (boating, camping, etc.) or residential use as well as septic systems. Septic systems that discharge to land and that are functioning and in accordance with accepted design standards (new systems) or performance standards (existing systems) and which are properly operated and maintained are deemed in compliance with prohibitions. Nonpoint

source runoffs containing coliform bacteria of animal and wildlife origin, at levels that do not result in exceedances of water quality objectives, is not considered “wastewater with particular characteristics of concern to beneficial uses” and therefore are also deemed in compliance with the prohibition.

All four targets are consistent with water quality objectives, the Shellfish Protection Act, and prohibitions included in the Basin Plan. Since these targets are based on conservatively established protective water quality objectives, they contain an inherent margin of safety. These targets are proposed as the desired water quality this TMDL aims to achieve.

5. POLLUTANT SOURCE ASSESSMENT

If not properly managed, the following Tomales Bay Watershed source categories have the potential to discharge pathogens to surface waters: on-site sewage disposal systems (OSDSs), small wastewater treatment facilities and sewage holding ponds, boat discharges, grazing lands, dairies, equestrian facilities, and municipal runoff. Pathogens sources are identified based on elevated coliform bacteria levels downstream of identified land uses or facilities and from documentation of inadequately treated human waste discharges.

- The Walker Creek watershed is dominated by grazing lands. Coliform bacteria levels and coliform loads from the Walker Creek watershed are extremely high during storm periods and a significant coliform source to Tomales Bay (TBSTAC, 2000; Water Board, 2001).
- High coliform levels detected in storm drains indicate that municipal runoff is a pathogens source (Water Board, 2001).
- High coliform levels and loads downstream of residential homes and equestrian facilities suggest that failing septic systems, municipal runoff, and equestrian facilities are coliform sources (Water Board, 2001).
- The Water Board regulates ten small wastewater treatment facilities and sewage holding ponds and prohibits direct discharges from these facilities into Tomales Bay or its tributaries. Four facilities have holding ponds and are permitted to discharge treated effluent to irrigation fields in the dry season. The other six wastewater treatment facilities utilize leach fields for dispersing treated effluent. Accidental malfunctions, including the breaching of ponds, a break in a sewage line, or land application when soil is saturated or it is raining, could result in discharge of untreated or partially treated effluent. Therefore, these facilities are considered potential sources.

Figure 6 below presents recent bacteriological monitoring results for different Tomales Bay Watershed's land uses (see Section 3.8 for recent bacteriological monitoring data).

Warm-blooded mammals and birds that reside in the watershed and Bay produce coliform bacteria. During non-storm periods Tomales Bay coliform levels are typically below the designated water quality objectives, indicating that in-Bay wildlife such as seals and birds are not significant sources (DHS, 2002). Approximately 30% of the lands draining to Tomales Bay are open space forested lands. Water quality monitoring of a watershed (Third Valley in Inverness) on the western shoreline of Tomales Bay with minimal human influences suggests that waters draining open space areas are below tributary bacteria water quality objectives and therefore terrestrial wildlife are not a significant source (Figure 7).

Figure 6

Summary of 2004 & 2005 Tomales Bay Watershed Bacterial Monitoring Results

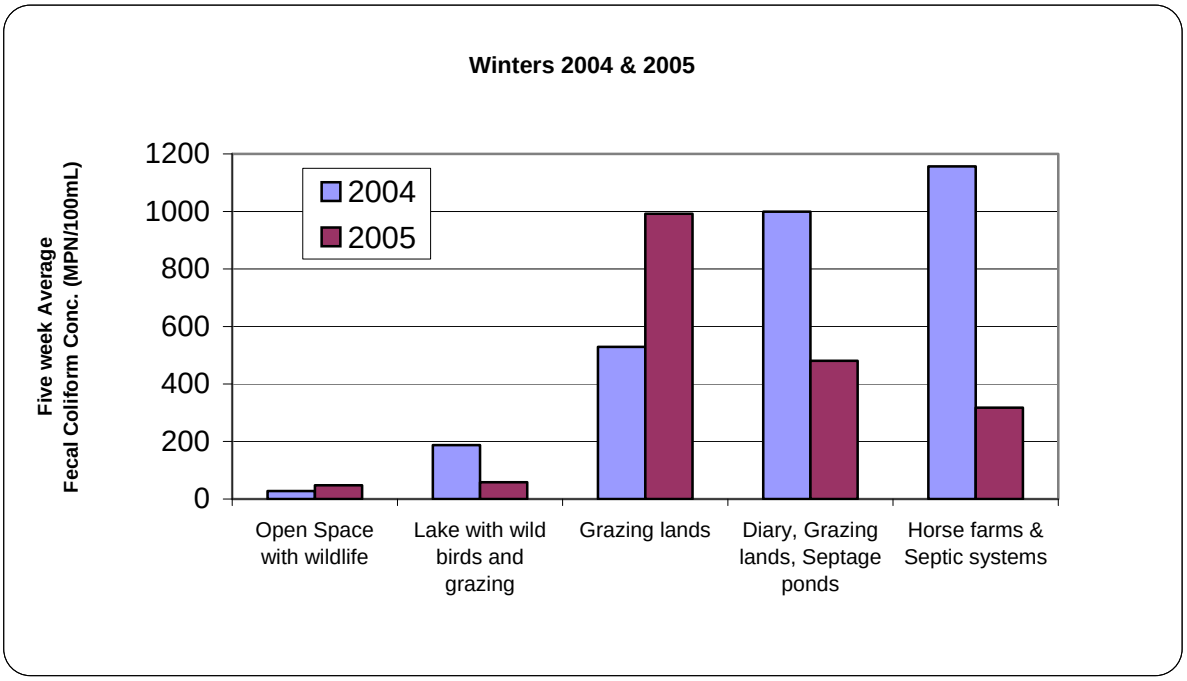
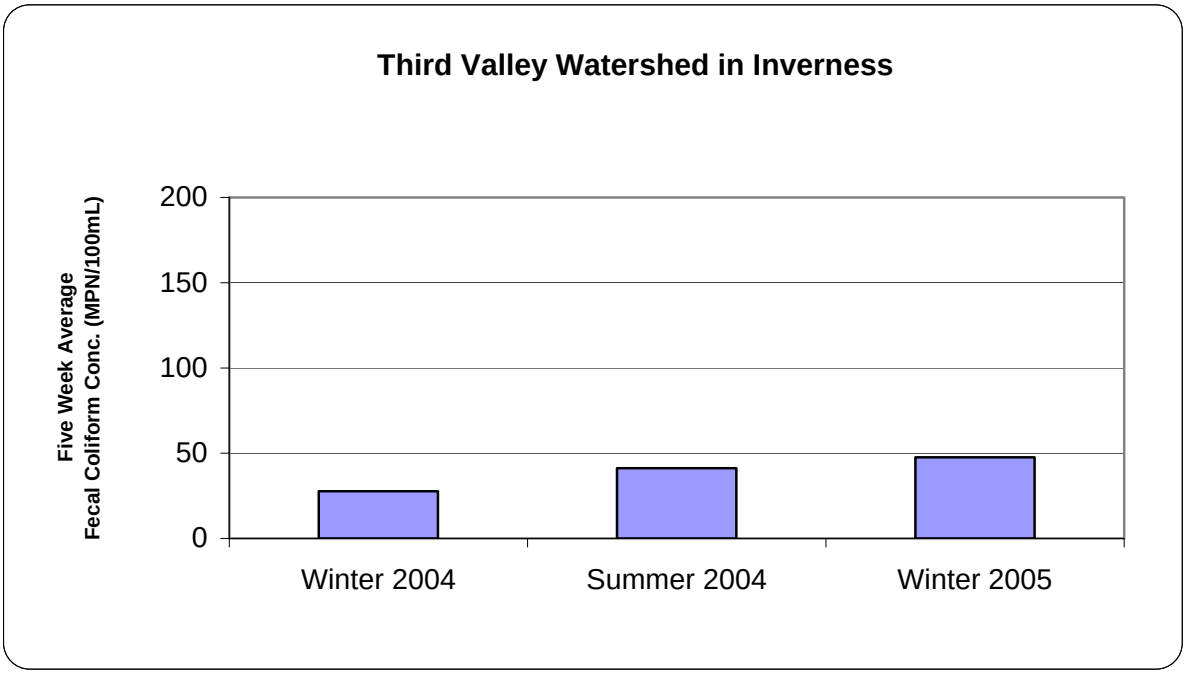


Figure 7

Background Bacteriological Monitoring Results



The following sections discuss the location, magnitude, and significance level of each source.

5.1 Agricultural Runoff

Location

Figure 8 shows the locations and distribution of various land uses within the greater Tomales Bay Watershed based on data obtained from Association of Bay Area Governments (ABAG), Department of Conservation Land Use, County of Marin, and National Park Service. As illustrated on the map, the cattle grazing and dairy land uses (Agriculture/Grazing) are mainly located on the east and southern portion of the Watershed and adjacent or very near the Bay and many of its tributaries.

Magnitude

Table 13 summarizes the land use acreage for each Tomales Bay Subwatershed. Dairies and grazing account for almost 55% of the land uses by acreage. Table 14 shows approximate numbers of livestock in different areas of the Watershed based on data collected in 1990. A review of the Report of Waste Discharge (submitted in early 2004) for the ten dairies draining into the Tomales Bay Watershed shows the total number of animals to be approximately 3,910 cows. The information from these files is taken directly from the dairy manager and is not independently verified.

Significance

A variety of bacteria and protozoa found in livestock waste can be transmitted to humans and pose serious health problems. Some of the pathogens of primary concern that can be shed in the feces of livestock and transmitted to humans through water are listed in Table 15. Because the Tomales Bay Watershed is dominated by animal agriculture land use (grazing, livestock farming), and due to the proximity and hydrological accessibility of these land uses to the Bay and its tributaries, agricultural runoff carrying animal waste from grazing lands and/or confined animal facilities (beef, dairy, sheep, horse farms), is a significant source of pathogen loading to Tomales Bay and its tributaries. As discussed in section 3, the 2001 monitoring study confirmed that the largest pathogen-indicator loads to the Bay are from watersheds that are primarily used for livestock grazing and dairy farming (Walker and Chileno Creeks watersheds) (Table 10). Also, several studies have documented that livestock grazing results in an increase in fecal coliform counts over the background concentrations (Gary et al., 1983; Tiedman et al, 1987).

Figure 8

Land Use in the Tomales Bay Watershed

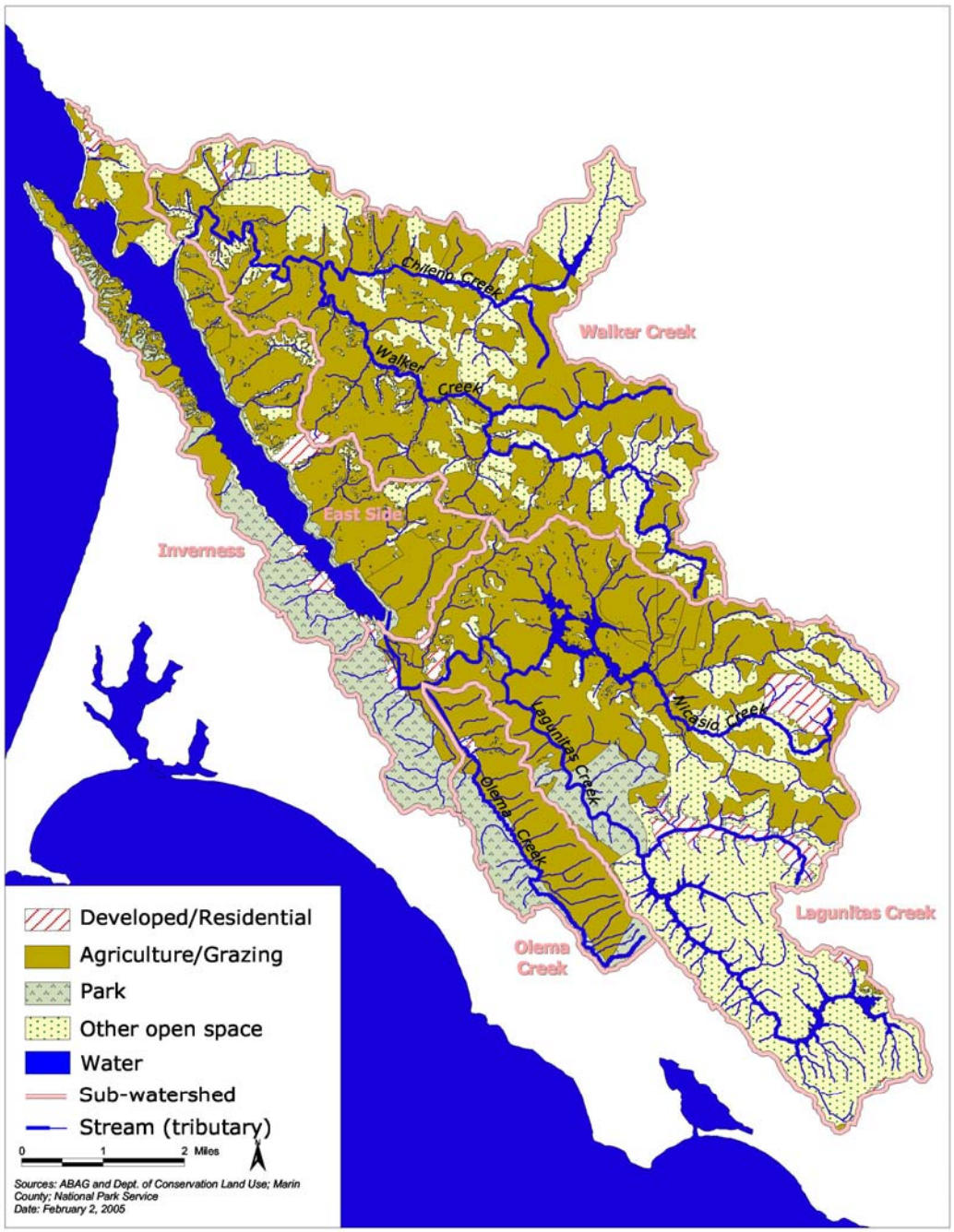


Table 13
Tomales Bay Land Use Acreage by Subwatershed

Land Use	Eastern Side	Inverness	Lagunitas	Olema	Walker	total	Percent Total
Agriculture/ Grazing[a]	11,972	2,308	25,138	6,202	30,014	75,633	**54.7%**
Developed[b]	623	206	3,487	93	281	4,690	**3.4%**
Park[c]	328	1,012	7,041	3,050	43	14,473	**10.4%**
Other/Open[d]	2,660	347	23,205	4	17,305	43,521	**31.5%**
Total	**15,583**	**3,873**	**58,871**	**9,349**	**47,643**	**138,317**	**100%**

a. Actual and potential grazing areas, defined as parcels with operating dairies, areas defined as "rangeland" in Association of Bay Area Governments (ABAG) 1996 dataset, and "grazing" areas identified by California Department of Conservation Farm Land Mapping and Monitoring Program dataset. These include lands within the jurisdiction of the Point Reyes National Seashore.
b. All "urban" land uses identified in the ABAG 1996 Land Use and Land Cover (LULC) dataset.
c. Non-grazing areas within the jurisdiction of the Point Reyes National Seashore and other state and local parks.
d. Non-rangeland areas in the ABAG 1996 LULC dataset. These are primarily forested areas.

Table 14
Estimated Numbers of Livestock[a] in the Tomales Bay Watershed[b]

Drainage	Dairy Cows/Heifers	Beef	Sheep	Total Head
Chileno Creek	2,592	230	---	2,822
Keyes Creek	786	---	---	786
Walker Creek (excluding Chileno Creek)	1,182	540	1,000	2,722
Marshall to Pt. Reyes Station	3,847	550	---	4,397
Lagunitas/Nicasio Reservoir	2,563	230	---	2,793
Totals	**10,970**	**1,550**	**1,000**	**13,520**

a. Approximate numbers based on rough estimate by the University of California Cooperative Extension.
b. Table adapted from TBSTAC, 2000.

Table 15 **List of Water-Transmissible Livestock Fecal Pathogens of Primary Concern to Humans**	
Waterborne Protozoa Pathogens of Primary Concern	**Special Concerns**
Cryptosporidium parvum	Low infectious dose; environmentally resistant oocysts
Giardia duodenalis	Low infectious dose; environmentally resistant cysts
Waterborne Bacterial Pathogens of Primary Concern	
Campylobacter spp.	Common in livestock and wild birds
Salmonella ssp.	Common in livestock feces
Pathogenic strains of E. coli	Can be highly infectious for humans
Waterborne Viral Pathogens of Primary Concern	
Hepatitis E virus	Little scientific evidence that viruses shed in the feces of livestock pose a health threat to humans in the United States. There is, however, growing concern regarding Hepatitis E virus from swine.
Source: Table adapted from "Microbial Pathogen Excreted by Livestock and Potentially Transmitted to Humans through Water." (Atwill, 1995).	

5.2 Faulty On-site Sewage Disposal Systems

Location

The unincorporated areas around the Bay and its tributaries are served entirely by various types of on-site sewage disposal systems (OSDS) including septic tank and leach-field systems, holding tanks, and seepage pits. Figure 9 shows the location and distribution of land parcels with OSDSs within 150 feet of the Bay and/or a stream in the Tomales Bay Watershed.

Magnitude

According to Marin County Community Development Department data, approximately 1,300 parcels within 100 feet of Tomales Bay and its tributaries have OSDSs.

The California Department of Health Services has also collected their own data through shoreline surveys. Their data collection followed different criteria than the County of Marin and therefore has slightly different estimates. The 2000 shoreline survey of the Tomales Bay by DHS found 134 parcels with OSDSs within 100 feet of the Bay (DHS, 2001).

In 2001, DHS conducted additional shoreline surveys and concluded that:

- Of the parcels surveyed, many of the residences are unsuitable for an OSDS.

- The majority of the parcels lack sufficient available land to install an OSDS that meets the required sanitary setbacks and construction standards.

- Proper functioning OSDSs are unlikely at many residences due to site conditions.

Since then, DHS has gathered more information on parcels with OSDSs in the Watershed of Tomales Bay, which is summarized below. They obtained this information through shoreline surveys, survey questionnaires, and file reviews (DHS, 2001).

- Of the known 2,260 parcels in the study area, approximately 1,600 parcels are assumed to have OSDSs.

- Along Tomales Bay shoreline, 134 systems have extremely limited area available to properly operate an OSDS with a leach field. Most of these parcels offer limited space for structures. Many of these parcels are directly adjacent to the Bay or hanging over the Bay. In addition, many of the leach fields are paved over or used for parking.

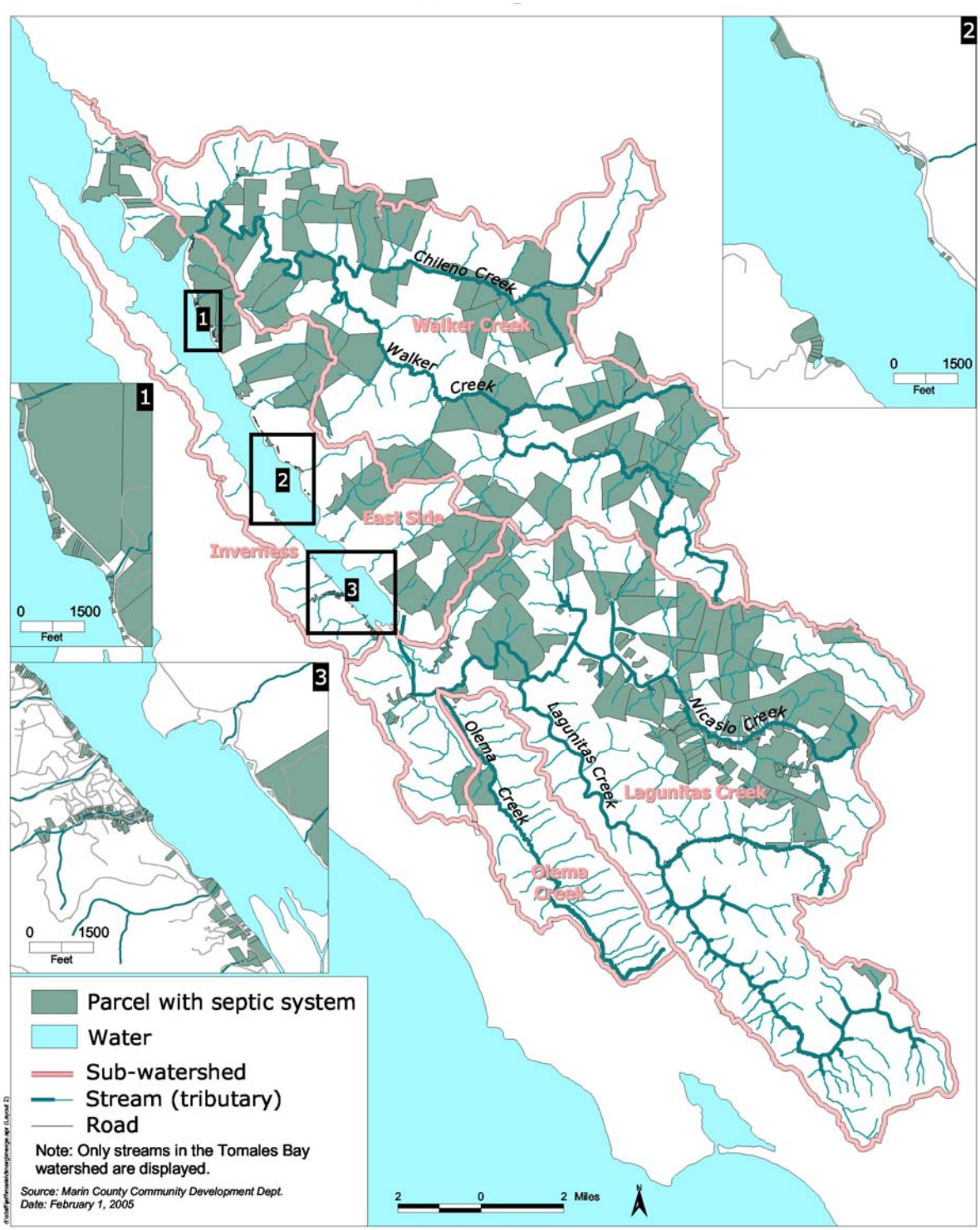
- The shoreline of Tomales Bay and tributaries to the Bay have 533 septic parcels within 100 feet of surface water. Although a detailed analysis of flood area maps was not performed, there are 15 flood-prone parcels in the vicinity of Lagunitas Creek and Highway 1. This number could increase based on further analysis. The septic systems on these properties will likely fail during flood events. The area also has 743 parcels located 100 to 500 feet from surface water. All of the estimated 1,600 parcels with OSDSs have poor soils for septic absorption fields as determined by USDA.

- DHS ranks the OSDS parcels into three categories as follows: The first rank (high-impact rank) is a group of 144 parcels with a scoring range of 55–110. The second rank (medium-impact rank) is a group of 708 parcels with a scoring range of 15–34. The third rank (low-impact rank) is a group of 754 parcels with a score of 5.

- The high-priority parcels are made up of a cumulative score of non-compliance, known septic system problem areas, incomplete file information, proximity to surface waters, limited space for functioning leach field, structure overhangs the Bay, area known to flood, and poor soils. These parcels are directly adjacent to the Bay or within 100 feet of surface water. The medium-priority sites are parcels that are within 500 feet of surface water and have poor soils. The lower-priority sites have only soil problems.

Figure 9

Septic Parcels Within 150 Feet of a Stream in Tomales Bay Watershed



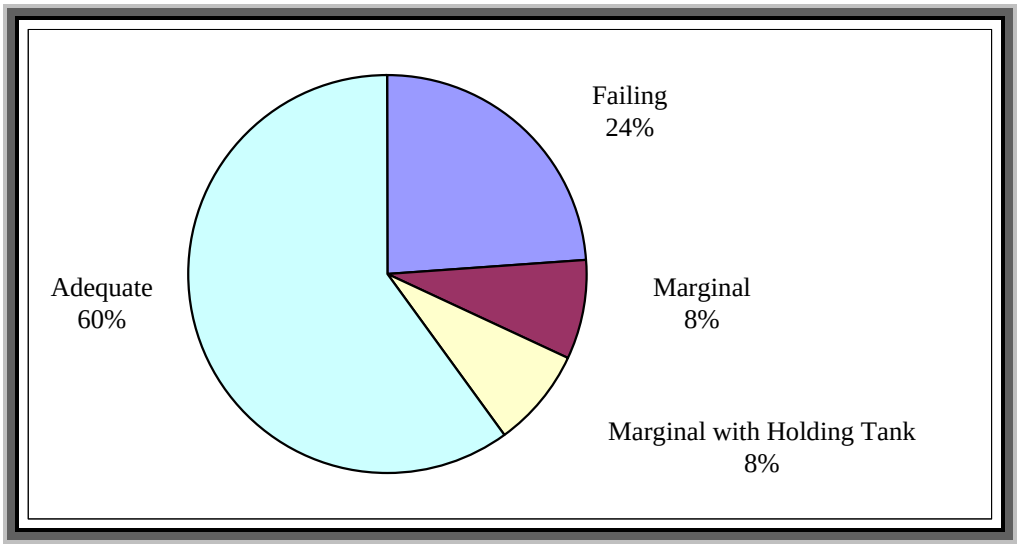
In a recent effort by the Marin County Community Development Agency and citizens of the East Shore of Tomales Bay, 37 OSDSs were inspected in the town of Marshall (on

the eastern shoreline of Tomales Bay) to create a geographically representative sample from which to draw inferences on the remainder of the OSDSs (CSW/Stuber-Stroeh, Inc., 2002). Of those inspected, 75% were adjacent to Tomales Bay and the remaining 25% were in the lower (properties within 150 feet of the east side of Highway 1) or upper (properties farther than 150 feet of the east side of Highway 1) uplands. This compares to 65% adjacent to Tomales Bay and 35% in the uplands for Marshall as a whole.

The study rated the 37 systems as follows: 22 (60%) Adequate, 3 (8%) Marginal, 3 (8%) others Marginal because they used holding tanks, and 9 (24%) Failing (Figure 10).

Figure 10

Septic System Performance Rating for Town of Marshall



Significance

Although both human and animal waste are associated with a variety of bacterial and protozoa pathogens, human waste can also contain viral pathogens, which are of greatest concern to human health (Table 16).

Faulty OSDSs are one of the most significant sources of human pathogens in the Watershed. One study (Cogger and Carlile, 1984) found that OSDSs in year-round saturated soil on average could only treat (reduce) the concentration of fecal coliforms in nearby wells to 1,700 MPN/L. The study also found that even the OSDSs that were only seasonally saturated on average could only reduce the concentration of fecal coliforms down to 560 MPN/L in the groundwater. The greatest amount of lateral transport occurred when continuous saturation was accompanied by a steep groundwater gradient.

Table 16
Selected Pathogenic Human Enteric Viruses

Virus Group	Diseases
Enteroviruses (e.g., Poliovirus, Coxsackievirus, Echovirus)	Paralysis, aseptic meningitis, myocarditis, encephalitis
Adenovirus	Gastroenteritis, acute conjunctivitis, diarrhea, eye infection
Rotavirus	Infantile gastroenteritis
Astrovirus	Gastroenteritis
Calcivirus	Gastroenteritis
Norwalk Viruses	Gastroenteritis

Source: Adapted from the U.S. Centers for Disease Control's Disease Information Web site (Respiratory and Enteric Viruses Branch) (CDC, 2005).

Based on various surveys and inspections, a significant percentage of all OSDSs in Tomales Bay Watershed appear to be either failing or in marginal condition. Further, results from the 2001 microbial monitoring study of Tomales Bay and its tributaries revealed that low-density residential and open space (San Geronimo) subwatersheds contributed the second-largest loadings of pathogen-indicators to the Bay (Table 10).

Based on the information stated above, faulty OSDSs are considered a significant pathogen source to the Bay and its tributaries and pose a risk to public health.

5.3 Boat Discharges

Location

There are 17 boating facilities in Tomales Bay including marinas, kayak rental operations and public access and boat launching areas (California Department of Boating and Waterways, 2004). The number of liveaboard boats in the Bay is estimated to be four (DHS, 2002). Small concentrations of moored boats are found at Lawson's Landing, Reynolds Cove, and the Marshall Boat Works. Liveaboards are not currently regulated in Tomales Bay and there are no controls over the mooring of boats that enter the Bay for short periods of time, primarily during the summer months.

Magnitude

The Bay is estimated to support summer weekend recreational boating community of approximately 450 boats (California Department of Boating and Waterways, 2004). This estimate includes motor boats, human and wind-powered vessels, and moored vessels. In 2000, DFG reported that 38 permits for commercial fishing vessels were issued for the Pacific Herring (*Cluper harengus*) Fishery. Most of the fishing companies double up

their fishing efforts, which translates to only 22 fishing boats on Tomales Bay. DFG currently has no plans to issue more permits for the Pacific Herring Fishery. Therefore, through attrition the number of permitees will only decrease over time.

The number of kayakers recreating on the Bay has increased in recent years. While the majority of kayakers head for the National Park land on the western shore, many begin their trips from the east shore, bringing them in proximity to several of the certified shellfish growing areas. The number of boats using the launching facilities at Miller Park has more than doubled since 1995. In 1995, 2,300 boats used the launch site; by October 2001, 6,000 boats had used the launch (DHS, 2002). There were an estimated 126 human powered crafts (includes kayakers, canoes, sculling craft) using the Bay on one summer weekend in 2003 (California Department of Boating and Waterways, 2004).

Significance

With thousands of boats using the Bay each year, boaters could potentially be a significant source of human pathogens to the Bay. Currently, monitoring and enforcement of boat and marina sewage disposal is unclear. Further, there are presently no sewage pump-out facilities or dump stations (for boats with holding tanks) within the Bay, increasing the risk of Bay pollution from boats. More importantly, it is believed that many of the boats do not have “head” facilities on board or the individual boaters chose not to use their on-board heads because of potential leakage or odor problems. It is possible that illicit waste discharges from boats are contributing fecal contamination to the Bay. Since the wastes are of human origin, these potential discharges pose a significant threat to water quality and public health.

5.4 Open Space Lands

Location and Magnitude

Open space lands account for approximately 32% of the land use in the Tomales Bay Watershed (Table 13). A variety of terrestrial wildlife, such as deer, elks, birds, rodents, that inhabit the open space lands adjacent to the Bay and its tributaries may contribute pathogens to these water bodies. No accurate information as to the magnitude and geographic dispersion of this waste is available at this time.

In addition to the terrestrial animals, various populations of marine birds and mammals are also present in the Bay. Migratory waterfowl are more numerous in the Bay during the winter months. Increased numbers of sea birds are also attracted to the Bay during) the Pacific Herring spawns, which occur from December through February. Census data from the Audubon Canyon Ranch (DHS, 2002) show that on December 14, 1991 there were some 5,700 waterbirds, primarily bufflehead (*Bucephula albeola*), surf scooter (*Melanitta perspicillata*), and black Brandt (*Branta bernicla nigricans*), in the area between Pelican Point and Tom’s Point. The maximum number of gulls observed was 7,400 in an area covering approximately 2.0 hectares of tidal flat between 0.0 and 1.0 feet above Mean Lower Low Water (DHS, 2002). In one study (DHS, 2002), the total

numbers of shorebirds observed reached a maximum of 25,553 in early winter and 7,066 in late winter.

Tomales Bay has a large harbor seal population. Since the Marine Mammal Protection Act became effective in 1972, the population in Tomales Bay has increased noticeably. There are seal haul out sites near the mouth of Tomales Bay, as well as on the shoreline of Hog Island. The average number of seals hauled out in the Bay varies between 100 to 200. The National Park Service recently reported that the population of seals in Tomales Bay can range from 400 to 650 year round, with about 200 to 300 seals likely to be residents to the area. For 2001, the National Park Service reported that there were 611 seals in Tomales Bay during the peak-breeding season (May), including 130 pups.

Significance
Water quality monitoring results from 2004 and 2005 from a watershed on the Western shoreline of Tomales Bay (Third Valley in Inverness) with minimal human impact which is selected as a background sampling site shows that tributary waters draining these areas are below the tributary target therefore excluding open space lands containing terrestrial wildlife as a significant source of pathogens (see Section 3.8 above for recent water quality monitoring data).

Because of the great variety of waterbirds, complex distribution and dispersal patterns, and fluctuating populations, it is very difficult to assess the impact of birds on water quality in the commercial shellfishing areas. Concentrations of birds on aquaculture structures can increase the potential for fecal contamination of the growing-area and shellfish.

None of the known harbor seal haul out sites are in the vicinity of the commercial shellfish growing areas. However, as with the avian populations discussed above, marine mammals follow the herring runs into Tomales Bay, and may have a potential for intermittent impact on the water quality in some areas. In addition, as with the bird populations, some aquaculture structures attract large numbers of marine mammals, creating the potential for fecal contamination of growing area waters and shellfish.

Overall, results of the long-term Bay water quality monitoring performed by shellfish growers and DHS show that during non-storm periods Tomales Bay coliform levels are typically below the water quality targets, indicating that in-Bay wildlife such as seals and birds are not a significant source of pathogens.

5.5 Municipal Runoff

Location and magnitude
There are nine small towns within the Tomales Bay Watershed (Figure 8). Overall, developed areas account for approximately 3.4% of all land use in the Watershed. According to the 2000 census, the west side of Tomales Bay (Inverness) has a

population of 1,421, with a total of 707 households. The east side of the Bay (Dillon Beach, Tomales, Point Reyes Station, Lagunitas-Forest Knolls, San Geronimo, and Woodacre) has a population of 5,011, with 2,047 households.

Significance
Municipal runoff can carry waste from pet or feral cats and dogs, as well as from leaky/failing OSDSs, therefore it may be a potential source of pathogens to the Bay and its tributaries. Results of the 2001 microbial monitoring study showed that the second-highest loading of pathogen-indicators to the Bay was from the segment of the San Geronimo Valley Subwatershed, whose main land use is low density residential (Table 10). In addition**,** municipal runoff water samples collected from storm drains in the town of Point Reyes Station showed high levels of fecal coliforms (Table 9).

5.6 Small Wastewater Treatment Facilities and Sewage Holding Ponds

Location
Figure 11 shows the location of all permitted small wastewater treatment plants and sewage holding ponds within the Tomales Bay Watershed. Almost all of these facilities are located near Bay tributary streams.

Magnitude
There are ten small wastewater treatment facilities within the Watershed, including one facility that accepts septage waste (Table 17). Water Board prohibits direct discharge from treatment facilities into Tomales Bay or the creeks within the Watershed. Four of the facilities have holding ponds and are permitted to discharge treated effluent to irrigation fields during the dry season. The other six wastewater treatment facilities utilize leach fields for dispersing treated effluent.

Significance
In each case, accidental malfunctions, including the breaching of ponds, a break in a sewage line, or land application at times when the soil is saturated, could result in a discharge of untreated or partially treated effluent to the streams. All facilities have the potential to adversely impact water quality and impair beneficial uses if an accidental discharge occurred. For example, in 1996 a 1.02 million gallon sewage spill from the Town of Tomales wastewater treatment facility caused the closure of shellfish growing areas in the Walker Creek delta.

These facilities are permitted by Waste Discharge Requirements (WDRs) and regulated by the Water Board. All permits contain requirements for routine monitoring as well as performance standards to protect the water quality of the Bay for all beneficial uses, including shellfish harvesting. Further, these permits require all wastewater treatment facilities to immediately notify the Water Board of any accidental waste discharge event. While these small wastewater treatment facilities have the potential to contaminate waters due to isolated and unexpected incidents such as a system malfunction or breaching of the holding ponds, under normal operating conditions they are not considered to be a significant ongoing source of pathogens to the Bay.

Figure 11

Small Wastewater Treatment Facilities in the Tomales Bay Watershed

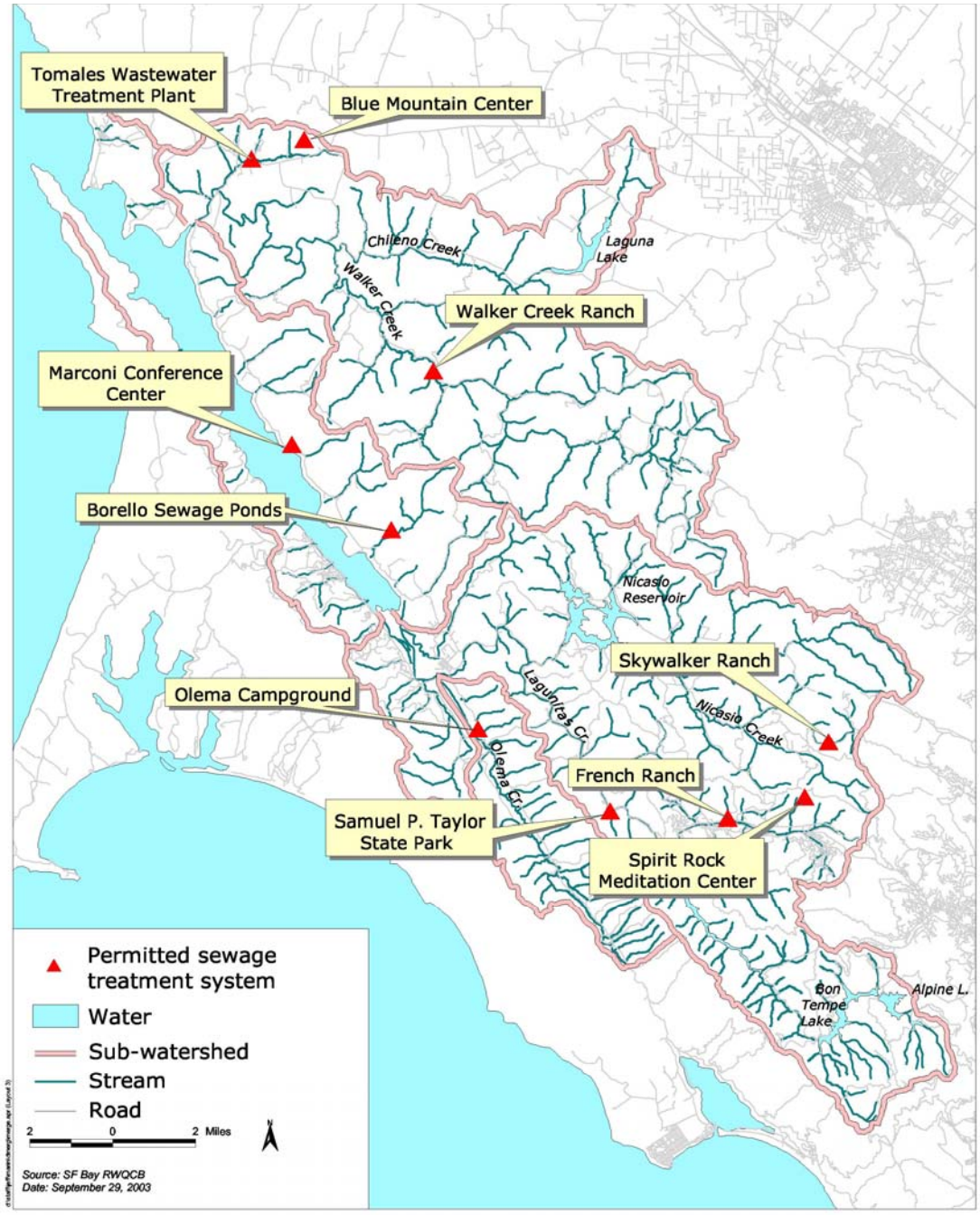


Table 17
Permitted Sewage Treatment Facilities in the Tomales Bay Watershed*

Name	Location	Waste (GPD[a])	Waste Source	Treatment Type	Effluent Disposal	Operator
Tomales Wastewater Treatment Plant	Three miles from Bay along Keyes Creek	38,000 (design) 11,000 (Avg.-dry) 25,000 (Avg.-wet)	Tomales (89 homes and school district.)	Aerated storage ponds; Chlorination	Spray Irrigation April to November	Tomales Village Community Services District
Marconi Conference Center	Highway 1 at Marconi Cove	25,000 (design) 13,500 (actual)	Conference facilities	Package plant secondary treatment; Chlorination	Leaching trench w/backup irrigation	California State Parks
Borello Sewage Ponds	NE of Millerton Point above Millerton Creek	9,700 (2002 annual avg.)	Domestic and commercial septage	Holding ponds	Spray irrigation April–October	Owner operated
Skywalker Ranch	Lucas Valley Road, upper Nicasio Creek	8,975 (maximum)	250 daytime users	Three septic tanks	Dual leachfields	Skywalker Ranch
Olema Campground	3.5 miles SW of Tomales Bay along Olema Creek	18,000 daily max	231 unit Campground	Septic tanks, holding tank, storage ponds; Chlorination	Spray irrigation, April–October	Campground Owner (Manager)
Samuel P. Taylor Park	10 miles SE of Bay along Lagunitas Creek	80,000 (design) 45,000 (actual)	Campground, park	Digestor, primary clarifier, trickling filter	Leach fields, spray disposal if necessary	California State Parks
Blue Mountain	Two miles E of Tomales on Keyes Creek	4,000 (actual)	50 residents, day use	Septic tanks, holding tank, two evaporation ponds	Discharge to leachfields	Blue Mountain Center
Spirit Rock	Sir Francis Drake Blvd. in Woodacre	9,000 (design) 4875 (actual)	Residents, classes	Two Septic tanks, one conventional, one sand filter	Leach fields	Insight Meditation Center
Walker Creek Ranch	11 miles from Bay, on Petaluma-Pt. Reyes Road	20,000 (design); 9,500 (2002 Annual Avg.)	100–220 overnighters, 230 day use	Package plant secondary treatment; Chlorination	Holding pond, pasture irrigation May–September	Marin County Office of Education
French Ranch	11 miles from Bay on SFD Blvd @ San Geronimo	11,000 (design); 4,000 (2002 Annual Avg.)	22 residential homes	Septic tanks and recirculating sand filter	Dual leach fields, seasonal rotation	Questa Engineering Corporation

a. GPD= Gallon Per Day
* All facilities listed are regulated by Water Board waste discharge requirements.

6. TOTAL MAXIMUM DAILY LOAD AND LOAD ALLOCATIONS

6.1 General Approach

U.S. EPA protocol (U.S. EPA, 2001) for developing pathogen TMDLs defines the total maximum daily load as the allowable loadings for specific pollutants that a water body can receive without exceeding water quality standards. TMDLs are the sum of individual wasteload allocations for point sources and load allocations for nonpoint sources for a given water body. The sum of these components must not result in the exceedance of water quality standards for that water body. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body.

For most pollutants, TMDLs are expressed on a mass-loading basis (e.g., pounds per day). For pathogen-indicators (i.e., fecal coliforms), however, it is the number of organisms in a given volume of water (i.e., their density), and not their mass or total number, which is significant with respect to public health risk and protection of beneficial uses. The density of fecal coliform organisms in a discharge and in the receiving waters is the technically relevant criterion for assessing the impact of discharges, the quality of the affected receiving waters, and the public-health risk. U.S. EPA guidance on the development of TMDLs recommends establishing a TMDL in this manner (density-based) for a pollutant that is not readily controllable on a mass basis. Therefore, this TMDL plan establishes density-based TMDLs and pollutant load allocations, expressed in terms of fecal coliform concentrations.

Establishment of a density-based, rather than a load-based TMDL carries the advantage of eliminating the need to conduct a complex and potentially error-prone analysis to link loads and expected densities. A load-based TMDL would require calculation of acceptable loads based on acceptable bacterial densities and expected flows, and then back-calculation of expected densities under various load reduction scenarios. Since flows in the Tomales Bay watershed are highly variable and difficult to measure, such an analysis would inevitably involve a great deal of uncertainty with no increased water quality benefit.

6.2 Proposed Total Maximum Daily Load

Table 18, below, lists the proposed TMDL for Tomales Bay and its tributaries: Walker, Lagunitas, and Olema creeks. These TMDLs will be applicable year-round. As shown, the TMDL established to ensure protection of water contact recreation use in the tributaries is the density-based REC-I water quality objective. This TMDL represents the total number of fecal coliform organisms that can be discharged from all sources, while not causing the water quality in the tributaries to exceed a five sample/month log mean fecal coliform density of 200 organisms/100 mL with no more than 10% of the samples exceeding 400 organisms/100 mL in a 30-day period.

Because shellfish harvesting is the most sensitive beneficial use of the Tomales Bay, we propose using the more stringent shellfish harvesting WQO as the TMDL for the Bay, which is expressed as the density of coliform organisms. This proposed TMDL requires that the water quality of the entire Bay (not just at the shellfish growing areas) be maintained to ensure a median of 14 MPN/100 mL of fecal coliform with no more than 10% of the samples in the Bay exceeding 43 MPN/100 mL.

Table 18
Total Maximum Daily Loads of Pathogen Indicators for the Bay and its Tributaries

Water Body	Indicator Parameter	TMDL
Tomales Bay	Fecal coliform	Median[a] < 14 MPN/100 mL 90th Percentile[b] < 43 MPN/100 mL
Major Tributaries: Walker Creek Lagunitas Creek Olema Creek	Fecal coliform	Log Mean[a] <200 MPN/100 mL 90th Percentile[b] <400 MPN/100 mL

a. Based on a minimum five consecutive samples equally spaced over a 30-day period.
b. No more than 10% of total samples during any 30-day period may exceed this number.

6.3 Proposed Load Allocations

As discussed above, density-based load allocations are proposed for this TMDL. Unlike mass-based load allocations, the density-based load allocations do not add up to equal the TMDL, since the densities of individual pollution sources are not additive. Rather, in order to achieve the density-based TMDL, it is simply necessary to ensure that each load allocation itself meets the density-based TMDL (Santa Ana Water Board, 1998).

Table 19a presents density-based load allocations for Tomales Bay Watershed pathogens source categories, and Table 19b presents geographic-based allocations to specific tributaries (see Section 7.2 below for further discussion on how the tributary load allocations were determined). All entities in a watershed are responsible for meeting their source category allocation and the applicable geographic-based allocations.

These load allocations will apply year-round to the different source categories of pollution in the Watershed (i.e., agricultural and urban runoffs, OSDSs, boat discharges, etc.). The attainment of these load allocations will ensure protection of the water quality and beneficial uses of the Bay and its major tributaries.

Table 19a
Density-Based Pollutant Wasteload and Load Allocations[a] for Dischargers of Pathogens in Tomales Bay Watershed

Categorical Pollutant Source	Wasteload and Load Allocations Fecal Coliform (MPN/100 mL)		
	For Direct Discharges to the Bay		For Discharges to Major Tomales Bay Tributaries
	Median[b]	90th Percentile[c]	Log Mean[b]
Onsite Sewage Disposal Systems	0	0	0
Small Wastewater Treatment Facilities	0	0	0
Boat Discharges	0	0	N/A
Grazing Lands	<14	<43	< 200
Dairies	<14	<43	< 200
Equestrian Facilities	<14	<43	< 200
Municipal Runoff	<14	<43	< 200
Open space lands (terrestrial wildlife)[d]	<14	<43	< 200
In-Bay Background (marine wildlife)[d]	<14	<43	N/A

a. These allocations are applicable year-round. Wasteload allocations apply to any sources (existing or future) subject to regulation by a NPDES permit.
b. Based on a minimum of five consecutive samples equally spaced over a 30-day period.
c. No more than 10% of total samples during any 30-day period may exceed this number.
d. Open space lands and the Bay contain wildlife and are therefore recognized as potential source areas. These areas are not believed to be a significant source of pathogens and their contribution is considered natural background; therefore, no management measures are required.

Table 19b
Density-Based Pollutant Load Allocations for Tomales Bay Tributaries

Tributary	Allocation Fecal Coliform (MPN/100 mL) Log Mean
Walker Creek at Highway 1 Bridge	95[a]
Lagunitas Creek at Green Bridge	95[a]

a. Based on a minimum of five consecutive samples equally spaced over a 30-day period.

Discharging entities will not be held responsible for uncontrollable coliform discharges originating from wildlife. If wildlife contributions are determined to be the cause of exceedances, the TMDL targets and allocation scheme will be revisited as part of the

adaptive implementation program. The discharge of human waste is prohibited. All sources of human waste have an allocation of zero. Nonpoint source runoff containing coliform bacteria of animal and wildlife origin, at levels that do not result in exceedances of water objectives, does not constitute wastewater with particular characteristics of concern to beneficial uses. Therefore, animal and wildlife-associated discharges, in compliance with the conditions of this TMDL, do not constitute a violation of applicable discharge prohibitions.

6.4 Seasonal Variation

The largest discharges of fecal coliform bacteria, and the great majority of the exceedances of the pathogen-indicator objectives in the Bay, are associated with rainfall, particularly during the winter season. During the winter rainfall season, commercial shellfish are harvested, except when the mandatory closure rules are enforced. Use of the Bay for water contact recreation activities is reduced during the winter season but not necessarily eliminated. Also, winter is perhaps a better time of the year to sport harvest mussels since the annual DHS quarantine on sport harvest is in effect statewide from May 1 through October 31 each year due to the greater chance of paralytic shellfish poisoning. Therefore, it is more likely for sport harvesters to gather mussels in winter than in the late spring and summer. Sport harvesting of clams, on the other hand, occurs in Tomales Bay year-round. Fecal coliform and associated pathogen discharges in winter season stormwater runoff are believed to originate mainly from animal agriculture land usages (TBSTAC, 2000). Control of wintertime fecal coliform and pathogen concentrations is expected to be very challenging.

Recreational use of the Bay and its major tributaries are most prevalent during the summertime, when water quality objectives for REC-I and REC-II as well as for SHEL are exceeded less often than during the winter season. The Bay and its tributaries, however, remain impaired by pathogens, in varying degrees during all seasons and the beneficial uses are not consistently protected during any season. No seasonal variations to the above-listed TMDLs and load allocations, therefore, are proposed.

7. LINKAGE ANALYSIS

7.1 Linkage Between Water Quality Targets and Pollutant Sources

An essential component of TMDL development is to establish a relationship (linkage) between pollutant loadings from various sources and the numeric targets chosen to measure the attainment of beneficial uses. Tomales Bay and its tributaries are impaired by pathogens. A number of sources discharge pathogens to surface waters. Fecal coliforms are indicators of pathogens. The proposed numeric targets are also based on pathogen concentrations. These numeric targets are expressed as fecal coliform concentrations because coliform concentrations are indicators of pathogen presence and magnitude.

For this TMDL, the proposed load allocations protect the beneficial uses (the linkage is established) because:

- The proposed density-based load allocations are the same or more stringent than the existing density-based numeric water quality objectives for the given water bodies; and
- The numeric water quality objectives, contained in the Basin Plan, are protective of beneficial uses.

Therefore, achievement of the proposed pollutant load allocations (listed in Section 6) will ensure the protection of the water quality and beneficial uses of the Bay and its tributaries.

7.2 Tomales Bay Modeling

Using a three-dimensional hydrodynamic state-of-the-art numerical model of Tomales Bay, U.C. Berkeley researchers evaluated the fate and transport of fecal coliforms entering the Bay from tributaries (Brennan and Stacey, 2005b). More specifically, Brennan and Stacey evaluated the probability of meeting TMDL targets at Bay shellfish growing areas for different tributary fecal coliform concentrations. The objective of this modeling effort was to determine how low tributary fecal coliform concentrations have to be in order to attain the proposed Bay TMDL target and the Water Board's Water Quality Objectives for shellfish harvesting (14 MPN fecal coliform/100 mL 30-day median, 43 MPN fecal coliform/100 mL 30-day 90^{th} percentile).

In order to examine the worst-case scenario with respect to tributary effects on shellfish harvesting, the model focused on Walker Creek and adjacent shellfish harvesting sites. It simulated a 30-day wet season period based on actual hydrographs from December 2003 through January 2004, an unusually wet month with over 24 cm (9.5 in) of rainfall. The model predicted bacterial densities over the 30-day time period at three established shellfish harvesting stations near the mouth of Walker Creek, with fecal coliform densities held constant in the creek for the entire period.

To account for natural die-off of bacteria, the model incorporated a conservative, first order bacterial decay coefficient of 0.02/hr (Brennan and Stacey, 2005c). It is important to note that this decay coefficient is *very* conservative. A U.S. EPA review of bacterial decay coefficients in natural waters indicates that 0.02/hr is at the low end of values reported throughout the nation (U.S. EPA, 1985). Furthermore, bacterial disappearance rates observed in the 2000 TBSTAC report suggest much higher die-off rates. Calibration of the model to observed coliform levels in the Bay would be conducted as part of the TMDL adaptive implementation effort.

Modeling showed that in response to the flow patterns created by tides and fresh water discharge from Walker Creek, the shellfish stations experience a wide range of fecal coliform concentrations, varying by a factor of five at intervals of only 100 meters. Shellfish stations close to the mouth of the creek showed instantaneous pathogen concentrations close to that of the tributary

Based on this modeling, Water Board staff calculated 30-day medians and 90th percentiles at the three shellfish stations for different steady-state fecal coliform densities in Walker Creek. These were compared with the Water Board's Water Quality Objectives for shellfish harvesting: 14 MPN fecal coliform/100 mL (30-day median), and 43 MPN fecal coliform/100 mL (30-day 90th percentile). It was determined that the highest Walker Creek fecal coliform density that would meet Water Quality Objectives at all stations was 95 MPN fecal coliform/100 mL. Results are summarized in Table 20, below.

Table 20
Predicted 30-Day in-Bay Fecal coliform Densities Assuming a Steady State 95 MPN/100 mL in Walker Creek

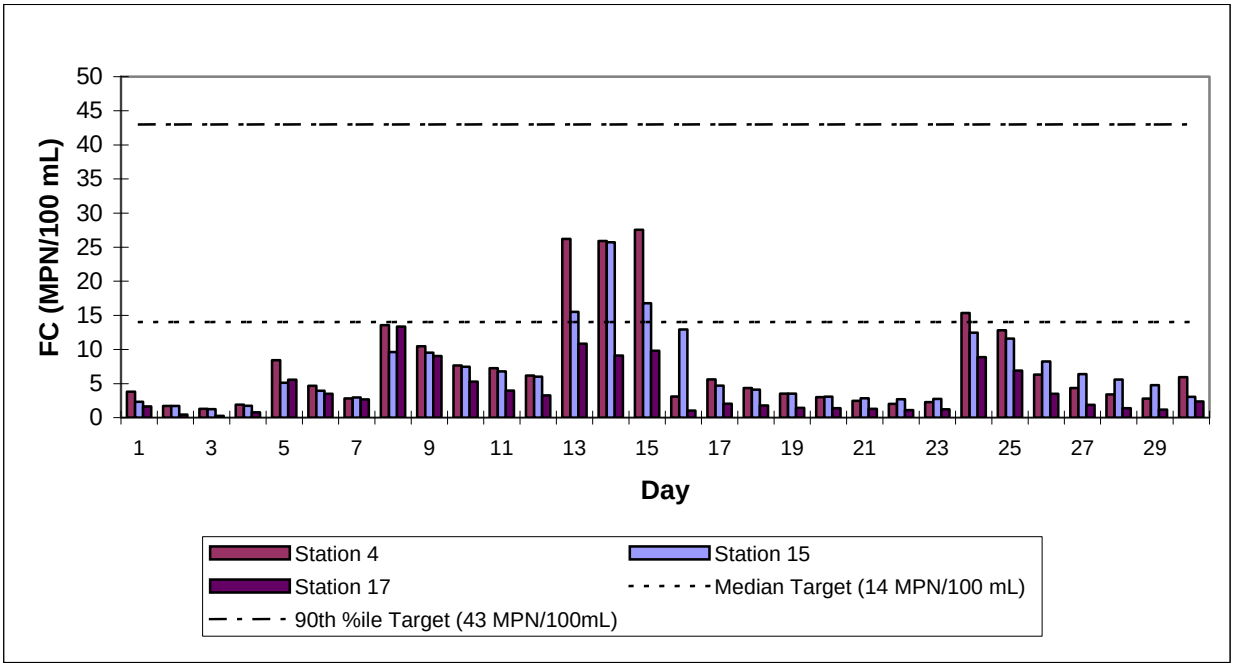
	Bay Shellfish Station		
	4	**15**	**17**
Predicted Median	5.1	5.2	2.4
Predicted 90th Percentile	42.9	20.2	20.0

The California Department of Health Services (DHS) establishes rainfall-triggered closure rules for shellfish harvest in Tomales Bay based on the assumption that increased runoff brings increased pathogens down from the upper watershed. These rules, which are based on actual in-Bay bacterial levels observed following rainfall events, are subject to periodic revision. As the TMDL is implemented and coliform loads decline, the rules will need to be reevaluated. Currently, rainfall events over 1.0 cm/24-hr result in a five day closure at oyster bed leases near the mouth of Walker Creek, and rainfall over 1.65 cm/24-hr results in six days of closure. A ten-day cumulative rainfall in excess of 7.5 cm results in an additional day of closure.

In order to examine the benefit of reducing Walker Creek fecal coliform densities to 95 MPN/100 mL on shellfish harvesting closures, predicted daily geometric means were

calculated for the 30-day period simulated by the model output. Results, shown in Figure 12 below, indicate that daily geometric means remain below 43 MPN fecal coliform/100 mL throughout the modeled 30-day scenario, and only exceed 14 MPN/100 mL for four days. Thus, it appears that reducing Walker Creek fecal coliform densities to 95 MPN fecal coliform/100 mL will provide a significant reduction in rainfall-triggered closures and result in shellfish closure days well below the target of less than 30 days per year.

Figure 12.
Predicted in-Bay Fecal Coliform Densities Assuming 95 MPN/100 mL in Walker Creek



In summary, this analysis indicates that a tributary load allocation of 95 MPN fecal coliform/100 mL will result in attainment of TMDL targets for the Bay. The allocation will also result in meeting Water Board Water Quality Objectives for shellfish harvesting waters under most conditions, and will reduce shellfish harvesting closures to less than 30 days per year.

7.3 Margin of Safety

TMDLs are required to include a margin of safety to account for data uncertainty, critical conditions, and lack of knowledge. Because the load allocations in this TMDL are identical or more stringent than the existing numeric WQOs, which are established as protective standards and inclusive of all uncertainties (e.g., regrowth, die-off of fecal coliforms), the margin of safety is implicitly incorporated into the proposed TMDLs and load allocations.

Moreover, it should be noted that the analysis used to determine the load allocations is based on a number of conservative assumptions:

- In order to account for natural die-off of bacteria in the environment of the Bay, the model incorporated a conservative, first order bacterial decay coefficient of 0.02/hr (Brennan and Stacey, 2005c) which is a very conservative decay coefficient. A U.S. EPA review of bacterial decay coefficients in natural waters indicates that 0.02/hr is at the low end of values reported throughout the nation (U.S. EPA, 1985). Furthermore, bacterial disappearance rates observed in the 2000 TBSTAC report suggest much higher die-off rates.
- Modeling was based on steady state tributary bacterial densities. Actual densities tend to peak early in the runoff event and decline thereafter.
- Peak shellfish station bacterial densities are predicted during pulses of fresh water directly from Walker Creek. Shellfish tend to reduce or discontinue feeding during low salinity pulses.

These conservative assumptions incorporates additional implicit margin of safety into the proposed TMDLs and Load allocations. Therefore, staff asserts that no additional and/or explicit margin of safety is needed for this TMDL.

8. IMPLEMENTATION PLAN

8.1 Overview of Proposed TMDL Implementation Plan

TMDLs are strategies to restore clean water. Implementation plans specify actions needed to solve the problem and are required under California Law. The following implementation plan describes existing regulatory controls and cites relevant sections of the California Water Code (CWC) establishing the Water Board's authority to enforce the provisions set forth in the implementation plan. Section 13242 of the CWC requires that an implementation plan be incorporated into the Basin Plan upon Water Board adoption of the final TMDL Basin Plan amendment. The implementation plan includes:

1. A description of the nature of the actions necessary to achieve water quality objectives, including recommendations for appropriate action by any entity, public or private;

2. A time schedule for the actions to be taken; and

3. A description of the compliance monitoring and surveillance to be undertaken to ensure successful implementation of Best Management Practices (BMPs).

The overall intent of this implementation plan is to restore and protect beneficial uses of the Bay and its major tributaries by reducing pathogen loadings. If not properly managed, the Tomales Bay Watershed source categories have the potential to discharge pathogens to surface waters: on-site sewage disposal systems (OSDSs), small wastewater treatment facilities and sewage holding ponds, boat discharges, grazing lands, dairies, equestrian facilities, and municipal runoff. The Water Board recognizes the technical, institutional, and monetary challenges that each source category may face in designing and implementing measures to reduce their respective loading. Because of this, we are trying to be as flexible as possible in the implementation approach for reducing pathogen loading. We anticipate that enforcement mechanisms will only be needed for situations in which individuals have chosen not to take actions needed to reduce their potential to impact water quality.

8.2 Summary of Implementation Plan Actions

Local stakeholders have demonstrated a strong commitment to improving water quality. A focused effort to reduce pathogen discharges and manage the Watershed is now needed to meet TMDL targets. The implementation plan identifies source reduction measures and factors that may be considered if the load allocations are not met. Water Board staff have made an effort to discuss the source control actions with all interested stakeholders and sought their input in regard to cost and feasibility. The implementation actions are provided in Tables 21–27. The Basin Plan will identify the implementation measures required under this TMDL.

The implementation plan acknowledges the progress made by each source type toward pathogen reductions and seeks to build upon these successful efforts. This TMDL strives to achieve a balance that allows human activities including agriculture, recreation, commercial fishing and aquaculture, and residential uses to coexist and also restores and protects water quality.
The Tomales Bay Watershed Pathogens TMDL Implementation Plan builds upon previous and ongoing successful efforts to reduce pathogen loads in Tomales Bay and its tributaries. The plan requires actions consistent with the California Water Code (CWC 13000 et seq.), the state's Nonpoint Source Pollution Control Program Plan (CWC Section 13369) and, the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, and human waste discharge prohibitions (Prohibitions 5 and 15, Table 4-1 of the Basin Plan).

All sources are expected to evaluate their operating practices and identify potential pathogen sources on their facilities and provide a schedule for implementing pathogen reduction efforts. Each source is responsible for proposing their own schedule for implementing site-specific management measures to reduce the pathogen runoff and to document the measures taken. In most cases, the proposed implementation schedules are to be submitted to the Water Board for review and approval.

Implementation of pathogen control measures that also reduce sediment and nutrient loads are encouraged, as this may preclude the need for implementation of additional management measures for those sources.

Each source category will provide documentation on progress made toward implementation of control measures. Progress reports may be submitted directly to the Water Board or, if designated, through third parties. These progress reports will serve as documentation that source reduction measures are being implemented. While third parties may provide valuable assistance to TMDL implementation, the discharger is the entity responsible for complying with the specified regulations and regulatory controls.

Responsible parties within each source category are required to implement the measures identified as specified in the Basin Plan. The numeric targets and load allocations are not directly enforceable. For purpose of demonstrating attainment of applicable allocations, responsible parties will only be responsible for compliance with specified implementation measures and ensuing waste discharge requirements or waiver conditions. Any further requirements would require Board action to revise these implementation measures.

In some cases, a third party with expertise in implementation could help evaluate reports for each source category. Where a third party is not identified, the Water Board will independently assess compliance. In all cases, the discharger is ultimately responsible for implementing identified control measures. Discharging entities will not be held responsible for uncontrollable coliform discharges originating from wildlife.
If a discharger demonstrates that all implementation measures have been undertaken or that it is infeasible to meet their allocation due to wildlife contributions, the Water

Board will consider revising allocations as appropriate. If source control actions are fully implemented throughout the Watershed and the TMDL targets are not met, the Water Board may consider re-evaluating or revising the TMDL and allocations. If, on the other hand, the required actions are not fully implemented, or are partially implemented, the Water Board may consider regulatory or enforcement action against parties or individual dischargers not in compliance.

Throughout the TMDL process, the Water Board and stakeholders in the Watershed will need to monitor compliance with management measure implementation and assess whether water quality is improving. The implementation plan includes steps for evaluation and follow-up for assessing compliance with the TMDL.

If reasonable progress toward implementing the management practices is not demonstrated, the Water Board will consider additional regulatory control or taking enforcement actions on those source categories and/or individual dischargers that are not participating in good faith. Examples of additional regulation include requiring permits for individual dairies, grazing lands, and equestrian facilities and/or requiring operating permits for all OSDSs.

For purposes of demonstrating attainment of applicable allocations, responsible parties will only be responsible for attainment of specified implementation measures and ensuing waste discharge requirements, prohibitions, or waiver conditions. . If it is demonstrated that all reasonable and feasible source control measures have been implemented for a sufficient period of time and TMDL targets are still not being met, the Water Board will reevaluate the water quality standards,TMDL targets and allocations as appropriate.

This implementation plan describes the Water Board's regulatory authority (Section 8.3) as well as other plans and policies in the Tomales Bay Watershed that affect pathogen-source management activities (Section 8.4). A description of the implementation actions and monitoring components are provided in Sections 8.8 and 8.10, respectively. The long-term water quality monitoring program for the Bay and its Watershed is described in Section 9.

8.3 Legal Authorities and Requirements

The plan requires actions consistent with the California Water Code (CWC 13000 et seq.), the state's Nonpoint Source Pollution Control Program Plan (CWC Section 13369), the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program and human waste discharge prohibitions (Prohibitions 5 and 15, Table 4-1 of the San Francisco Bay Basin Water Quality Control Plan). The Water Board has the responsibility and authority for regional water quality control and planning per the state's Porter-Cologne Water Quality Control Act. The Water Board regulates point source pollution by implementing a variety of programs, including the NPDES Program for point sources discharging into waters of the state. The state also controls

nonpoint source pollution as specified in the state's *Plan for California's Nonpoint Source Pollution Control Program* (hereafter referred to as the State NPS Management Plan). The state's Porter Cologne Water Quality Control Act gives the Water Board authority to issue Waste Discharge Requirements (WDRs) for point and nonpoint sources of contamination.

8.4 California Nonpoint Source Program

California's Nonpoint Source (NPS) Pollution Control Program has been in effect since 1988 (WMI Chapter, 2001). The NPS Program is a regulatory strategy aimed at addressing nonpoint source pollution throughout the state. The NPS program is being revised to enhance efforts to protect water quality, and to conform to the Clean Water Act Section 319 (CWA 319) and the Coastal Zone Act Reauthorization Amendments Section 6217 (CZARA). The lead state agencies for the NPS Program are the State Water Resources Control Board, the nine regional water quality control boards and the California Coastal Commission. The NPS Program's long-term goal is to "improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013."

The state also established the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (State Water Board, 2004), which requires that current and proposed nonpoint source discharges are regulated under waste discharge requirements (WDRS), waiver of waste discharge requirements, Basin Plan prohibition, or some combination of these tools. For each source category that is currently discharging but not yet regulated, a regulatory tool has been identified.

8.5 Plans and Policies in the Tomales Bay Watershed

Below is a description of the current regulations, policies, and plans for each of the categorical pathogen sources in Tomales Bay. The Tomales Bay pathogen sources of concern include:

- Onsite Sewage Disposal Systems (OSDSs);
- Small Wastewater Treatment Facilities;
- Boat discharges;
- Grazing lands (includes all land areas grazed by livestock such as ranchlands, riparian areas, and pastureland);
- Dairies;
- Equestrian Facilities; and
- Municipal runoff.

In addition to the above sources, warm-blooded mammals and birds that reside in the watershed and Bay produce coliform bacteria. During non-storm periods Tomales Bay coliform levels are typically below the water quality objectives for shellfish harvesting

waters, indicating that in-Bay wildlife such as seals and birds are not significant sources. Approximately 30% of the lands draining to Tomales Bay are open space forested lands. Water quality monitoring of a watershed on the western shoreline of Tomales Bay with minimal human influences suggests that waters draining open space areas are below tributary bacteria water quality objectives and therefore terrestrial wildlife are not a significant source.

Onsite Sewage Disposal Systems

The Water Board Basin Plan specifically addresses water quality issues related to on-site wastewater treatment and disposal systems. In 1978, the Water Board adopted a policy on discrete facilities enumerating the following principles, which apply to all wastewater discharges:

- The system must be designed and constructed so as to be capable of preventing pollution or contamination of waters of the state or creating a nuisance for the life of the development project;
- The system must be operated, maintained, and monitored so as to continually prevent pollution or contamination of the waters of the state and the creation of a nuisance;
- The responsibility for both of the above must be clearly and legally assumed by a public entity with the financial and legal capability to assure that the system provides protection to the quality of the waters of the state for the life of the development project.

The policy also makes the following requests of city and county governments:

- The use of new discrete sewerage systems be prohibited where existing community sewerage systems are reasonably available;
- The use of individual septic systems for any subdivision of land be prohibited unless the governing body having jurisdiction determines that the use of the septic systems is in the best public interest and that the existing quality of the waters of the state is maintained consistent with the State Water Board's Resolution 68-16; and
- The cumulative impacts of individual disposal system discharges be considered as part of the approval process for development.

The Water Board has delegated authority for the regulation of individual OSDSs in Marin County to the County Health Officer, through Resolution 84-12, which waives WDRs for individual systems. Under a county ordinance approved by the Board of Supervisors in August 1984, the Marin County Environmental Health Department has responsibility for overseeing individual OSDSs. This includes the responsibility for siting and design, installation and repair standards, and monitoring and inspection programs.

Small Wastewater Treatment Facilities

Pursuant to Section 13260 of the CWC, any person discharging waste or proposing to discharge waste that could affect water quality (other than to a community sewer

system) must file a Report of Waste Discharge (ROWD) with Water Board. The CWC further provides that the Water Board may prescribe requirements for the discharge through issuance of Waste Discharge Requirements (WDRs). These WDRs typically include a prohibition on the discharge into waters of the state, monitoring requirements, treatment requirements, and a categorization of the WDRs according to its threat to water quality and its complexity.

As described in Chapter 5 there are a number of small wastewater facilities in the Tomales Bay Watershed that are regulated by WDRs. The Water Board regulates ten small wastewater treatment facilities and sewage holding ponds and prohibits direct discharges from these facilities into Tomales Bay or its tributaries. Four facilities have holding ponds and are permitted to discharge treated effluent to irrigation fields in the dry season. The other five wastewater treatment facilities utilize leach fields for dispersing treated effluent. Accidental malfunctions, including the breaching of ponds, a break in a sewage line, or land application when soil is saturated or it is raining, could result in discharge of untreated or partially treated effluent. Therefore, these facilities are considered potential sources. These facilities are regularly inspected and evaluated by Water Board staff for compliance with the applicable WDRs.

Boat Discharges

Jurisdictions over boating and recreational uses in Tomales Bay are complex and overlap in many areas. Most of the waters and submerged lands of Tomales Bay are managed by four trustee agencies: California State Lands Commission; California Department of Fish and Game; the U.S. Department of the Interior (National Park Service); and the U.S. Department of Commerce (Gulf of the Farallones National Marine Sanctuary).

As part of the Gulf of the Farallones, Tomales Bay is designated as a no-discharge zone and discharges of untreated sewage into the Bay are prohibited. The U.S. Coast Guard and California boating laws also regulate discharges of untreated sewage into navigable waters.

These regulations require use of a Coast Guard-approved Marine Sanitation Device (MSD) on all boats with installed toilets (33 U.S.C. III 1322). An MSD is any equipment for installation onboard a vessel, other than a toilet, which is designed to receive, retain, treat or discharge sewage and any process to treat such sewage. It has been recommended by DHS that all boats in Tomales Bay be equipped with some type of MSD, including a portable toilet or a bucket with a tight fitting lid, to contain the waste until it can be disposed of properly. Since existing Basin Plan prohibitions ban discharge of “any wastewater which has particular characteristics of concern to beneficial uses to Tomales Bay…” only an MSD type III (holding tank) would be allowed for use in Tomales Bay.

The Water Board’s Basin Plan (Table 4-1) includes two discharge prohibitions (No. 5 and No. 15) that apply to Tomales Bay and prohibits the discharge of human waste; including raw sewage or inadequately treated waste.

The regional water quality control boards also have the authority to require that all vessel terminals be equipped with pumpout facilities (Harbors and Navigation Code Section 775–786). The State Water Resources Control Board may also require that any marine terminal provide adequate vessel sewage pumpout capability, if needed for the protection of water quality (California Code of Regulations Title 23, Division 3, Chapter 20). The California Department of Boating and Waterways recently completed a study of the adequacy of sewage disposal facilities in Tomales Bay and recommended installation of a pump-out station and a dump station (California Department of Boating and Waterways, 2004).

Ongoing local, state, and national park efforts specifically related to human waste disposal from boating and recreational activities in the Bay have focused on distribution of educational materials identifying the location of sanitary facilities along the shoreline and informing the public about proper sanitary disposal methods. The park managers have also focused on providing adequate sanitary facilities that are commensurate with the amount of recreational use. The Point Reyes National Seashore established a permit program for overnight camping along Tomales Bay. Both Tomales Bay State Park and the Point Reyes National Seashore are in the process of revising and updating their recreational management plans.

A number of agencies have been meeting to discuss development of a boating management plan for Tomales Bay. The management plan would describe mooring guidelines and permitting procedures, and possible management and enforcement measures to prevent boat discharges.

Grazing Lands

The State Water Board and the California Coastal Commission have identified management measures to address nonpoint source pollution from grazing activities. In response to nonpoint source pollution concerns, livestock industry representatives and members of the public formed the Range Management Advisory Committee. The Committee developed a California Rangeland Water Quality Management Plan, which concludes that ranches should complete rangeland Water Quality Management Plans for their respective ranches. Three approaches for voluntary compliance with the plan include: drafting a letter of intent with local Resource Conservation District office; developing a nonpoint source management plan; or using a recognized nonpoint source management plan.

All of the ranches on lands leased from the Department of Interior and the majority of the ranches in private ownership have completed a ranch plan. However, the ranch plans vary in their coverage of water quality concerns, thoroughness, and recommendations for implementation. In addition, not all the plans recommend having a compliance schedule. The National Seashore and UC Cooperative Extension is working with grazing resource specialists and Water Board staff to develop a checklist for evaluating how its grazing lands are addressing pathogen-related runoff.

Dairy Facilities
Minimum design and management standards for the protection of water quality from these animal operations are promulgated in Title 23, California Code of Regulations, Chapter 15, Article 6. These regulations prohibit the discharge of facility wash water, animal wastes, and stormwater runoff from animal confinement areas into waters of the state. They also specify minimum design and waste management standards for the:

- COLLECTION OF ALL WASTEWATERS;
- Retention of water within manured areas during a 25-year, 24-hour storm event;
- Use of paving or impermeable soils in manure storage areas; and,
- Application of manures and wastewaters on land at reasonable rates.

The Water Board has the authority to enforce these regulations through Waste Discharge Requirements (WDRs). Dairies are the typical animal confinement operation within the Watershed. The Water Board typically waives WDRs for dairies (Resolution No 83-3) that have proper waste control facilities in place and whose management practices conform with the California Code of Regulations: Title 23, Article 3, Chapter 15 (Discharge of Waste to Land). In 2004, the Water Board revised the Waiver of Waste Discharge Requirements for Confined Animal Facilities (Resolution No. R2-2003-0094) and completed its assessment of each dairy's compliance with the waiver. In the Tomales Bay watershed, all of the dairies met the conditions for the waiver of WDRs and the most recent inspections show proper management practices are in place. However, the WDRs only apply to the confined animal portions of the dairy facility and do not address the grazing lands on dairy facilities.

In 1990, the State Board established a Dairy Waste Task Force to look at the dairy industry statewide and develop standards for dairy regulation. The main emphases have been on developing better communication and guidance materials for the industry; developing a dairy survey form to help the Water Board determine if a dairy qualifies for a WDRs waiver; determining the number and location of dairies; developing more-uniform WDRs; and preparing an outreach program aimed at the dairy industry, local government, and the public. The State Water Board members directed staff to continue the following activities:

- Work with the dairy industry through the local dairy waste committees, county farm bureaus, Resource Conservation Districts (RCDs), and other local/state agencies in obtaining cooperative correction of dairy waste problems.

- Recommend adoption of WDRs in those cases in which water quality objectives for waters within an agricultural watershed are consistently exceeded, or in which corrective action is unsuccessful in eliminating either the short- or long-term water quality problems or threats.

- Monitor compliance with animal waste guidelines and WDRs waiver.

Equestrian Facilities
As discussed for dairies, the Water Board has the authority to regulate equestrian facilities as a confined animal facility through use of Waste Discharge Requirements (WDRs) or waiver of WDRs.

The Water Board also has authority over equestrian facilities through its comprehensive runoff control program that is designed to be consistent with federal regulations (40 CFR 122-24). The runoff from equestrian facilities and other land uses within the Tomales Bay Watershed is addressed in Phase II of the stormwater program. Marin County's Stormwater Pollution Prevention Program (MCSTOPPP) is responsible for implementing Phase II requirements in the Tomales Bay Watershed.

The Water Board has provided funding for development and implementation of a technical assistance program for such facilities. To date, Marin County has developed a technical assistance program for the Tomales Bay equestrian facilities and determined that half of the facilities have adequate waste management practices and no potential for water quality impairment (Nicholson et al, 2004). The MCSTOPPP program continues to provide technical assistance and outreach to equestrian facilities in the Watershed.

Municipal Runoff
The Water Board has a comprehensive runoff control program that is designed to be consistent with federal regulations (40 CFR 122-24) and is implemented by issuing NPDES permits to owners and operators of large storm drain systems and systems discharging significant amounts of pollutants. Each storm water permit requires that the entities responsible for the system develop and implement comprehensive control programs. Phase I of the storm water conveyance program ran from 1990–2003 and included requirements for construction sites greater than five acres, industrial storm water discharges, and large and medium municipalities.

Phase II began March 10, 2003 and addresses storm water runoff from construction sites greater than one acre and small municipalities. The runoff from land uses within the Tomales Bay Watershed is addressed in Phase II. MCSTOPPP is responsible for implementing Phase II requirements in the Tomales Bay Watershed.

Phase II Municipal program requirements include the following elements:

- Develop, implement, and enforce a storm water management plan (SWMP) to reduce the discharge of the pollutants to the maximum extent practicable;
- Address specific program areas, including public education and outreach on storm water impacts, public involvement, illicit discharge detection and elimination, construction site storm water runoff control, post construction storm water management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations;
- Evaluation and assessment of measures; and
- Monitoring and reporting.

Open Space Lands
Warm-blooded mammals and birds that reside in the watershed and Bay produce coliform bacteria. During non-storm periods Tomales Bay coliform levels are typically below the water quality objectives for shellfish harvesting waters, indicating that in-Bay wildlife such as seals and birds are not significant sources. Approximately 30% of the lands draining to Tomales Bay are open space forested lands. Water quality monitoring of a watershed on the western shoreline of Tomales Bay with minimal human influences suggests that waters draining open space areas are below tributary bacteria water quality objectives and therefore terrestrial wildlife are not a significant source. The Water Board is not proposing any control actions or implementation measures for open space lands or measures to control wildlife at this time. Discharging entities will not be held responsible for uncontrollable coliform discharges originating from wildlife. If wildlife contributions are determined to be the cause of exceedances, the TMDL targets and allocation scheme will be revisited as part of the adaptive implementation program.

8.6 Participating Stakeholders

A number of active stakeholder groups, government entities and non-governmental organizations play an important role in reducing pathogen loadings and attaining water quality targets. These stakeholders are described below:

County of Marin

- *Marin County Stormwater Pollution Prevention Program (MCSTOPPP)*: Marin County administers and manages the countywide storm water program through the MCSTOPPP department. MCSTOPP is also working with the Marin Resource Conservation District on improving waste management of equestrian facilities.

- *Environmental Health Services*: The Water Board has delegated responsibility for overseeing individual OSDSs including siting and design, installation and repair standards, and enforcement, monitoring, and inspection programs to the County of Marin. The Environmental Health Services Department administers the OSDS program for the county. They have launched a public education program and a voluntary campaign to inspect septic systems within 100 feet of an impaired water body.

Shellfish Technical Advisory Committee
The Shellfish Protection Act of 1993 applies to all commercial shellfish growing areas determined to be threatened and requires the formation of the Tomales Bay Shellfish Technical Advisory Committee (TBSTAC). TBSTAC convened in 1994 with the main goal of developing a strategy to eliminate pathogen impairment of the Bay in order to protect the beneficial use of shellfish harvesting.

Tomales Bay Agricultural Group
The Tomales Bay Agricultural Group (TBAG) is a private organization composed of dairy farmers and cattle ranchers within the Tomales Bay Watershed. The group was formed in 1999 to provide direction and support on water quality management for animal agricultural producers.

University of California (U.C.) Cooperative Extension
U.C. Cooperative Extension in Marin County is part of a statewide system that makes U.C. research-based information available to local agencies, industries, and the public. The U.C. Cooperative Extension program provides countywide farm and home advisor services through an agreement between the county and the University of California. TBAG, U.C. Cooperative Extension, and the Marin Resource Conservation District are working collaboratively on a grant to assess impacts of dairy practices on water quality. The U.C. Cooperative Extension is also assisting local ranchers to develop a facility checklist for use in identifying potential pathogen sources.

Sonoma-Marin Animal Resource Management Committee
The Sonoma-Marin Animal Resource Management Committee is an association of county dairymen and ranchers. They meet regularly to discuss proper management of animal waste, provide technical assistance to members, and monitor streams to assist with identification of problem areas.

Western United Dairymen
The Western United Dairymen is an association of dairy farm families. They have initiated innovative management activities including development of an on-farm environmental stewardship program called the California Dairy Quality Assurance Program (CDQUAP).

Point Reyes National Seashore Ranchers Association
The Point Reyes Seashore Ranchers Association (PRSRA) is a volunteer organization of historic ranching families who live and operate agricultural businesses within the federally owned lands of the Point Reyes National Seashore and Golden Gate National Recreation Area. PRSRA's goals are to maintain the agricultural lands within the park(s) by educating the public on historic stewardship of the land by local ranchers and offering a forum for park service staff and local ranchers to work more cooperatively. PRSRA is also participating in a pilot effort to evaluate rangeland management and pathogen runoff.

Marin Resource Conservation District (RCD)
Resource Conservation Districts (RCDs) are non-regulatory, special districts established by Division 9 of the California Public Resources Code. Volunteer boards of directors provide local leadership in directing conservation services to meet the needs of residents and landowners. RCDs assist landowners by providing technical advice and conservation education, supporting locally led watershed-planning efforts, protecting waterways and groundwater from pollution, and encouraging habitat restoration projects. Additionally, the Marin County and Southern Sonoma Resource Conservation

Districts have a cooperative, voluntary program in which a farmer agrees to use the land according to its capabilities, develop a conservation plan, and apply conservation practices to meet RCD objectives and technical standards. The Marin RCD is managing several grants related to ensuring source control and implementation of Best Management Practices on dairies and ranchlands. The RCD is also working with the Council of Bay Area RCDs, MCSTOPPP, and the Marin Horse Council to provide manure management manuals and technical assistance to equestrian facilities. Specific projects include an Equine Facilities Assistance Program, a manure facility site assessment and production of a manual, *Horse keeping: A guide to land management and water quality.* The RCD has also worked with ranchers to prepare the Walker Creek Enhancement Plan, which targeted reduction of erosion and sedimentation in Walker Creek.

Government Agencies
Federal and state agency jurisdictions over Tomales Bay are complex, interconnected, and overlap in many areas. Most water quality issues are managed by two state agencies: The Water Board and California Department of Health Services. Most resources are managed by three trustee agencies: Department of Fish and Game; Department of the Interior (Point Reyes National Seashore); and U.S. Department of Commerce (Gulf of Farallones National Marine Sanctuary).

Natural Resource Conservation Service (NRCS), Department of Agriculture
NRCS provides technical and financial assistance to agriculture property owners. Specific activities in the Watershed include technical assistance and outreach, BMP implementation, the funding projects of primarily through the Environmental Quality Incentives Program (EQIP) and development of ranch plans.

Department of the Interior, Point Reyes National Seashore
The Point Reyes National Seashore (PRNS) is one of the largest landowners in the Tomales Bay Watershed. PRNS also issues leases to dairy and ranch facilities to operate on park lands. PRNS is assisting with the pathogen reduction effort through its monitoring and technical assistance efforts. PRNS has also applied for federal funding to improve its on-site disposal systems, boating facilities, and establish a technical assistance program for local ranchers to assess their operations for pathogen runoff potential.

Tomales Bay Watershed Council (TBWC)
The Tomales Bay Watershed Council is a non-governmental organization that uses a community-wide consensus approach to address water quality and resource concerns in the Tomales Bay Watershed. The TBWC adopted The *Tomales Bay Watershed Stewardship Plan: A Framework for Action* (July 2003). The TBWC also developed a draft Water Quality Monitoring Program (December 2003) and is interested in assisting with the TMDL monitoring efforts.

8.7 Watershed-Wide Implementation Strategy

This section describes potential management measures for the Tomales Bay Watershed. Load reductions and implementation of pollution control measures are necessary throughout the Watershed to achieve TMDL targets and load allocations in Tomales Bay.

As discussed above in Section 4 and illustrated in Figure 6 (Tomales Bay land use map), the potential pathogen sources are distributed (although not uniformly) throughout the Tomales Bay Watershed. In this document, implementation measures are organized by source category rather than by Subwatershed. If a given Subwatershed has a predominant land use type or a predominant source of pathogens, then the management measures for that particular source may be emphasized for that geographic area.

As part of its adaptive management effort, the Water Board will evaluate site-specific, sub-watershed specific, and watershed-wide specific compliance with the identified implementation measures specified in the Basin Plan.

8.8 Implementation Actions to Reduce Pathogens

To determine the appropriate level and type of source control and regulatory actions necessary to achieve water quality objectives, the Water Board will consider the following factors:

- The feasibility of achieving the required level of performance (assigned pollutant load allocations) for each source;
- The magnitude of the water quality impairment caused by each source; and
- The history of source control efforts and regulatory requirements.

The technical capability and cost of management measure implementation affect feasibility. Water quality impairment is a function of the type of source (i.e., human versus animal waste) and its potential for causing an exceedance of water quality objectives.

In commenting on earlier versions of the TMDL, stakeholders recommended that the implementation plan identify the relative contribution of each source category and the water quality significance of that source category. The Water Board does not have sufficient data (e.g., number of failing septic systems, number of animals per parcel, number of boaters committing illicit discharges, number of pets and wildlife within the Watershed, etc.) at this time to determine the magnitude of the water quality impairment caused by each source category. However, as discussed in Sections 3 and 5, available information indicates that all source categories are contributing to the water quality

impairment. Therefore, the Water Board is recommending Watershed-wide reduction of pathogen sources from all controllable source categories. Many implementation activities are already underway in the Watershed. Water Board staff strongly supports these activities and recommends that these efforts be continued.

In most cases, the individual discharger or source category will be responsible for documenting its pathogen management measures. Acceptable ways of demonstrating that a source category is complying with their allocation are discussed below. For purpose of demonstrating attainment of applicable allocations, responsible parties will only be responsible for compliance with specified implementation measures and ensuing waste discharge requirements or waiver conditions.

Implementation actions need to be "trackable" and include existing efforts as well as those required under existing or anticipated regulatory requirements.

The TMDL includes actions to be carried out by the Water Board and also includes actions that each facility or source-type is required to conduct. Active participation from local entities and third parties within the Watershed will also be essential for attainment of water quality standards. To help ensure that actions anticipated from other entities, such as the RCD, U.C. Cooperative Extension, and government agencies (including County of Marin, Point Reyes National Seashore, Gulf of Farallones Sanctuary, DFG, and DHS) are implemented, the Water Board will rely on interagency coordination, grant funding, and research and monitoring.

Opportunities and benefits for interagency and third-party participation need to be further explored (e.g., Maintenance Districts for OSDSs). Some third parties are considering offering technical assistance (e.g., MCSTOPPP with equestrian facilities, U.C. Cooperative Extension with dairies and grazing lands). It has been suggested that the role third parties play in the TMDL implementation be further clarified. The Water Board will continue to explore methods for clarifying the role that third parties play including: identifying their responsibilities in official Water Board documents (including WDRs); requesting reports from them; developing memoranda of understanding between the Water Board and third parties; and continuing the ongoing, informal collaboration and discussions with them. Ultimately, the discharger is responsible for following all regulations.

Tables 21–27 describe the recommended implementation actions to be performed by the Water Board and other parties. The implementation actions described in Tables 21–27 are likely to be more detailed than the actions included in the Basin Plan amendment language adopting this TMDL. Tables 21–27 are intended to serve as guidance and clarify the intent of the regulatory action.

Table 21
Water Board Actions

Area of Focus	Action
FUNDING	1. Awarded $750,000 to Marin RCD under the Proposition 13 fund to assist dairies and ranches in the Tomales Bay Watershed to reduce pathogens and nutrients. 2. Awarded $600,000 to Council of Bay Area Resource Conservation Districts under 319 Grant to Equine Facilities Assistance Program and Manure Management Program. 3. Awarded $800,000 to Marin County under the Proposition 13 fund to repair failed OSDSs along the east shore of Tomales Bay and provide technical assistance to homeowners in the Watershed. 4. Awarded $280,000 to U.C. Cooperative Extension under the Proposition 13 fund to conduct a study of pathogen sources in coastal estuaries. 5. Encourage grant funding for activities likely to reduce pathogen loadings, promote improved management practices, or otherwise further the goals of this implementation plan.
COORDINATION	1. Work with stakeholders in the Watershed to clearly define the role they can play in assisting with TMDL implementation. Options to consider include developing Memoranda of Understanding between the Water Board and third parties and continuing ongoing, informal collaboration and discussions between third parties, stakeholders, and Water Board staff. 2. Work with stakeholders in the Watershed to identify guidelines and criteria for water quality protection plans and/or technical assistance checklists. 3. Assist RCD/U.C. Cooperative Extension with conducting technical assistance and outreach to animal waste facilities. 4. Promote the implementation of pathogen-reducing management practices within Tomales Bay Watershed.

Table 21, continued
Water Board Actions

Area of Focus	Action
COORDINATION	5. Assist Point Reyes National Seashore (PRNS), Gulf of Farallones, Tomales Bay State Parks, Coastal Commission, State Lands Commission and recreational community in providing education and outreach and in developing water quality protection and management plan for reducing human waste from recreational users in Tomales Bay. 6. Provide technical assistance and guidance to Marin County Stormwater Pollution Prevention Program (MCSTOPPP) to incorporate necessary requirements into the stormwater management plan to reduce pathogen loadings within Tomales Bay Watershed. 7. Assist MCSTOPPP and Marin Horse Council in continuing technical assistance program to equestrian facilities to reduce pathogen runoff. 8. Assist PRNS in continuing technical assistance program to ranches to reduce pathogen runoff. 9. Assist Department of Health Services with evaluating and updating rainfall model used to determine closures for shellfish lease. 10. Assist Marin County to develop an inventory of On-site Sewage Disposal Systems (OSDSs) and provide ongoing evaluation of how OSDSs are functioning. 11. Promote establishment of management and maintenance program for bringing faulty OSDSs up to County's repair standards. 12. Assist with permit streamlining for implementation of management practices.
RESEARCH AND MONITORING	1. Promote the development and adoption of evaluation methods (e.g., fate and transport models) for determining how pathogens are distributed and transported in the environment. 2. Promote studies to evaluate the effectiveness of source control measures.

Table 21, continued
Water Board Actions

Area of Focus	Action
RESEARCH AND MONITORING	3. Encourage pilot demonstration projects to evaluate methods for reducing pathogen discharges. 4. In coordination with responsible parties and interested third parties in the Watershed, develop monitoring program to measure progress toward attainment of water quality objectives, meeting benchmarks, and compliance with TMDL implementation plan. 5. Coordinate implementation of monitoring program (i.e, funding options and mechanisms). 6. Conduct monitoring and evaluate results of monitoring to determine progress toward attainment of water quality objectives. 7. Provide update on progress implementing management measures and attaining water quality objectives. Report should evaluate site-specific, sub-watershed and watershe-wide compliance with implementation measures and discuss options for regulatory action and follow-up, as needed.
PROACTIVE REGULATION	1. Inspect and evaluate each small wastewater treatment facility and recommend appropriate update(s) to Waste Discharge Requirements (WDRs). 2. Provide report on status of WDR facilities and identify facilities with greatest risk to water quality. 3. Enforce conditions of permits related to pathogen reduction, including dairy compliance with applicable WDRs or waiver of WDRS, small wastewater treatment facilities' compliance with WDRs, and homeowner compliance with OSDS regulations. 4. In coordination with stakeholders, develop and implement WDRs or waiver of WDRs related to pathogen reduction, including equestrian facilities and ranching facilities.

Table 21, continued
Water Board Actions

Area of Focus	Action
PROACTIVE REGULATION	5. Identify third party with expertise to review and comment on source assessment and implementation of appropriate management measures for each source type. 6. In coordination with interested stakeholders in Tomales Bay, make a determination on the adequacy of on-shore restroom facilities and boater disposal/pump out facilities and prepare a schedule for a determination of Pumpout Facility Need and Public Hearing Notification, as appropriate. 7. In coordination with Point Reyes National Seashore, Gulf of the Farallones, State Lands Commission, California Coastal Commission, California State Parks, and the County of Marin develop and implement a Tomales Bay boating management plan that includes: evaluation of existing moorings and water quality impacts, permitting and enforcement procedures to ensure compliance with applicable mooring requirements and to ensure no sewage discharge from boats.

Table 22
Actions for Onsite Sewage Disposal Systems Source Category

Organization	Action
MARIN COUNTY EHS	1. Provide education to homeowners on managing septic systems. Homeowner manual mailed to all homeowners in Watershed describing how to improve management and maintenance of their system. 2. Identify areas of greatest water quality concern from septic system failure. Conduct a GIS Risk Assessment that identifies septic parcels and rates their risk to public health and considers proximity to impaired waters, drinking wells, shellfish beds, and swimming areas. 3. Offer incentives to homeowners to measure how their systems are performing (i.e., free, voluntary inspection program offered to homeowners along Tomales Bay shoreline). 4. Create watershed-wide management program that assesses and documents performance of on-site sewage disposal systems (OSDSs). Priority should be given to systems within 100 feet of stream or Bay. Notify and/or report progress on inventory and OSDS repair to appropriate entity. 5. For OSDSs that do not pass routine evaluation, develop management plan with implementation schedule for bringing OSDS up to county's repair standards. Priority should be given to systems within 100 feet of water body. 6. Submit to the Executive Officer of the Water Board for approval a plan and implementation schedule to evaluate OSDS performance for the Tomales Bay watershed and to bring identified OSDS up to County's repair standards.
TBSTAC	1. Support community-based management measures (such as the East Shore Planning Group) and regular evaluation of OSDSs.

Table 23

Actions for Grazing Lands, Dairies, and Equestrian Facilities Source Categories

Organization	Action
MCSTOPPP	1. Assist equestrian facilities to help reduce animal waste runoff. Efforts may include providing educational materials and assisting with water quality plan development. 2. Continue technical assistance program for assessing equestrian facility potential for pathogen runoff. 3. Assess commercial and non-commercial horse facilities in Watershed and their potential to contribute to pathogen runoff. Priority should be given to facilities within 100 feet of a water body. 4. Identify and implement management measures needed to reduce animal waste runoff from equestrian facilities.
EQUESTRIAN FACILITIES	1. Participate in Resource Conservation District (RCD) and MCSTOPPP to improve horse facilities and manure management. 2. Work with RCD and county to identify equestrian facilities in the Watershed and steps needed to reduce animal waste runoff. 3. Participate in technical assistance assessment efforts on how to reduce animal waste runoff. 4. Identify site-specific source control measures and conservation practices needed to reduce animal waste runoff. Develop implementation schedule for implementing management measures to reduce animal waste runoff. 5. Submit Report of Waste Discharge to the Water Board that provides the following: a description of the facility; identification of necessary site-specific management measures to reduce animal waste runoff; and an implementation schedule of identified management measures. 6. Comply with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs. 7. Report progress on implementation of management measures that reduce animal waste runoff.

Table 23, Continued

Actions for Grazing Lands, Dairies, and Equestrian Facilities Source Categories

Organization	Action
POINT REYES NATIONAL SEASHORE	1. In partnership with other agencies, develop technical assistance checklist, approved by Water Board staff, for assessing pathogen runoff potential in grazing lands. 2. Assess grazing lands in Watershed that are within proximity of a water body and their potential to contribute to pathogen runoff. 3. Develop management measure recommendations and implementation schedule for those ranch facilities not meeting checklist guidelines. 4. Notify and/or report progress on source assessment and implementation of management measures for ranches to appropriate entity as specified in applicable WDRs or waiver of WDRs.
RCD/U.C. COOPERATIVE EXTENSION/ NRCS	1. Provide education and technical assistance to equestrian facilities, dairy facilities, and ranches so that they can develop management measures for reducing animal waste runoff. 2. Assist with monitoring and assessment of dairy, equestrian, and grazing-land waste practices. 3. Identify and promote pilot demonstration projects in dairies, equestrian facilities, and grazing lands. 4. Provide technical assistance and training programs to identify and implement site-specific management practices for dairies, equestrian facilities, and grazing lands.
DAIRY OPERATORS	1. Participate in Sonoma-Marin Animal Resource Committee. The Committee supports dairy operators in their efforts to solve waste control problems and locate technical and financial assistance. The committee serves as a vehicle through which the Water Board and DFG can disseminate information on water quality regulations and requirements. 2. Participate in an annual training program that identifies water quality concerns and site-specific best management practices for reducing such water quality impacts (e.g., Dairy Quality Assurance Program Training).

Table 23, Continued

Actions for Grazing Lands, Dairies, and Equestrian Facilities Source Categories

Organization	Action
DAIRY OPERATORS	3. Implement management practices to reduce pathogen loading to the Watershed. 4. Ensure that facility is in full compliance with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs. 5. Fully implement management practices and apply conservation measures on land to meet water quality objectives for pathogen reduction (e.g., riparian planting, riparian fencing and crossings, etc.).
GRAZING LANDS (OWNERS AND LEASEES ON PRIVATE LANDS)	1. Participate in available technical assistance programs to ensure that land is used within its capabilities 2. Comply with state's Nonpoint Source Guidelines for rangelands. 3. Participate in Ranch Management training program(s). 4. Identify site-specific source control measures and conservation practices needed to reduce animal waste runoff. 5. Develop and begin implementation of a ranch conservation plan (e.g., Ranch Management Plan). 6. Fully implement management practices and apply conservation measures on land as needed for reduction of animal waste runoff (e.g., riparian planting, riparian fencing and crossings, etc.). 7. Participate in Point Reyes National Seashore and other programs to ensure that land is used within its capabilities. 8. Submit a Report of Waste Discharge to the Water Board that provides the following: a description of the facility; identification of necessary site-specific management measures to reduce animal waste runoff; and a schedule for implementation of identified management measures.. 9. Comply with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs.

Table 23, Continued

Actions for Grazing Lands, Dairies, and Equestrian Facilities Source Categories

Organization	Action
GRAZING LANDS (OWNERS AND LEASEES ON PUBLIC LANDS)	10. Report progress on implementation of management measures that reduce animal waste runoff as specified in the applicable WDRs or waiver of WDRs.
TBSTAC	1. Support ongoing research and technical assistance currently being performed by the U.C. Cooperative Extension and TBAG and implementation of management measures at these facilities. 2. Review monitoring information on water quality and implementation of management measures.

Table 24
Actions for Municipal Runoff Source Category

Organization	Action
MARIN COUNTY STORMWATER POLLUTION PREVENTION PROGRAM (MCSTOPPP)	1. Provide educational information and technical assistance to municipal areas to help promote pathogen reduction. 2. Submit to the Water Board for approval a stormwater management plan that includes management measures to reduce pathogens runoff and a schedule for implementation of identified management measures. 3. Implement storm water management plans, public education and outreach, and discharge detection and elimination program(s) in Tomales Bay Watershed. 4. Update/Amend stormwater management plan to include specific measures to reduce Tomales Bay Watershed pathogen loads. 5. Report progress on implementation of pathogens reduction measures as specified in the approved stormwater management plan.

Table 25
Actions for Small Wastewater Treatment Facilities Source Category

Organization	Action
WATER BOARD	1. Inspect and evaluate each small wastewater treatment facility and recommend appropriate update to Waste Discharge Requirements (WDRs). 2. Provide report on status of facilities and identify facilities with greatest risk to water quality.
SMALL WASTE WATER TREATMENT FACILITIES	1. Comply with applicable Waivers of Waste Discharge Requirements.

Table 26
Actions for Boat Discharges Source Category

Organization	Action
NATIONAL PARK SERVICE, TOMALES BAY STATE PARKS, GULF OF FARALLONES, COUNTY OF MARIN, CALIFORNIA COASTAL COMMISSION, STATE LANDS COMMISSION, BOATERS, AND RECREATIONAL USERS	1. Inform public about importance of proper human waste disposal. Continue such efforts as posting signs at local, state, and national parks. 2. Continue planning process identifying recreational use guidelines in Tomales Bay. Progress to date includes the *Guidelines for Protection and Use of Tomales Bay* (National Park Service, 2001) planning document, which recommended development of a long-range comprehensive plan for dealing with community waste. 3. Provide adequate and aesthetically designed sanitary waste facilities for recreational users at appropriate locations in Tomales Bay Watershed. 4. Evaluate recreational study and boating survey (provided by Water Board) to determine number of boaters in Tomales Bay and adequacy of vessel waste disposal facilities. 5. Participate in the development of a waste facilities management plan that evaluates the need for additional on-shore restrooms, disposal facilities and pump-out facilities in Tomales Bay and contains a schedule of actions necessary to provide adequate waste facilities in the future. 6. Develop recommended disposal methods for each boat type (non-motorized, recreational, commercial, liveaboards). Work with boating and recreational community to help publicize proposed methods. 7. Develop recommendations for reducing water quality impacts from existing moorings. Identify appropriate management actions, permitting and enforcement procedures to ensure compliance with applicable mooring requirements and to ensure no sewage discharge from boats.

Table 26, Continued
Actions for Boat Discharges Source Category

Organization	Action
NATIONAL PARK SERVICE, TOMALES BAY STATE PARKS, GULF OF FARALLONES, CALIFORNIA COASTAL COMMISSION, COUNTY OF MARIN, STATE LANDS COMMISSION, BOATERS, AND RECREATIONAL USERS	8. Develop enforcement procedures for boats to ensure compliance with existing waste discharge prohibitions contained in Basin Plan. 9. Report progress on source assessment, plan development, and plan implementation to appropriate entity as specified in applicable Boating Management Plan. 10. Develop waste facilities necessary to ensure that Tomales Bay will have sufficient on-shore restrooms, boat disposal facilities, and pump-out facilities to accommodate and properly dispose of human waste. 11. Recommend appropriate follow-up actions, management strategies or enforcement actions, as needed, to ensure boats provide sufficient capacity to accommodate human waste and that there is no sewage discharge from boats. Incorporate recommendations into management plans. 12. Coordinate with agencies and rely on interests and authorities to develop and implement a Tomales Bay boating management plan that includes: evaluation of existing moorings and water quality impacts; permitting and enforcement procedures to ensure compliance with applicable mooring requirements and to ensure no sewage discharge from boats. Recommend appropriate follow-up actions, management strategies or enforcement actions, as needed, to ensure boats provide sufficient capacity to accommodate human waste and that there is no sewage discharge from boats. Incorporate recommendations into management plans.
TBSTAC	1. Assist with expanding restroom facilities for recreational users (e.g., siting and design of boater pump-out facility at Miller Park).

Table 27
Actions for DHS and Shellfish Growers

Organization	Action
DEPARMENT OF HEALTH SERVICES (DHS)	1. Evaluate rainfall closure standards (rules) and recommend appropriate revisions if necessary. 2. Provide education and outreach to shellfish industry on appropriate methods for preventing internal product contamination from ill employees
SHELLFISH GROWERS	1. Comply with DHS's "Management Plan for Commercial Shellfishing in Tomales Bay" by developing and implementing a "Wildlife Management Plan" to prevent product contamination or an approved Standard Operating Procedure (SOP) detailing methods used to mitigate fecal contamination of the product caused by wildlife.

8.9 Future Plans and Policies

There are a number of plans and policies that are anticipated, but not yet completed. In particular, Assembly Bill (AB) 885 affects Water Board and local counties' management of OSDSs. AB 885 requires the State Water Board to adopt specified regulations or standards for the permitting and operation of prescribed OSDSs by January 1, 2004. The State Water Board released a Notice of Preparation for the environmental document to evaluate the adoption of new regulations in June 2005.

8.10 Evaluating Progress Toward Attaining Implementation Goals

In 2009 and approximately every five years after the adoption of the TMDL, the Water Board will evaluate site specific, sub-watershed specific, and watershed-wide compliance with the trackable implementation measures. In evaluating compliance with the trackable implementation measures, the Water Board will consider the level of participation of each source category as well as individual dischargers (as documented by Water Board staff or designated third parties). The results of the evaluation will be reported to stakeholders in the Watershed.

If a discharger demonstrates that all implementation measures have been undertaken or that it is infeasible to meet their allocation due to wildlife contributions, the Water Board will consider revising allocations as appropriate. If source control actions are fully implemented throughout the Watershed and the TMDL targets are not met, the Water Board may consider re-evaluating or revising the TMDL and allocations. If, on the other hand, the required actions are not fully implemented, or are partially implemented, the Water Board may consider regulatory or enforcement action against parties or individual dischargers not in compliance.

The state's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (State Water Board, 2004) requires that current and proposed nonpoint source discharges are regulated under a waste discharge requirement (WDR), waiver of waste discharge requirement, Basin Plan prohibition, or some combination of these tools.

Table 28 describes the method that will be used to regulate each of the discharger categories. Such prohibition, waivers or WDRs will be further clarified, as needed, in 2009 when the Board reviews the progress of this TMDL. The Water Board has established conditions for waiving WDRS for dairies. The Water Board intends to work with stakeholders to develop similar waiver conditions for grazing lands and equestrian facilities.

The Basin Plan requires equestrian facilities and grazing land operators to submit a Report of Waste Discharge that will identify specific information about the facility, the identification of necessary site-specific grazing management measures to reduce animal waste runoff and a schedule to implement identified management measures. The intent of this submittal is to give the operators maximum site-specific flexibility to identify and implement source reduction measures. The Water Board, in developing conditions for the proposed waiver of WDRs may allow other submittals in lieu of a Report of Waste Discharge. At this point, there are no identified fees for waivers of WDRs. The Water Board may, however, petition the State Water Board to impose fees if the resource requirements of implementing the waiver program warrant such fees.

Table 28
Regulatory Framework for Discharges by Source Category

Source Category	**Regulatory Tool**
On-site Sewage Disposal Systems (OSDS)	Waiver[a] of Waste Discharge Requirements
Small Wastewater Treatment Facilities	Individual Facility Waste Discharge Requirements
Boat Discharge	Prohibition of Human Waste Discharge applies to all boaters in Tomales Bay
Grazing Lands (Ranchlands and Riparian Pasture Lands)	Waiver[a] of Waste Discharge Requirements
Dairies	Waiver[a] of Waste Discharge Requirements or Individual WDRs, as appropriate
Equestrian Facilities	Waiver[a] of Waste Discharge Requirements
Municipal Stormwater	General NPDES Permit

a. Water Board has option of requiring an individual permit if discharge is not meeting conditions of the waiver.

As previously stated, each responsible party will be required to comply with the specified implementation measures and ensuing waste discharge requirements, prohibitions or waiver of waste discharge requirements. To measure compliance, various proposed benchmarks for assessing implementation of management measures are discussed below. If the implementation benchmarks are not met the Water Board

may consider more-advanced regulatory action and/or taking enforcement action. The possible regulatory options for each source are also discussed below.

Onsite Sewage Disposal Systems

- Establish watershed-wide management district with ability to complete inventory of systems and assess overall performance of OSDSs within the Watershed or establish appropriate alternative to management district.
- If benchmarks not met, options include: Modify existing waiver to require operating permits for all OSDSs; moratorium on building permits with septic systems; enforcement actions for individual septic systems discharging to waters.

Small Wastewater Treatment Facilities

Water Board staff inspect and evaluate facilities and recommend appropriate update to WDRs. Facilities will comply with existing WDRs.

- If benchmarks are not met, consider enforcement actions.

Boat Discharges

- Develop facilities management plan that identifies anticipated need for additional on-shore restrooms, disposal facilities and pump-out facilities in Tomales Bay. Require installation of appropriate marine waste facility.
- Develop recommendations for appropriate boating regulations in Tomales Bay to help reduce the potential for boat discharges. Identify appropriate management actions to ensure compliance with boating program.
- Develop recommended waste disposal methods for each boat type (non-motorized, recreational, commercial, liveaboards). Work with boating and recreational community to help publicize proposed methods.
- If benchmarks not met, options include: Impose requirement to install adequate restroom/disposal/pumpout facilities; develop waiver and inspection program for all boats in Watershed; prohibition on boating in watershed.

Grazing Lands

- Assess facilities in the Watershed and their potential to contribute to pathogen runoff.
- Implement grazing management measures to reduce animal waste runoff according to approved implementation schedule and provide documentation of efforts.
- If benchmarks not met, options include: require individual Waste Discharge Requirements (WDRs) for all facilities not in compliance; take enforcement actions for all facilities not in compliance.

Dairy Operators

- All dairy operators in the Watershed in full compliance with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs or approved compliance schedule by Water Board.

- If benchmarks not met, options include: require individual WDRs for all facilities not complying for all facilities not complying with identified management measures; enforcement actions for all facilities not in compliance.

Equestrian Facilities

- Assess commercial and non-commercial equestrian facilities in the Watershed and their potential to contribute to animal waste runoff.
- Implement measures to reduce identified runoff from equestrian facilities according to approved implementation schedule and provide documentation of efforts.
- If benchmarks not met, options include: require individual Waste Discharge Requirements (WDRs) for all facilities not complying with identified management measures; enforcement actions for all facilities not in compliance.

Municipal Runoff

- Identify Municipal Program Requirements for NPDES storm water program for residential areas in Tomales Bay Watershed (including Pt. Reyes Station, Inverness, Marshall, etc.), receive Water Board approval for program and incorporate into Action Plan 2010 (not yet released).
- Implement municipal program requirements in Watershed.
- If benchmarks not met, options include: limits on building permits in the Watershed, enforcement action.

If the Water Board determines that load and concentration reductions are being achieved as management measures are effectively implemented, then the recommended appropriate course of action would be to continue management measure implementation and compliance oversight. If it is determined that all proposed control measures have been implemented, yet the TMDL is not achieved, further investigations will be made to determine whether: 1) the control measures are not effective; 2) the high fecal coliform level is due to uncontrollable (wildlife) sources; or, 3) the TMDL is unattainable.

If measures are not implemented and water quality objectives are not achieved within five years of the TMDL adoption, the Water Board will evaluate and consider more-advanced regulatory measures. These direct regulatory measures may include (but not be limited to) a moratorium on building permits for homes with OSDSs; enforcement actions against equestrian, dairy, and grazing land facilities; limits on boats in Bay not meeting human waste requirement; limits on development in areas not complying with the storm water management plan; and a prohibition of boaters in Tomales Bay.

9. MONITORING AND EVALUATION PROGRAM

9.1 Overview

It is important to monitor water quality progress, track TMDL implementation, and modify TMDLs and implementation plans as necessary, in order to:

- assess trends in water quality to ensure that improvement is being made;
- oversee TMDL implementation to ensure that implementation measures are being carried out;
- address any uncertainty in various aspects of TMDL development; and
- ensure that the TMDL remains effective, given changes that may occur in a watershed after TMDL development.

The primary measure of success for this TMDL is attainment and/or continuous progress toward attainment of the TMDL targets and load allocations (see Section 6.2). However, in evaluating successful implementation of this TMDL, attainment of trackable implementation actions (i.e., BMPs) will also be heavily relied upon (see section 8.2). Therefore, two types of monitoring are proposed for this TMDL: 1) water quality monitoring, which is discussed in this section, and 2) monitoring of implementation of actions, which was discussed in Section 8.10.

9.2 Water Quality Monitoring

In order to assess the progress made in water quality and obtain additional information for further refinement of the TMDL, Water Board staff and stakeholders in the Watershed will collaborate to monitor selected water quality testing stations within the Watershed and the Bay. The main objectives of the Monitoring Program are to:

- Assess attainment of TMDL targets
- Evaluate spatial and temporal water quality trends in the Bay and its tributaries
- Further identify significant pathogens source areas
- Evaluate coliform levels and loadings to the Bay at the terminus of major tributaries
- Collect sufficient data to calibrate and validate the Bay hydrodynamic model to observed coliform levels and
- Collect sufficient data to prioritize implementation efforts and assess the effectiveness of implementation actions.

The proposed water quality monitoring stations for the Watershed and the Bay are:

<u>Lagunitas Watershed:</u>

1. Woodacre Creek
2. East Fork Woodacre
3. West Fork Woodacre

4. San Geronimo Creek at Roy's Pool
5. San Geronimo Creek at Inkwells
6. Lagunitas Creek below Devil's Gulch Creek
7. Lagunitas Creek below Cheda Creek
8. Lagunitas Creek below Jewell
9. Lagunitas Creek at Gallagher Ranch
10. Arroyo Creek
11. Montezuma Creek

Olema Watershed:

1. Olema 1 - John West Fork of Olema
2. Olema 6 - Davis Boucher Creek
3. Olema 10 - Olema Creek at Caltrans
4. Olema 11 - Olema Creek at Bear Valley Road Bridge
5. Olema 14 - Mainstem Olema at Five Brooks
6. Olema 18 - Mainstem Olema above Randall Gulch Confluence

Walker Watershed:

1. Walker Creek Ranch
2. Walker Creek at Highway 1 Bridge
3. Keys Creek at Tomales
4. Upper Chileno Creek at Milepost 5.86 on Chileno Road

East Shore:

1. Millerton Creek
2. Drainage at Milepost 36.17 on Highway 1

West Shore:

1. Inverness Public Utility District's sampling station 1
2. Inverness Public Utility District's sampling station 2
3. Inverness Public Utility District's sampling station 3

Bay:

1. Water Quality Station # 7 (Inner-Bay, North of Tomasini Point)
2. Water Quality Station # 11 (South end, near Millerton Point)
3. Water Quality Station # 39 (Southeast corner of the Walker Creek delta)
4. Water Quality Station # 47 (Northeast corner of the Walker Creek delta)

Table 29 outlines the locations, constituents, sampling frequency, analytical methods, and the responsible parties for the long-term water quality monitoring program. The Water Board, in coordination with the responsible parties and interested third parties in the Watershed, such as National Park Service, Department of Health Services, commercial shellfish growers, the Inverness Public Utility District, and Salmon Protection and Watershed Network (SPAWN) will conduct the proposed long-term water quality monitoring plan. All water quality monitoring (including Quality Assurance [QA] and Quality Control [QC] procedures) will be performed pursuant to the State Water

Board's Quality Assurance Project Plan for the Surface Water Ambient Monitoring Program.

Table 29
Constituents, Sampling Frequency, Analytical Methods, Duration, and Sampling Parties

Constituent	Location	Frequency	Analytical Method	Sampling Entities
Bay				
Fecal Coliform [a]	Four of the 17 designated DHS monitoring stations at shellfish growing lease areas	Weekly for five weeks from January to early February; Monthly from March through December Weekly for five weeks during summer months	U.S. EPA Standard Multiple Tube Fermentation Method; 9221B	DHS, Shellfish Growers
Watershed				
Fecal coliform Stream Flow	Olema Creek	Weekly for five weeks from January to early February; Monthly from March through December Weekly for five weeks during summer months	U.S. EPA SM 9221B NPS gauging station	National Park Service
Fecal coliform	West Shore	Same as above	U.S. EPA SM 9221B	Inverness PUD
Fecal coliform	East Shore	Same as above	U.S. EPA SM 9221B	Water Board
Fecal coliform Stream Flow	Lagunitas Creek	Same as above	U.S. EPA SM 9221B USGS gauging station	Water Board, SPAWN
Fecal coliform Stream Flow	Walker Creek	Same as above	U.S. EPA SM 9221B USGS gauging station	Water Board

a. *E. coli* monitoring may be used in the future to assess general water quality trends and exceedances. If E. coli is used instead of fecal coliform to assess general water quality trends and exceedances, samplers will also collect duplicate samples (10% of the total number of samples) to be analyzed for fecal coliform, in order to obtain a Tomales Bay specific correlation factor between fecal coliform and *E. coli*.

9.3 Data Management and Evaluation

Water Board staff will compile and analyze monitoring data from all stations and will present the results to the Tomales Bay Shellfish Technical Advisory Committee (TBSTAC) and Tomales Bay Watershed Council (TBWC) on an annual basis. Water Board staff will use the monitoring data to: 1) determine whether appropriate bacterial levels are attained; 2) make any necessary adjustments to the monitoring plan; 3) revise, as necessary, various aspects of the TMDL including the implementation plan; 4) obtain a more refined assessment of contributing sources; and 5) determine whether TMDL targets are attainable.

In 2009 and approximately every five years after the adoption of the TMDL, the Water Board will evaluate site specific, sub-watershed specific, and watershed-wide compliance with the trackable implementation measures specified in Table 4-23. In evaluating compliance with the trackable implementation measures, the Water Board will consider the level of participation of each source category as well as individual dischargers (as documented by Water Board staff or third parties).

If a discharger demonstrates that all implementation measures have been undertaken or that it is infeasible to meet their allocation due to wildlife contributions, the Water Board will consider revising allocations as appropriate. If source control actions are fully implemented throughout the Watershed and the TMDL targets are not met, the Water Board may consider re-evaluating or revising the TMDL and allocations. If, on the other hand, the required actions are not fully implemented, or are partially implemented, the Water Board may consider regulatory or enforcement action against parties or individual dischargers not in compliance.

The California Department of Health Services, working in consultation with the Shellfish Technical Advisory Committee, is encouraged to periodically evaluate, beginning in 2009, shellfish harvest closure guidelines and the relationship between precipitation, runoff, coliform levels, and water quality exceedances.

9.4 Adaptive Implementation

Approximately every five years, the Water Board will review the Tomales Bay Watershed Pathogens TMDL and evaluate new and relevant information from monitoring, special studies, and scientific literature. The reviews will be coordinated through the Water Board's continuing planning program and will provide opportunities for stakeholder participation. Any necessary modifications to the targets, allocations, or implementation plan will be incorporated into the Basin Plan. In evaluating necessary modifications, the Water Board will favor actions that reduce sediment and nutrient loads, pollutants for which the Tomales Bay Watershed is also impaired. At a minimum, the following questions will be used to conduct the reviews. Additional questions will be developed in collaboration with stakeholders during each review.

1. Are the Bay and the tributaries progressing toward TMDL targets as expected? If progress is unclear, how should monitoring efforts be modified to detect trends? If there has not been adequate progress, how might the implementation actions or allocations be modified?
2. What are the pollutant loads for the various source categories (including naturally occurring background pathogen contributions and the contribution from open space lands), how have these loads changed over time, how do they vary seasonally, and how might source control measures be modified to improve load reduction?
3. Is there new, reliable, and widely accepted scientific information that suggests modifications to targets, allocations, or implementation actions? If so, how should the TMDL be modified?
4. The allocations assume a conservative bacterial die-off rate of 0.02 per hour. This value is based on rates reported for San Francisco Bay in 1970. If bacterial die-off is found to be higher, higher allocations may be considered. What are bacterial die-off rates in the water column and stream sediments? Do they vary by season? What are bacteria transport times from sources to the Bay?
5. How does estuarine mixing and dilution of tributary waters vary by flow and season?
6. What is the relationship between precipitation, runoff, tributary loads, Bay coliform levels, and water quality exceedances and shellfish harvesting closures?
7. Are there bacteria in Tomales Bay sediments that enter the water column during storm events? If yes, how should this process be accounted for?

If it is demonstrated that all reasonable and feasible source control measures have been implemented for a sufficient period of time and TMDL targets are still not being met, the Water Board will reevaluate water quality standards, TMDL targets and allocations as appropriate.

In addition, it is recommended that future Water Board planning resources be directed toward the review of the Tomales Bay Watershed Pathogens TMDL and evaluation of new and relevant information from monitoring and scientific literature.

10. REGULATORY ANALYSES

10.1 Overview

This section includes the analyses required pursuant to the Administrative Procedures Act to adopt or modify a regulation. Many Basin Plan provisions are considered regulations, and many of the changes contained in the proposed Basin Plan amendment add regulatory provisions to the Basin Plan. To adopt these changes, the Water Board must complete an environmental checklist pursuant to the California Environmental Quality Act (CEQA), consider reasonable alternatives to the proposal, and consider economic factors relating to compliance with all new regulatory requirements.

10.2 Environmental Checklist

CEQA requires agencies to review the potential for their actions to result in adverse environmental impacts. CEQA further requires agencies to adopt feasible measures to mitigate potentially significant impacts. Chapter 11 contains the environmental checklist for the proposed Basin Plan amendment. An explanation follows the environmental checklist and provides details concerning the environmental impact assessment. The analysis concludes that adopting the proposed Basin Plan amendment will not have any significant adverse environmental effects.

10.3 Alternatives

To illustrate how some of the choices made in developing the proposed Basin Plan amendment affect its foreseeable outcomes, this analysis considers a range of alternatives to the Basin Plan amendment. It discusses how each alternative would affect foreseeable outcomes and the extent to which the alternative would achieve the goals of the proposed Basin Plan amendment. As discussed in Chapter 11, the Basin Plan amendment does not pose any significant adverse environmental impacts; therefore, the alternatives would not avoid or lessen any significant adverse impacts. The following alternative scenarios involve different targets, allocations, and implementation strategies: (1) proposed Basin Plan amendment, (2) no Basin Plan amendment, (3) higher TMDL targets and allocations, (4) lower TMDL targets and allocations, (5) seasonal TMDL, and (6) longer implementation.

Proposed Basin Plan Amendment
The proposed project is the adoption of the Basin Plan amendment presented in Chapter 11. The Basin Plan amendment is based on the technical analyses described in Sections 2 through 9 of this report. The Basin Plan amendment includes target fecal coliform concentrations for Tomales Bay (14 MPN/100 mL), and its tributaries (200 MPN/100 mL), and assigns load allocations to the various pathogen source categories to achieve the targets.

No Basin Plan Amendment
Under this alternative, the Water Board would not amend the Basin Plan to adopt the proposed pathogen TMDL. Neither the proposed targets nor the proposed allocations would be adopted, and no new implementation activities would be initiated. In the event that no actions were taken to address the Tomales Bay Watershed's pathogens impairment, pathogen concentrations would likely either stay the same or increase over time, due to the aging of waste management systems.

If the Water Board were to decline to adopt a pathogens TMDL, the Clean Water Act requires the U.S. Environmental Protection Agency (U.S. EPA) to complete a TMDL for Tomales Bay Watershed. How U.S. EPA's TMDL would differ from the TMDL described in the proposed Basin Plan amendment is unknown. U.S. EPA would likely rely, at least in part, on analyses completed to date; however, U.S. EPA would be free to develop its own TMDL in any manner it deemed appropriate, within legal constraints. U.S. EPA would identify targets and allocate pathogen loads. U.S. EPA would not impose an implementation plan directly. However, the Water Board would be expected to incorporate U.S. EPA's TMDL and appropriate implementation actions into the Basin Plan through the continuing planning process.

This alternative would involve the Water Board declining to exercise the authority and responsibility delegated to it by U.S. EPA to implement Section 303(d) of the Clean Water Act. The Water Board would not maintain responsibility for developing and implementing the Tomales Bay Watershed Pathogens TMDL. In addition, the U.S. Federal Government may not be as effective as the Water Board at developing a TMDL and encouraging stakeholder participation for this area given the regional expertise of the Water Board and local stakeholders.

Higher TMDL Targets/Allocations
Under this alternative, the TMDL targets would be set at a higher level than those proposed in the Basin Plan amendment, therefore raising the proposed pathogen load allocations.

This alternative would not protect the beneficial uses of the Tomales Bay Watershed (i.e., shellfish harvesting, water contact recreation, non-contact water recreation) to the same extent as the proposed targets.

Lower TMDL Targets/Allocations
Under this alternative, the TMDL targets would be set at a lower level than those proposed in the Basin Plan amendment. While the proposed targets are protective of human health, this alternative could ensure additional protection for the shellfish consumers and recreational users of the Tomales Bay Watershed. The pathogen load allocations, however, would need to be reduced to achieve these lower TMDL targets. This could necessitate additional TMDL implementation actions.

Meeting the lower allocations could require substantial additional effort to reduce pathogen loads. Because the costs of achieving these greater pathogen reductions may be disproportionately large when compared to the costs of the proposed reductions, the added costs may be unreasonable relative to the environmental benefits.

Seasonal TMDL
Under this alternative, the TMDLs for Tomales Bay and its tributaries would be applicable only during certain periods of the year (i.e., the dry season) and not throughout the year, as proposed by the Basin Plan amendment.

This alternative would be easier to achieve. It would not, however, fully protect the beneficial uses of the Tomales Bay Watershed at all times.

Longer Implementation
Under this alternative, the allocations would be phased in over a longer period of time (i.e., ten years) than what is proposed by the Basin Plan amendment. Therefore, attainment of the designated water quality objectives would be postponed, putting public health in jeopardy.

This alternative would not meet the Basin Plan amendment's objectives because it would delay without any reasonable justification attainment of the water quality objectives and protection of beneficial uses of the Tomales Bay Watershed. Further, most of the proposed implementation actions are and have been required under various established regulatory programs. Therefore, their implementation should be already underway, and by the end of the identified implementation period should be fully completed.

Preferred Alternative
Because the proposed Basin Plan amendment will not pose any significant adverse environmental impacts, the alternatives would not avoid or lessen any significant impacts. Some alternatives could be considered environmentally superior because they could conceptually involve lower allocations and greater implementation efforts. In this way, they could result in lower pathogen concentrations in the Tomales Bay Watershed. These alternatives are the lower TMDL targets and lower allocations scenarios. Both could be less feasible to implement than the proposed Basin Plan amendment. The proposed Basin Plan amendment is the preferred alternative.

10.4 Economic Considerations

Overview
The California Environmental Quality Act requires that whenever one of California's nine regional water boards, such as the San Francisco Bay Regional Water Quality Control Board (Water Board), adopts a rule that requires the installation of pollution control equipment or establishes a performance standard or treatment requirement, it must conduct an environmental analysis for reasonably foreseeable methods of compliance (Public Resource Code 21159 [a][3][c]). This analysis must take into account a

reasonable range of factors, including economics. Furthermore, if the rule includes an agricultural control plan, then the total cost of the program must be estimated and potential sources of funding must be identified (Water Code 13141).

The proposed Tomales Bay Pathogens Basin Plan amendment includes performance standards (i.e., targets and allocations), and therefore, requires the consideration of economic factors.[6] The Total Maximum Daily Load (TMDL) implementation plan also proposes activities for agriculture, and therefore, the total cost of the implementation effort is estimated and potential funding sources are identified.

The objective of this analysis is to estimate the costs of implementing the TMDL for pathogen reduction on land areas that drain into the Tomales Bay Watershed. It has been determined that pathogens originating from on-site sewage disposal systems (OSDS), small wastewater treatment facilities, boat discharges, grazing lands, dairies, equestrian facilities, and municipal runoff can be reduced to achieve the goals of the TMDL. In the proposed Basin Plan amendment (BPA), the Water Board has proposed implementation measures for each pathogen source. The implementation measures are primarily composed of monitoring, implementation of management practices (MPs), and reporting.

The TMDL implementation costs were estimated for each source category and for each of the proposed implementation actions contained in the BPA. Summary Tables 30 and 31 provide the cost estimates. We provided an upper and lower range of cost estimates since there is uncertainty about the exact costs. In most cases, the particular elements of the implementation action are required to be developed at some point in the future, and therefore, the specifics are unknown. For cases in which it is possible to make educated guesses about the likely elements of an implementation action, cost estimates are included. For other cases, estimating the elements of a program would be decidedly speculative, and therefore, no cost estimates are developed. Cost estimates were projected for a 10-year planning horizon. Costs of implementing existing requirements are also not included in this report.

Table 30
Summary of Estimated Costs for Tomales Bay Watershed Pathogen TMDL Implementation (Year 0 through 10)

Source Category	One Time Cost (Site Development/Infrastructure)		Annual Costs		Ten-Year Program Cost	
	Low	High	Low	High	Low	High
Municipal Runoff	$0	$0	$4,000	$19,000	$40,000	$190,000
Onsite Sewage Disposal Systems (OSDS)	$2,800,000	$43,750,000	$284,000	$1,118,000	$4,340,000	$49,680,000
Grazing Lands	$7,965,000	$15,930,000	$111,000	$451,000	$9,070,000	$20,431,000
Dairies	$0	$0	$0	$0	$0	$0
Equestrian Facilities	$495,000	$825,000	$229,000	$271,000	$2,780,000	$3,531,000
Boat Discharges	$53,000	$70,000	$0	$0	$53,000	$70,000
Small Wastewater Treatment Facilities	$0	$0	$0	$0	$0	$0
GRAND TOTAL	$11,313,000	$60,575,000	$628,000	$1,859,000	$16,283,000	$73,902,000

Table 31

Tomales Bay Implementation Actions, Estimated Costs, and Timing

Implementation Action	Responsible Party		One-Time Cost		Annual Cost		10-Year Program Cost	
	Name	No.	Low	High	Low	High	Low	High
Municipal Runoff								
1. Inspection/ Monitoring	Marin County Stormwater Pollution Prevention Program (MCSTOPPP)	1	$0	$0	$2,000	$4,000	$20,000	$40,000
2. Stormwater Plan Implementation	MCSTOPPP	1	$0	$0	$2,000	$15,000	$20,000	$150,000
3. Reporting	MCSTOPPP	1	$0	$0	$0	$0	$0	$0
	Total		$0	$0	$4,000	$19,000	$40,000	$190,000
Onsite Sewage Disposal Systems (OSDS)								
1. Evaluation/ Monitoring[1]	Marin County, Community Development Agency	3,500	$0	$0	$260,000	$1,050,000	$1,300,000	$5,250,000
2. Repair Program Implementation[2]	Homeowner	3,500	$2,800,000	$43,750,000	$0	$0	$2,800,000	$43,750,000
3. Reporting	Marin County, Community Development Agency	1	$0	$0	$24,000	$68,000	$240,000	$680,000
	Total		$2,800,000	$43,750,000	$284,000	$1,118,000	$4,340,000	$49,680,000
Grazing Lands								
1. Inspection/ Monitoring[3]	Dairies and Ranchers	151	$0	$0	$23,000	$302,000	$227,000	$3,020,000
2. Implement Management Measures	Dairies and Ranchers	151	$7,963,000	$15,930,000	$73,000	$73,000	$8,693,000	$16,656,000
3. Reporting	Dairies and Ranchers	151	$0	$0	$15,000	$76,000	$150,000	$755,000
	Total		$7,963,000	$15,930,000	$111,000	$451,000	$9,070,000	$20,431,000
Dairies								
1. Comply with applicable Waste Discharge Requirements (WDRs) or waiver of WDRs	Dairies	12	$0	$0	$0	$0	$0	$0
	Total		$0	$0	$0	$0	$0	$0
Equestrian Facilities								
1. Inspection/ Monitoring	Equestrian Facilities	33	$0	$0	$6,000	$48,000	$55,000	$477,000
2 Implement Management Measures	Equestrian Facilities	33	$495,000	$825,000	$218,000	$218,000	$2,675,000	$3,004,000
3. Reporting	MCSTOPPP or other entity	1	$0	$0	$5,000	$5,000	$50,000	$50,000
	Total		$495,000	$825,000	$229,000	$271,000	$2,780,000	$3,531,000
Boat Discharges								
1. Inspection/ Monitoring	Agencies[4]	1	Unknown	Unknown	$0	$0	$0	$0
2.Implement Boating Management Plan	Agencies[4]	1	$53,000	$70,000	$0	$0	$53,000	$70,000
3. Reporting	Agencies[4]	1	$0	$0	$0	$0	$0	$0
	Total		$53,000	$70,000	$0	$0	$53,000	$70,000

Table 31, continued
Tomales Bay Implementation Actions, Estimated Costs, and Timing

Implementation Action	Responsible Party		One-Time Cost		Annual Cost		10-Year Program Cost	
	Name	No.	Low	High	Low	High	Low	High
Small Wastewater Treatment Facilities								
1. Inspection/ Monitoring	Water Board	6	$0	$0	$0	$0	$0	$0
2. Comply with applicable Waste Discharge Requirements	Small Water Waste Treatment Facilities	1	$0	$0	$0	$0	$0	$0
3. Reporting	Water Board	1	$0	$0	$0	$0	$0	$0
Total			$0	$0	$0	$0	$0	$0
Grand Total			$11,311,000	$60,571,000	$628,000	$1,859,000	$16,283,000	$73,902,000

1. Low cost: Assumes only 1,300 tanks will be inspected every two years at $400/system. High cost: Assumes 3,500 tanks inspected every two years at $600/system).
2. Low cost: Assumes 10% failure rate at $8,000 per repair. High cost assumes 25% failure rate at $50,000 per repair.
3. Assumes three inspections over 10-year period.
4. Point Reyes National Seashore, California Costal Commission, California State Lands Commission, California State Parks, County of Marin, Gulf of the Farallones.

Cost Estimates

Municipal Runoff

The Tomales Bay municipal runoff program is managed by the County of Marin's Stormwater Pollution Prevention Program (MCSTOPPP). Municipal runoff for the Tomales Bay Watershed is regulated under federal NPDES storm water permit requirements. MCSTOPPP's permit requires development and implementation of a storm water management plan that includes specifics on what MPs will be used to address certain program areas. The program areas include public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations. MCSTOPPP's storm water management plan is entitled *Action Plan 2005* (Marin County, 2003) and is already being implemented.

To meet the requirements of the TMDL, the county will be required to develop additional management measures for pathogen reduction; identify measurable goals and time schedules of implementation; and assign responsibility for each task. The specifics of the storm water program efforts to reduce pathogens are not yet known and will be described in MCSTOPP's *Action Plan 2010* (to be released in 2005). MCSTOPPP is required to submit the stormwater management plan to the Water Board for approval. The Water Board will review this document for its adequacy in meeting the storm water requirements. An estimate of the storm water program efforts and their costs is provided below.

Inspections/Monitoring: As part of it storm water program, Marin County will be monitoring for bacteria levels in four outfalls in the town of Point Reyes Station. Monitoring will be conducted between 3–6 times per year at a cost of $640 per each sampling event ($400 hours of staff time for each sample event plus $60/lab fees per sampling site) for a total cost of $2,000–4,000/year (Lewis, pers. comm., 2004a).

Stormwater Plan Implementation: Development and implementation of a storm water program for this watershed is required independently of the Basin Plan amendment. Since this is an existing requirement under Phase II of the storm water program, no additional cost is estimated for implementation of the existing storm water management program. Some additional implementation measures or management programs may be needed for pathogen reductions. The specific measures are not known at this time. For the most part, these implementation measures would be extensions of existing programs. For example, an outreach program to local schools on runoff may be expanded to include a brief description of specific sources of pathogens in the Watershed (such as domestic animals or leaky septic tanks). Therefore, we estimate a minimum increase in storm water program costs of 2% of the existing $100,000 annual budget ($2,000), and a maximum increase of 15% per year ($15,000) above the existing budget for the storm water program (Lewis, pers. comm., 2004b).

Reporting: Reporting on the municipal storm water program is required independent of the TMDL under Phase II of the municipal storm water program. Therefore, no costs have been estimated for reporting.

Onsite Sewage Disposal Systems

The Basin Plan amendment requires the County to develop a plan and implementation schedule to evaluate Onsite Sewage Disposal Systems (OSDS) performance in the Tomales Bay Watershed and to bring identified OSDS up to the County's repair standards. It anticipates that repairs will be made to failing systems. The specifics of the management program that will document and assess performance of OSDS have not yet been determined. Within the Tomales Bay Watershed, approximately 3,500 parcels have septic systems. Of those, approximately 1,300 are considered "high-priority" or include parcels that are within 100 feet of a surface drainage watercourse (creek, bay, etc) (Taylor, pers. comm.).

The cost of system repairs will vary according to the type, age, and location of the system. The national average for failing systems ranges from 10–20% (US EPA, 2002). A recent survey of septic systems in the Town of Marshall indicated a 24% failure rate (CSW/Stueber-Stroeh, 2002).

Evaluation/Monitoring: The specifics of the program that will document and assess performance of OSDS have not yet been determined (Smith, pers. comm.). For calculating low-range cost estimates, we assumed that all of the parcels with septic systems within 100 feet of a water body would be inspected every two years. For calculating high-range cost estimates, we assumed that all septic systems in the Watershed should be inspected every two years. Inspections would likely include a visual survey of the tank, water level, and leach field. A hydraulic load and dye test would be necessary if the system is located near a waterway. This type of inspection could be performed by a qualified contractor and would cost approximately $400–$600 per OSDS inspection (Smith, pers. comm.).

Repair Program Implementation: OSDS repair costs vary greatly depending upon the problem. As a low-range cost estimate, we assumed that repairs would require replacement of a leaky septic tank. Tank replacement would cost approximately $8,000 (including risers, hook-ups, tank and labor) (Giamonna, pers. comm.). As a high-range cost estimate, a complete system replacement of a failed leach field could require installation of a mound system for a cost of approximately $50,000 (including labor and engineering) (Giamonna, pers. comm.). For the low-range estimate, a 10% failure rate for a repair cost of $8,000 per system is calculated. For a high-range estimate, a 25% failure rate at $50,000 per system is calculated.

Reporting: The Basin Plan amendment also requires the County to report progress on implementation of the OSDS management program. Oversight of the inspection results and follow-up, whether by the County of Marin or a local organization, would vary according to the number of systems inspected, frequency of inspection, type of system, and economies of scale. Assuming existing staff will have only the additional task of collecting and distributing information on septic records, the cost (with the added administrative and management support) is $24,000/year (Economic Planning Systems, 2003). As a high-range cost estimate, the creation of a new office with the addition of a half-time staff person was added to the low-range cost estimate, giving a total of $68,000/year (Economic Planning Systems, 2003).

Grazing Lands Runoff

The proposed Basin Plan amendment anticipates that the Water Board will develop waiver of Waste Discharge Requirements (WDRs) conditions (similar to the existing waiver conditions for Dairies) for grazing land operators. It also requires grazing operators to submit a Report of Waste Discharge that identifies site-specific grazing management measures and provides a schedule to implement measures to reduce animal runoff. At this point, the site-specific actions or general waiver conditions are unknown.

Approximately 55% of the land use in the Tomales Bay region is devoted to livestock production and dairies; we found no available data on grazing land acreage within the watershed. For cost estimation purposes, we assumed a minimum parcel size of 150 acres is capable of sustaining grazing activities (Larson, pers. comm.). Approximately 151 parcels (including 12 operational dairies) within the Tomales Bay Watershed meet this minimum (Kapellas, pers. comm.). Costs of some of the BPA requirements were estimated by using the number of parcels involved and the cost per individual parcel owner meeting the requirements. These costs estimates result from communications with National Resource Conservation Service (NRCS) and U.C. Cooperative Extension and past experience of consultants familiar with actions suggested in the TMDL.

Inspection/Monitoring: We assumed that all facilities would require an initial visit from technical assistance staff. The initial visit ranges from a minimum one half-day visit (roughly $500) to a maximum of two full-day visits (roughly $2,000). Frequency of facility visits may vary from semi-annual to once every five years depending upon each facility's adequacy in managing pathogen runoff. We found no data on how well the

range lands in the Tomales Bay Watershed are managed for pathogen reduction. Therefore, the low-range cost estimate includes one initial half-day visit with half-day inspections every five years. The high-range cost estimate includes an initial two-day visit with semi-annual two-day inspections thereafter.

Management Measures Implementation:
The specific pathogen reduction implementation measures will vary with the geography, pattern of animal use, and management practices. Without knowing specific grazing practices or the geography of individual ranches, we assume that typical MP measures will include livestock rotation through pastures, fencing animals out of the waterways, and installing off-stream water troughs. Since fencing is likely to be the most costly MP, this was used as a conservative cost estimate. However, the Water Board acknowledges that there are other acceptable methods of managing livestock access to streams. This cot estimate may also be high; as it does not account for implementation actions that are already fully or partially in place or may not require any measures.

Fence installation (39 inches high with barb wire and galvanized posts) is estimated to cost approximately $4.80 per linear foot to install. Fence maintenance and livestock movement is estimated at two hours per day per year at an assumed cost of $100/hour, or $73,000/ranch/year. These costs are estimated from formal communications with National Resource Conservation Service (NRCS) and U.C. Cooperative Extension staff and informal discussions with individual ranchers. The annual cost of fence and livestock maintenance is assumed to be the same for both low and high estimates.

Water troughs (224 gallon capacity, 2x2x8 feet) are estimated to cost $163/trough. As a high-range cost estimate, we assumed that all of the blue-line streams (as determined using GIS) within the existing 150-acre potential grazing parcels would be fenced. Using GIS, we calculated 1,640,000 linear feet of blue-line streams. With $4.80/foot to install and 1, 640,000 (x2) linear feet of stream to be fenced, the high-range cost for fencing $15,740,000. The high-range cost for water troughs (one water trough per 20 acres) is approximately $186,000. The low range cost estimate is assumed to be one half of the high range estimate.

Vegetation planting and fencing can help reduce erosion of forage land. It is possible that fencing the creeks may reduce the amount of forage available to livestock, thus resulting in a decline in livestock productivity and/or causing a reduction in herd size. The Natural Resources Conservation Service (NRCS) conducted a survey of Marin County ranchers to determine the financial impact of fencing riparian and wetland areas. Based on this 2004 survey of six ranchers, fencing of riparian areas could result in an estimated 5–10% loss of foraging acreage and a fiscal impact ranging from $90/acre/year to $730/acre/year (Sanders, pers. comm.). We found no accurate estimates of foraging land in the Tomales Bay Watershed; therefore, we could not calculate the total cost.

Reporting: We found no information on how the grazing land operators will choose to report on their compliance with the BPA requirements. Since these facilities will be

operating under a waiver of Waste Discharge Requirements (WDR), we assumed that Water Board staff would inspect each of the 151 facilities. As a high-range cost estimate, each facility will be inspected once a year at $500 per inspection. As a low-range cost estimate, each facility will be inspected once every five years at $500 per inspection.

Dairies
Twelve dairies currently operate in the Tomales Bay Watershed. Under existing law and regulations, all dairies are required to meet conditions of the Water Board's waiver of waste discharge requirements or the individual waste discharge requirements. The Basin Plan amendment is not imposing any new requirements or actions for the confined animal operations associated with dairies. Therefore, no cost estimates are calculated here. Dairies may incur some additional costs due to implementation of management practices associated with cow grazing on pasturelands. These costs are included in the above section entitled Grazing Lands Runoff (Ranchland and Riparian Pastureland).

Equestrian Facilities
The Tomales Bay Watershed contains 33 equestrian facilities (both commercial and private) (Nicholson and Murphy, 2004). The proposed Basin Plan amendment anticipates that the Water Board will develop waiver of Waste Discharge Requirements (WDRs) conditions (similar to the existing waiver conditions for Dairies) for equestrian facilities. It also requires facility operators to submit a Report of Waste Discharge that identifies site-specific management measures and provides a schedule to implement measures to reduce animal runoff. At this point, the site-specific actions or general waiver conditions are unknown. The cost estimates for an equestrian assessment and management program are based on Marin County's equestrian assistance program, currently in progress. In our analysis we made some assumptions solely for the purposes of estimating costs.

Inspection/Monitoring: We assumed all facilities would require an initial visit from technical assistance staff. Frequency of visits will vary from semi-annual to once every three years depending upon each facility's adequacy in managing pathogen runoff. The initial visit ranges from a minimum half-day inspection (roughly $500) up to a maximum of two full-day inspections (at $2,000). Based on a study of 18 facilities in the Tomales Bay Watershed, six (one-third) had potential to affect water quality (Nicholson and Murphy, 2004). For a high-range cost estimate, we assumed that the one-third of the facilities with the potential to affect water quality would receive a two full-day technical assistance visit twice a year, and the remaining two-thirds of the facilities would receive one half-day visit every three years. For a low-range cost estimate, we assumed all facilities would receive one half-day visit every three years.

Management Measure Implementation: MP implementation likely includes physical improvements and maintenance activities such as increased scraping, composting, and hauling of manure. Many of the typical MPs are already being implemented by the equestrian facilities. The hauling costs for individual sites can range from $75/year to

$24,000/year depending upon the size of the facility, manure storage methods (pasture land or stalls), and hauling distance to a manure facility. In Marin County, the manure management costs averaged $6,600 per ranch (Nicholson and Murphy, 2004). Other physical improvements can vary and may include construction of covered manure areas, berms, fencing, and planting of riparian vegetation. These physical improvements are estimated to average from $15,000 to $25,000 per facility (Lewis, pers. comm., 2004a). As a low-range cost estimate, we assumed all facilities would pay $6,600 for manure management and $15,000 for physical improvements each year. As a high-range cost estimate, we assumed that all facilities would pay $6,600 for manure management and $25,000 for physical improvements.

Reporting: It is anticipated that facilities will provide documentation of their inspection to the Marin County Stormwater Pollution Prevention Program or other entity. Review and oversight of these reports will require an additional 5% of Marin County's total storm water budget for reporting or $5,000/year (Nicholson and Murphy, 2004).

Boat Discharges

This TMDL requires specific government agencies to evaluate the adequacy of existing restroom facilities and to develop a boating management plan for Tomales Bay. Specific recreational tasks may include additional signage, development and implementation of a mooring management plan, and/or installation of a boater sewage pump-out facility or dump station.

Inspections/Monitoring: Currently, no inspection or monitoring program is anticipated for boat discharges. While the boating management plan may propose an inspection program, there has been no discussion about the potential elements of such a program. Therefore, it is too speculative to estimate any costs.

Implementation: An evaluation of the adequacy of restrooms (both on-shore and boater pump-out facilities) has already been completed through funding from the State Water Resources Control Board (California Department of Boating and Waterways, 2004). It is anticipated that at least one pump-out facility will be needed in Tomales Bay. Estimates for installation of a pump-out facility range from $3,000–$20,000 depending upon site conditions (California Department of Boating and Waterways, 2004).

To develop a boating management plan, the public agencies with appropriate jurisdiction over Tomales Bay are anticipated to devote existing staff time and resources. While no new resources will be affected, staff time devoted to plan development is estimated to cost approximately $50,000 (Neubacher, pers. comm.). Without knowledge of the boating management plan specifics, it would be speculative to assign some type of program costs, and therefore, no costs are estimated for this task.

Reporting: No reporting requirement is anticipated for boat discharges. The comprehensive plan may call for some type of reporting; however, without knowledge of the plan specifics it would be speculative to assign some type of program costs. Staff

will be required to report on progress associated with development of a boating management plan. We expect this cost to be nominal.

Small Wastewater Treatment Facilities
The Basin Plan amendment requires that all small wastewater treatment facilities comply with their existing requirements, called waste discharge requirements (WDRs). The Basin Plan amendment also requires regular inspections and updates to the WDRs as appropriate. Finally, the Basin Plan amendment requires that Water Board staff provide a report to its Board on the status of the small wastewater treatment facilities in Tomales Bay.

Inspections/Monitoring: Water Board personnel routinely perform inspections of wastewater treatment facilities. These inspections are part of the existing staff responsibilities and budgets. No additional costs are anticipated as a result of the TMDL.

Implementation: Improvements to the facilities would be required only as necessary to meet existing water quality objectives and waste discharge requirements. Since this is part of the waste discharge requirements and no change is anticipated, no additional cost is estimated.

Reporting: Wastewater treatment facilities are already required to provide regular reports as part of their waste discharge requirements. Since this is part of the waste discharge requirements and no change is anticipated, no additional cost is estimated.

Potential Sources of Funding
The State Water Resources Control Board has awarded $1.5 million in public funds to help offset pathogen pollution from agricultural runoff ($750,000 to Marin Resource Conservation District), and onsite sewage disposal systems ($800,000 to Marin County). Additional funding of $600,000 has been granted to the Resource Conservation District for equine facility assistance program (EFAP) from the 319 grant program and the U.S. Environmental Protection Agency has awarded approximately $400,000 to Marin County to assist with onsite sewage disposal systems. Additional funds for improvements to agricultural lands are also available through the U.S. Department of Agriculture, Natural Resources Conservation Service. Between 1997 and 2004, the NRCS granted approximately $1,175,000 in funds to livestock and dairy farms in the Tomales Bay Watershed (Sanders, pers. comm.).

Benefits of the Basin Plan Amendment
The most tangible benefit of implementing this TMDL would be overall water quality improvement of Tomales Bay and achievement of the water quality objectives for shellfishing uses. Marin County's shellfishing industry total revenue is estimated at $2.49 million/year (University of California Cooperative Extension, 2005). In addition, the aquaculture industry also contributes secondary benefits to the local economy in tourism, employment opportunity, and support businesses. These secondary benefits

are estimated at 2.5 times the industry's total revenues (University of California Cooperative Extension, 2005). These secondary benefits have not been calculated.

The shellfish industry in Tomales Bay averages closures of 70 days per year (Commandatore, pers. comm.). A survey of 10% of the overall shellfishing industry indicated that the cost of these closures varies from $800/day to $1400/day of closure (Olin, pers. comm.). Over ten years, this translates to $552,000 (low-range benefit)–$966, 000 (high-range benefit) if water quality were improved sufficiently to eliminate shellfish closures. Closures of the oyster industry also cause revenue loss to the other activities that are dependent upon or affected by the oyster industry. It has been further suggested that the unpredictable nature of the closures leads to a greater revenue loss in the secondary benefits.

The Tomales Bay area, with its federal, state, and local parks is an important recreational resource. Successful implementation of the TMDL would provide improved water quality for the many recreational uses including recreational uses: shellfishing, kayaking, swimming, windsurfing, and other shoreline activities. It is difficult to estimate the financial benefits of these activities and we assumed they are included in the secondary benefits discussed above.

11. ENVIRONMENTAL CHECKLIST

1. **Project Title:** Pathogens in Tomales Bay Watershed Total Maximum Daily Load (TMDL) Basin Plan Amendment

2. **Lead Agency Name and Address:** California Regional Water Quality Control Board, San Francisco Bay Region
   1515 Clay Street, Suite 1400
   Oakland, California 94612

3. **Contact Person and Phone Number:** Farhad Ghodrati (510) 622-2331 Rebecca Tuden (510) 622-5685

4. **Project Location:** Tomales Bay and Tomales Bay Watershed, San Francisco Bay Region

5. **Project Sponsor's Name and Address:** California Regional Water Quality Control Board, San Francisco Bay Region
   1515 Clay Street, Suite 1400
   Oakland, California 94612

6. **General Plan Designation:** Not Applicable

7. **Zoning:** Not Applicable

8. **Description of Project:**

   The project is a proposed Basin Plan amendment to adopt a TMDL for pathogens in the Tomales Bay Watershed. The project would involve numerous actions to reduce pathogen concentrations in Tomales Bay, Lagunitas Creek, and Walker Creek. Additional details are provided in the explanation attached. The proposed Tomales Bay Watershed TMDL applies to both Tomales Bay and its tributaries.

9. **Surrounding Land Uses and Setting:**

   The proposed Basin Plan amendment would affect all segments of the Tomales Bay Watershed. Implementation would involve specific actions throughout the Watershed. Tomales Bay Watershed land uses include a mix of low-density residential, agricultural, and open space.

10. **Other public agencies whose approval is required** (e.g., permits, financing approval, or participation agreement.)

    The California State Water Resources Control Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency must approve the proposed Basin Plan amendment.

ENVIRONMENTAL IMPACTS: *Issues:*	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*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?	☐	☐	☐	☒
II. AGRICULTURE 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 Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. **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?	☐	☐	☐	☒
c) 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?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
III. AIR QUALITY—(cont.):				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐
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 Game or U.S. 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?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
IV. BIOLOGICAL RESOURCES—(cont.):				
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 a unique 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?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VI. GEOLOGY AND SOILS—(cont.):				
c) Be located on 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 wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒
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?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VII. HAZARDS AND HAZARDOUS MATERIALS -- (cont.):				
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 groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater 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 of 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 stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
VIII. HYDROLOGY AND WATER QUALITY—(cont.):				
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 of 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?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
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?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
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?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XV. TRANSPORTATION /TRAFFIC–(cont.):				
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 statutes and regulations related to solid waste?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
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 cumulative considerable? ("Cumulative 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?	☐	☐	☐	☒

11.1 Explanation

Project Description

The proposed project is a Basin Plan amendment to adopt a Total Maximum Daily Load (TMDL) for pathogens in the Tomales Bay Watershed (see proposed Basin Plan amendment). The goal of the Basin Plan amendment is to improve environmental conditions. The Basin Plan amendment would include target density-based pathogen concentrations for Tomales Bay and its tributaries, Lagunitas, Olema, and Walker creeks, and assign wasteload allocations to achieve the targets. The Basin Plan amendment implementation plan would involve numerous actions to achieve the targets and allocations. The Basin Plan amendment would affect all segments of the Tomales Bay Watershed, and implementation actions would occur throughout the western portion of Marin County, California.

The proposed targets and allocations are measures of performance. The implementation plan outlines the Water Board's approach to meeting these measures of performance. To reduce pathogen concentrations in the Tomales Bay Watershed, the plan describes actions the Water Board would take, actions expected of dischargers in the Watershed, and actions the Water Board might take to compel, as necessary, entities to do their parts. The Water Board would not directly undertake any actions that could physically change the environment, but adopting the proposed Basin Plan amendment could indirectly result in other parties (e.g., land owners, government entities, and special districts) undertaking projects to satisfy requirements derived from the Basin Plan amendment. These projects could physically change the environment. The adverse environmental impacts of such physical changes are evaluated below to the extent that they are reasonably foreseeable. Changes that are speculative in nature do not require environmental review.

Until the parties that must comply with requirements derived from the Basin Plan amendment propose specific projects, many physical changes cannot be anticipated. These specific projects would be subject to environmental review under the California Environmental Quality Act (CEQA), and CEQA compliance would be the responsibility of the lead agency for each project. The environmental reviews would identify any potentially significant adverse environmental impacts of the specific proposals, along with appropriate mitigation measures. Until such projects are proposed, however, identifying specific impacts and mitigation measures would require inappropriate speculation. Moreover, any mitigation deemed necessary by the lead agencies for those projects would not be within the jurisdiction of the Water Board to require.

Direct and Indirect Physical Changes

Table 32 summarizes the actions that could conceivably be undertaken if the proposed Basin Plan amendment were adopted, and explains the rationale for including them or not including them in this environmental review. The physical changes that require evaluation are those associated with (1) minor construction, (2) earthmoving and grading operations, and (3) waste handling and disposal. Although these activities are

reasonably foreseeable, the implementation plan does not specify the nature of these actions. Therefore, this analysis considers these actions in general programmatic terms. To illustrate the possible nature of these activities, some examples are described below.

Table 32
Implementation Actions Subject to Environmental Review

Possible Actions	**Environmental Change Subject to Review**
Pollution prevention/storm water management plan	Waste handling and disposal
Storm water treatment	Minor construction/waste handling and disposal
Storm sewer maintenance	Waste handling and disposal[1]
Inspections of existing septic systems, animal operations, and small wastewater treatment facilities	None—No physical environmental change
Repair/Replace septic systems	Earthmoving operations/waste handling and disposal[2]
Best Management Practices; fence construction, development of off-stream water sources	Minor Construction
Development of restroom facilities	Minor Construction/waste handling and disposal[1]
Development of facilities for boater waste	Minor Construction/waste handling and disposal[1]
Repair/Replace existing animal waste ponds	Earthmoving operations/waste handling and disposal[2]
Data collection and analysis	None—No physical environmental change

[1] The Basin Plan amendment may not increase maintenance, but maintenance activities may be targeted to maximize removal and disposal of collected waste.
[2] Earthmoving could include grading, sediment removal, capping, or other actions taken to prepare a site for wastewater treatment.

- *Minor Construction.* Basin Plan amendment-related construction activities would generally be small in scale. Most would relate to replacing or repairing existing wastewater treatment and disposal systems such as septic systems, dairy waste management ponds and/or manure stockpiles. In a few cases, new systems could be constructed, including public restrooms, boater pump-out facilities, and community leach fields. Animal facility operators could also choose to adopt best management practices (BMPs) that include retention or detention basins, separators, infiltration basins, or vegetated swales. Construction could also be undertaken to divert storm water flows. It is speculative to determine where these new systems will be located and any new system would require an independent review under CEQA. Individual landowners may also undertake minimal construction activities to reduce animal waste runoff including fence construction

and off-creek water troughs. These would likely be limited to barbed wire fencing along portions of waterways.

- *Earthmoving Operations.* The Basin Plan amendment could result in the use of heavy equipment to move soils from one place to another. For example, construction or repair of wastewater treatment facilities could include grading, soil removal and disposal, soil containment, capping, slope stabilization, or landscaping. Recontouring and restoring animal facilities to redirect runoff flows could involve temporarily diverting creeks or other less disruptive soil movement. Routine channel maintenance could entail periodic sediment removal.

- *Waste Handling and Disposal.* Human and animal waste requires disposal. Pollution prevention and outreach activities could encourage more collection of human and animal waste, which could increase the amount of waste requiring proper disposal. For example, programs could support the inspection of waste containment ponds or septic tanks, thereby increasing the need for maintenance and collection of such waste. In some cases, disposal could be arranged on site (e.g., by constructing a leach field or waste pond on site). In others, the waste could be transported to another site for disposal or further treatment. While implementation projects would reasonably collect more waste for proper disposal, the possible amount of this waste stream is unknown. The Basin Plan amendment would not affect the amount of waste generated, but additional waste could be collected.

These examples are not intended to be exhaustive or exclusive. As specific implementation proposals are developed and proposed, lead agencies would undertake environmental review and could identify specific environmental impacts and appropriate mitigation measures.

Changes Likely With or Without the Basin Plan Amendment

The implementation plan relies on some actions that will occur with or without the proposed Basin Plan amendment. Because these actions do not result from the Basin Plan amendment, environmental review is not included in this analysis. Some implementation actions for the Tomales Bay Watershed are likely to occur with or without the proposed Basin Plan amendment because nutrient and sediment TMDLs are proposed to be developed for the Tomales Bay watershed. Many of the actions intended to reduce nutrient and sediment loading to the Watershed will also reduce pathogen loading. Because the TMDLs are not yet developed, however, specific implementation details are unknown. Additional environmental review will occur as the nutrient and sediment TMDLs are completed.

Other actions likely to occur with or without the Basin Plan amendment include implementing Phase II of the storm water management plan pollution prevention program and implementation of existing programs such as technical assistance programs from the University of California Cooperative Extension, Marin Resource

Conservation District, and the Natural Resource Conservation Service. All these activities are already underway.

Changes Too Speculative to Evaluate

Several conceivable actions that could be taken as a result of the Basin Plan amendment require speculation and cannot be evaluated in this environmental review. Although the proposed Basin Plan amendment includes plans to implement management practices (MPs) for animal facilities, more site-specific information is needed before actual controls can be implemented. Therefore, specific actions are too speculative to consider. Similarly, it would be speculative to determine whether implementation of MPs will cause any changes in the feasibility of maintaining the land in agricultural uses. Therefore, potential changes in land use are speculative and will not be evaluated. Lastly, as discussed above, even in cases in which some physical changes are foreseeable (e.g., additional wastewater facilities, such as a restroom, community leach field, or boater pump-out), the exact nature of these changes is often speculative pending specific project proposals to be put forth by those subject to requirements derived from the Basin Plan amendment.

Environmental Analysis

The proposed Basin Plan amendment does not define the specific actions entities could take to comply with requirements derived from the Basin Plan amendment. As discussed above, physical changes resulting from the Basin Plan amendment are foreseeable, but the attributes of specific implementation actions (e.g., location, extent, etc.) are unknown, pending specific proposals to comply with Basin Plan amendment requirements. CEQA requires lead agencies to review the potential for their actions to result in adverse environmental impacts. CEQA further requires lead agencies to adopt feasible measures to mitigate potentially significant impacts. Therefore, the analysis below assumes that lead agencies would adopt mitigation measures necessary to address potentially significant impacts as long as appropriate measures are readily available. As explained below, mitigation measures are readily available to address all the foreseeable impacts of the Basin Plan amendment, including possible local agency actions to the extent that they can be anticipated. Therefore, the potential impacts of the proposed Basin Plan amendment would be less-than-significant.

An explanation for each box checked on the environmental checklist is provided below:

I. Aesthetics

a–b) Any physical changes to the aesthetic environment as a result of the Basin Plan amendment would be small in scale. Possible MPs that could be implemented on individual properties, such as fence construction or off-stream water troughs, are common practices that would have less-than-significant impact on the aesthetic environment. Another possible physical change might be construction of a public restroom or boater pump out facility. These projects would result in minor physical changes to the area and would likely be sited in a location that was

visible to potential users of the facility. If specific construction projects were proposed to comply with requirements derived from the proposed Basin Plan amendment, local agencies would require environmental review and any necessary mitigation. Therefore, the proposed project would result in less-than-significant impact to scenic vistas and resources.

c–d) The Basin Plan amendment would not degrade the existing visual character or quality of any site or its surroundings. Potential minor construction (e.g., of a public restroom or boater pump-out facility) would be consistent with the open space and low density residential land uses in the area. It would not create any new source of light or glare.

II. Agriculture Resources

a–c) The Basin Plan amendment would not involve the conversion of farmland to non-agricultural use. It would not affect agricultural zoning or any Williamson Act contract.

III. Air Quality

a) Because the Basin Plan amendment would not cause any change in population or employment, it would not generate ongoing traffic-related emissions. It would also not involve the construction of any permanent emissions sources. For these reasons, no permanent change in air emissions would occur, and the Basin Plan amendment would not conflict with applicable air quality plans.

b) The Basin Plan amendment would not involve the construction of any permanent emissions sources or generate ongoing traffic-related emissions. Construction that would occur as a result of Basin Plan amendment implementation, including earthmoving operations, would be short-term. Fine particulate matter (PM_{10}) is the pollutant of greatest concern with respect to construction. PM_{10} emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved surfaces, and vehicle and equipment exhaust. If specific construction projects were proposed to comply with requirements derived from the proposed Basin Plan amendment, local agencies would require any necessary mitigation through their environmental reviews. The Bay Area Air Quality Management District has identified readily available measures to control construction-related air quality emissions (BAAQMD 1999). These measures include watering active construction areas; covering trucks hauling soil; paving, applying water, or applying soil stabilizers on unpaved areas; sweeping paved areas; and sweeping public streets. Lead agencies would ensure that appropriate emissions control measures are implemented. Therefore, the Basin Plan amendment would not violate any air quality standard or contribute substantially to any air quality violation, and its temporary construction-related air quality impacts would be less-than-significant.

c) Because the Basin Plan amendment would not generate ongoing traffic-related emissions or involve the construction of any permanent emissions sources, it would not contribute considerably to cumulative emissions.

d–e) Because the Basin Plan amendment would not involve the construction of any permanent emissions sources, it would not expose sensitive receptors to ongoing pollutant emissions posing health risks or creating objectionable odors.

IV. Biological Resources

a–d) The Basin Plan amendment is designed to benefit water quality. If, pursuant to the proposed Basin Plan amendment, specific projects were proposed that were to involve construction and earthmoving activities that could modify habitats, adversely affect special-status species, disturb riparian habitat or sensitive natural communities, or affect federally protected wetlands or interfere substantially with movement of resident or migratory fish or wildlife species, these projects would be minor and temporary in nature. In such cases, local agencies would also conduct environmental review and identify necessary mitigation measures. Through the CEQA and permitting processes, lead agencies would ensure that readily available mitigation measures are implemented, such as avoiding or, if feasible, relocating or replacing sensitive habitat. Fences that may be constructed are designed to restrict cattle without impeding wildlife movement. Therefore, the Basin Plan amendment would not substantially affect habitats, special-status species, sensitive communities, wetlands, wildlife movement, migratory corridors, or nurseries and its review would ensure that readily available measures are implemented, such as avoiding construction during the breeding season, avoiding sensitive habitat areas, and minimizing disturbances. Therefore, the Basin Plan amendment would not substantially affect habitats, special-status species, sensitive communities, wetlands, migratory corridors, or nurseries, and its impacts would be less-than-significant.

e–f) If, pursuant to Basin Plan amendment requirements, specific projects were proposed that were to involve construction or earthmoving activities, then local agencies would develop such proposals in accordance with their own local policies and ordinances, including any applicable habitat conservation plans, natural community conservation plans, or other plans intended to protect biological resources. Therefore, the Basin Plan amendment would not conflict with local policies, ordinances, or adopted plans.

V. Cultural Resources

a–d) Local agencies could propose specific projects involving earthmoving or construction to comply with requirements derived from the proposed Basin Plan amendment. Construction would generally be small in scale, and earthmoving would likely occur in areas already disturbed by recent human activity. If

necessary to protect historical, archaeological, or paleontological resources, local agencies would require mitigation through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as requiring a trained professional to observe major earthmoving work and stop the work if evidence of cultural resources is discovered. Therefore, the Basin Plan amendment would not substantially affect any cultural resource, and its impacts would be less-than-significant.

VI. Geology and Soils

a) The Basin Plan amendment would not involve the construction of habitable structures;
therefore, it would not involve any human safety risks related to fault rupture, seismic ground-shaking, ground failure, or landslides.

b) Local agencies could propose specific projects involving earthmoving or construction activities to comply with requirements derived from the proposed Basin Plan amendment. To meet the proposed Basin Plan amendment targets, construction would be designed to reduce overall soil erosion and pathogen loads associated with erosion. However, temporary earthmoving operations could result in short-term erosion. Local agencies would require necessary mitigation measures through their environmental review and grading permit processes. Lead agencies would ensure that readily available measures are implemented, such as dust suppression (e.g., spraying water), use of erosion control BMPs, and proper construction site management. In addition, construction projects over one acre in size would require a general construction National Pollutant Discharge Elimination System permit and implementation of a storm water pollution prevention plan. Therefore, the Basin Plan amendment would not result in substantial soil erosion, and its impacts would be less-than-significant.

c–d) The Basin Plan amendment would not involve the construction of habitable structures, and any construction would be relatively small in scale. Local agencies proposing construction to comply with requirements derived from the Basin Plan amendment would undertake engineering and environmental studies to ensure that they do not locate structures on unsuitable soil, including expansive soil. Construction would be designed to minimize any potential for landslides, lateral spreading, subsidence, liquefaction, or collapse. Therefore, the Basin Plan amendment would not create safety or property risks due to unstable or expansive soil.

e) The purpose of the Basin Plan amendment is to ensure that existing wastewater systems are properly designed and functioning. Activities include increased inspections of such facilities and repair/replacement of existing facilities. Such activities would not place new septic tanks or other wastewater disposal systems

in unsuitable soils. Therefore, the Basin Plan amendment would not affect the capability to adequately support wastewater disposal systems.

VII. Hazards and Hazardous Materials

a–h) This Basin Plan amendment would not affect the transportation or potential release of hazardous materials, nor create a significant public or environmental hazard beyond any hazards currently in existence. Basin Plan amendment-related activities would not interfere with any emergency response plans or emergency evacuation plans and would not affect the potential for wildland fires.

VIII. Hydrology and Water Quality

a) The project would amend the Basin Plan, which articulates applicable water quality standards; therefore, it would not violate standards or waste discharge requirements.

b) The Basin Plan amendment would not decrease groundwater supplies or interfere with groundwater recharge. Construction of facilities such as retention or detention basins, infiltration basins, or vegetated swales could increase groundwater recharge.

c) Local agencies could propose specific projects involving earthmoving or construction activities to comply with requirements derived from the proposed Basin Plan amendment. Such projects could affect existing drainage patterns. However, to meet the proposed Basin Plan amendment targets, they would be designed to reduce overall soil erosion and pathogen loads associated with erosion. Nevertheless, temporary earthmoving operations could result in short-term erosion. If necessary to address specific impacts, local agencies would require mitigation measures through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as dust suppression (e.g., spraying water), use of erosion control MPs, and proper construction site management. In addition, construction projects over one acre in size would require a general construction National Pollutant Discharge Elimination System permit and implementation of a storm water pollution prevention plan. Therefore, the Basin Plan amendment would not result in substantial erosion, and its impacts would be less-than-significant.

d) The Basin Plan amendment could involve some earthmoving operations that could affect existing drainage patterns, but Basin Plan amendment-related activities would not substantially increase the amount of impervious surfaces in any watershed. Therefore, the Basin Plan amendment would not increase the rate or amount of runoff, or result in flooding.

e–f) Basin Plan amendment-related activities would not substantially increase the amount of impervious surfaces in any watershed. Therefore, the Basin Plan amendment would not increase the rate or amount of runoff, or exceed the

capacity of storm water drainage systems. Because the proposed Basin Plan amendment is intended to reduce pathogen-laden runoff, it would not be a source of new polluted runoff, or degrade water quality.

g–i) Basin Plan amendment-related construction would be small in scale and would not include housing or structures that would pose or be subject to flood hazards.

j) Basin Plan amendment-related construction would not be subject to substantial risks due to inundation by seiche, tsunami, or mudflow.

IX. Land Use and Planning

a) Basin Plan amendment-related construction would be limited to existing open space and grazing areas and would be too small in scale to divide any established community.

b–c) The Basin Plan amendment would not conflict with any land use plan, policy, or regulation, and would not conflict with any habitat conservation plan or natural community conservation plan.

X. Mineral Resources

a–b) Basin Plan amendment-related earthmoving (i.e., excavation) and construction would be relatively small in scale and would not result in the loss of availability of any known mineral resources.

XI. Noise

a) Earthmoving and construction could temporarily generate noise. Projects that local agencies propose to comply with requirements derived from the Basin Plan amendment would be consistent with the local agencies' own standards.

b) To comply with requirements derived from the Basin Plan amendment, local agencies could propose specific projects involving earthmoving or construction, which could result in temporary groundborne vibration or noise. If necessary, local agencies could require mitigation measures through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as restricting the hours of operations and ensuring that earthmoving equipment is equipped with mufflers to reduce noise. Therefore, the Basin Plan amendment would not result in substantial noise, and its impacts would be less-than-significant.

c) The Basin Plan amendment would not cause any permanent increase in ambient noise levels. Any noise would be short-term.

d) To comply with requirements derived from the Basin Plan amendment, local agencies could propose specific projects involving earthmoving or construction, which could result in temporary increases in ambient noise levels in excess of noise levels without the Basin Plan amendment. Noise-generating operations would comply with local noise minimization requirements, including local noise ordinances. If necessary, local agencies could require that noise reduction mitigation measures are implemented, such as restricting the hours of noise-generating operations. Therefore, the Basin Plan amendment would not result in substantial noise, and its impacts would be less-than-significant.

e–f) The Basin Plan amendment would not cause any permanent increase in ambient noise levels, including aircraft noise. Therefore, it would not expose people living within an area subject to an airport land use plan or in the vicinity of a private airstrip to excessive noise.

XII. Population and Housing

a–c) The Basin Plan amendment would not affect the population of the Tomales Bay Watershed. It would not induce growth through such means as constructing new housing or businesses, or by extending roads or infrastructure. The Basin Plan amendment would also not displace any existing housing or any people that would need replacement housing.

XIII. Public Services

a) The Basin Plan amendment would not affect populations or involve construction of substantial new government facilities. The Basin Plan amendment would not affect service ratios, response times, or other performance objectives for any public services, including fire protection, police protection, schools, or parks.

XIV. Recreation

a–b) Because the Basin Plan amendment would not affect population levels, it would not affect the use of existing parks or recreational facilities. No recreational facilities would need to be constructed or expanded.

XV. Transportation /Traffic

a–b) Because the Basin Plan amendment would not increase population or provide employment, it would not generate any ongoing motor vehicle trips. Earthmoving and construction would be temporary, and related traffic would be of short-term duration. Therefore, the Basin Plan amendment would not substantially increase traffic in relation to existing conditions. Levels of service would be unchanged.

c) The Basin Plan amendment would not affect air traffic.

d) Because the Basin Plan amendment would not affect any roads or the uses of any roads, it would not result in hazardous design features or incompatible uses.

e) The small-scale construction that could occur as a result of the Basin Plan amendment would not likely restrict emergency access. Local agencies would confirm that specific proposals would not restrict emergency access through their environmental reviews.

f) Because the Basin Plan amendment would not increase population or provide employment, it would not affect parking demand or supply.

g) Because the Basin Plan amendment would not generate ongoing motor vehicle trips, it would not conflict with adopted policies, plans, or programs supporting alternative transportation.

XVI. Utilities and Service Systems

a) The project would amend the Basin Plan, which is the basis for wastewater treatment requirements in the Bay Area; therefore, the Basin Plan amendment would be consistent with such requirements.

b) Because the Basin Plan amendment would not affect water demands or supplies, it would not require the construction of new or expanded water facilities. To comply with requirements derived from the proposed Basin Plan amendment, local agencies could propose to repair older facilities or construct some new wastewater treatment facilities. However, such construction would not pose any adverse impacts not otherwise discussed in this analysis. Local agencies could require necessary mitigation measures through their environmental reviews, and as described throughout this analysis, all potential impacts can be mitigated to less-than-significant levels. Because lead agencies would ensure that readily available measures are implemented, the impacts of constructing storm water facilities would be less-than-significant.

c) To comply with requirements derived from the proposed Basin Plan amendment, local agencies could propose to construct some new or expanded urban runoff management facilities. However, such construction would not pose any adverse impacts not otherwise discussed in this analysis. Local agencies could require necessary mitigation measures through their environmental reviews, and as described throughout this analysis, all potential impacts can be mitigated to less-than-significant levels. Because lead agencies would ensure that readily available measures are implemented, the impacts of constructing storm water facilities would be less-than-significant.

d) Because the Basin Plan amendment would not increase population or provide employment, it would not require an ongoing water supply. It would also not require ongoing wastewater treatment services.

e) Basin Plan amendment implementation would comply with federal, state, and local wastewater treatment requirements. Pollution prevention and outreach activities could divert pathogen-containing waste from improper leaching into the environment toward proper disposal facilities. Therefore, it is possible that repair to existing wastewater facilities may be required or facility capacity may need to be expanded. However, such construction would not pose any adverse impacts not otherwise discussed in this analysis. Local agencies could require necessary mitigation measures through their environmental reviews, and as described throughout this analysis, all potential impacts can be mitigated to less-than-significant levels. Because lead agencies would ensure that readily available measures are implemented, the impacts of repairing or expanding wastewater facilities would be less-than-significant.

f–g) The Basin Plan amendment would not substantially affect municipal solid waste generation or landfill capacities.

XVII. Mandatory Findings of Significance

a) When taken as a whole, the Basin Plan amendment would not degrade the quality of the environment. The proposed Basin Plan amendment is intended to benefit human health by decreasing pathogen concentrations in the Tomales Bay Watershed.

b) As discussed above, the Basin Plan amendment could pose some less-than-significant adverse environmental impacts related to earthmoving and construction operations. These impacts would be individually limited, and most would be short-term. As specific implementation proposals are developed and proposed, lead agencies would undertake environmental review and identify specific environmental impacts and appropriate mitigation measures. For cases in which potential impacts could be significant, local lead agencies would adopt readily available mitigation measures to ensure that possible impacts would be less-than-significant. Therefore, the incremental effects of the Basin Plan amendment are inconsequential. For this reason, the Basin Plan amendment's cumulative effects would be less-than-significant, and adopting the Basin Plan amendment would require no mandatory findings of significance.

c) The Basin Plan amendment would not cause any substantial adverse effects to human beings, either directly or indirectly. The Basin Plan amendment is intended to benefit human beings (particularly swimmers and consumers of shellfish) by decreasing pathogen concentrations.

12. GLOSSARY

Bacteria: Single-celled microorganisms that lack a fully defined nucleus and contain no chlorophyll. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality.

Beneficial Uses: Uses of water that may be protected against degradation include, but are not limited to, domestic, municipal, agricultural, and industrial water supply; power generation; recreation; aesthetic enjoyment; navigation; preservation and enhancement of fish, wildlife, and other aquatic resources and preserves. (California Water Code [CWC] section 13050[f]).

Coliform bacteria: See Total coliform bacteria.

***Cryptosporidium*:** See Protozoa.

Discharge: Flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to the discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Effluent: Municipal sewage or industrial liquid waste (untreated, partially treated, or completely treated) that flows out of a treatment plant, septic system, pipe, and the like.

Enterococci: A subgroup of the fecal streptococci that includes *S. faecalis* and *S. faecium.* The enterococci are differentiated from other streptococci by their ability to grow in 6.5 percent sodium chloride, at pH 9.6, and at 10^{o}C and 45^{o}C. Enterococci are a valuable bacterial indicator for determining the extent of fecal contamination of recreational surface waters.

***Escherichia coli*:** A subgroup of the fecal coliform bacteria. E. coli is part of the normal intestinal flora in humans and animals and is, therefore, a direct indicator of fecal contamination in a water body. The O157 strain, sometimes transmitted in contaminated water bodies, can cause serious infection, resulting in gastroenteritis. See also fecal coliform bacteria.

Fecal coliform bacteria: A subset of total coliform bacteria that are present in the intestines or feces of warm-blooded animals. They are often used as indicators of the sanitary quality of water. They are measured by running the standard total coliform test at an elevated temperature (44.5^{o}C). Fecal coliform is approximately 20% of total coliform. See also Total coliform bacteria.

Feedlot: A confined area for the controlled feeding of animals. Tends to concentrate large amounts of animal waste that cannot be absorbed by the soil and hence, may be carried to nearby streams or lakes by rainfall runoff.

Gastroenteritis: An inflammation of the stomach and the intestines.

***Giardia lamblia*:** See Protozoa.

Hydrology: The study of the distribution, properties, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Indicator: Measurable quantity that can be used to evaluate the relationship between pollutant sources and their impact on water quality.

Indicator organism: Organism used to indicate the potential presence of other (usually pathogenic) organisms. Indicator organisms are typically associated with the other organisms, but are usually more easily sampled and measured.

Load allocation (LA): The portion of a receiving water body's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

Loading capacity (LC): The greatest amount of loading that a water body can receive without violating water quality standards. The LC equals the TMDL.

Management Practices (MPs): Methods, measures, or practices selected by an agency to meet its nonpoint source control needs. MPs include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. MPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters.

Margin of safety (MOS): A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (CWA section 303[d][1][C]).

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Nonpoint source: Pollution sources that are diffused and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by stormwater runoff. Commonly used categories for nonpoint sources are agriculture, forestry, mining, construction, land disposal, and saltwater intrusion.

Pathogen: Disease-causing agent, especially microorganisms such as bacteria, protozoa, and viruses.

Point source: 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, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigation agriculture or agricultural stormwater runoff (40 CFR 122.2).

Protozoa: Single-celled organisms that reproduce by fission and occur primarily in the aquatic environment. Waterborne pathogenic protozoans of primary concern include *Giardia lamblia* and *Cryptosporidium*, both of which affect the gastrointestinal tract.

Septic system: An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent. Sludge that remains in the tank after decomposition of the solids by bacteria must be pumped out periodically.

Stakeholder: Those parties likely to be affected by, or that can affect, the TMDL.

Total coliform bacteria: A particular group of bacteria, found in the feces of warm-blooded animals that are used as indicators of possible sewage pollution. They are characterized as aerobic or facultative anaerobic, gram-negative, nonspore-forming, rod-shaded bacteria that ferment lactose with gas formation within 48 hours at 35^{o} C. Note that many common soil bacteria are also total coliforms, but do not indicate fecal contamination. See also fecal coliform bacteria.

Total Maximum Daily Load (TMDL): The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, and a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standards.

Virus: Submicroscopic pathogen consisting of a nucleic acid core surrounded by a protein coat. Requires a host in which to replicate (reproduce).

Waste Load Allocation (WLA): The portion of a receiving water body's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2[h]).

Wastewater treatment: Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

Water Quality Standard (WQS): Provisions of state and federal law that consist of a designated use or uses for the waters of the United States, water quality criteria for such waters to protect such uses, and statements to prohibit antidegradation. Water

quality standards are to protect public health or welfare, enhance the quality of the water, and serve the purpose of the Clean Water Act (40 CFR 131.3).

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

13. REFERENCES

Atwill, E.R. 1995. *Microbial Pathogens Excreted by Livestock and Potentially Transmitted to Humans Through Water.* Tulare, California: University of California, Davis Veterinary Medicine Teaching and Research Center, School of Veterinary Medicine.

Bay Area Air Quality Management District (BAAQMD). 1999. *BAAQMD CEQA Guidelines: Assessing the Air Quality Impacts of Projects and Plans*, pp. 13–20.

Brennan, M. and Stacey, M. 2005a. *Modeling the Fate and Transport of Tracer Concentration of Walker Creek Discharge into Tomales Bay.* Report to Regional Water Quality Control Board, San Francisco Region, February 2005: Berkeley, California: University of California, Berkeley Department of Civil and Environmental Engineering.

Brennan, M. and Stacey, M. 2005c. *Modeling scalar decay and revised boundary conditions for scalar discharges from Walker Creek to Tomales Bay*. Report to Regional Water Quality Control Board, San Francisco Region, June 30, 2005: Berkeley, California: University of California, Berkeley Department of Civil and Environmental Engineering.

Brennan, M. and Stacey, M. Stacey. 2005b. *Modeling the fate and transport of tracer concentration of Walker Creek discharge into Tomales Bay*. Report to Regional Water Quality Control Board, San Francisco Region, May 3, 2005: Berkeley, California: University of California, Berkeley Department of Civil and Environmental Engineering.

California Department of Boating and Waterways. 2004. *Recommendations for Pumpout and Dump Stations in Tomales Bay.* Final Draft Report to the State Water Resources Control Board.

California State Water Resources Control Board and California Coastal Commission. 2000. *Plan for California's Nonpoint Source Pollution Control Program.*

CDC (Centers for Disease Control and Prevention). 2005. Webpage with information on viral gastroenteritis. Atlanta, Georgia: National Center for Infectious Diseases, Respiratory and Enteric Viruses Branch. http:www.cdc.gov/ncidod/dvrd/revb/gastro/faq.htm. Active link as of December 19,2005.

Cogger, C. G., and Carlile, B.L. 1984. Field Performance of Conventional and Alternative Septic Systems in Wet Soils. *Journal of Environmental Quality* vol. 13, no. 1, 137–142.

Commandatore, A. M., California Department of Health Services. February 1, 2005. Personal communication.

Council of Bay Area Resource Conservation Districts and the USDA Natural Resources Conservation Service. 2001. *Horse Keeping: A Guide to Land Management for Clean Water*.

CSW/Stuber-Stroeh Engineering Group, Inc. 2002. *Inspection of On-Site Wastewater Treatment Systems for Town of Marshall*. Report prepared for the County of Marin Community Development Agency.

DHS (California Department of Health Services). 2001. *Draft Twelve-Year Sanitary Survey Report: Shellfish Growing Area Classifications for Tomales Bay, California.* Richmond, California: Preharvest Shellfish Sanitation Unit, pp. 15-16, 28-31; Table 9; Figs. 3a, 3b, 3c.

DHS (California Department of Health Services). 2002. *Twelve-Year Sanitary Survey Report: Shellfish Growing Area Classifications for Tomales Bay, California*. Richmond: California: Preharvest Shellfish Sanitation Unit, pp. 17, 19, 56. 02-04

Economic and Planning Systems. 2003. *West Marin Septic Management Organizational Options and Feasibility Analysis* (Draft Report).

Gary, H.L.; Johnson, S.R.; and Ponce, S.L. 1983. Cattle Grazing Impact on Surface Water Quality in a Colorado Front Range Stream. *Journal of Soil and Water Conservation* vol. 38, no. 2:124–128.

Giamonna, M., City Sewer. August 4, 2004. Personal communication.

Havelaar A.H. 1993. Bacteriophages as Models of Human Enteric Viruses in the Environment. *Journal of American Society of Microbiology News* 59:614–619.

Kapellas, J., SFBRWQCB GIS analyst. July 23, 2004. Personal communication

Larson, S., U.C. Cooperative Extension (Marin County). June 29, 2004., Personal communication.

Lewis, L. July 27, 2004 (2004b). Personal communication.

Lewis, L., Marin County Stormwater Pollution Prevention Program, July 23, 2004 (2004a). Personal communication.

MCSTOPPP (Marin County Stormwater Pollution Prevention Program). 2003. *Stormwater Management Plan: Action Plan 2005* (Fiscal Years 2000–2001 through 2004–2005).

National Park Service. 2001. *Tomales Bay: Guidelines for Protection and Use*. Point Reyes Station, California: Point Reyes National Seashore.

Neubacher, D., Point Reyes National Seashore. August 5, 2004. Personal communication.

Nicholson, D. and Murphy, M. 2004. *Assessment of Best Management Practices for*

Equestrian Facilities in the Tomales Bay Watershed. Draft Report on a study conducted by the Marin County Stormwater Pollution Prevention Program.

Olin, P., Seagrant Program, U.C. Cooperative Extension. August 20, 2004. Personal communication.

Sanders, C., Natural Resources Conservation Service. September 7, 2004. Personal communication.

Santa Ana Water Board (California Regional Water Quality Control Board, Santa Ana Region). 1998*. Total Maximum Daily Load for Fecal Coliform Bacteria in Newport Bay, California*. Riverside, California.

Santo Domingo, J.W. and Stoeckel, D. 2003. *Summary: Joint Government-Academic Researcher Meeting on Microbial Source Tracking*, August 14-15. Cincinnati, Ohio: U.S. EPA Office of Research and Development.

Santo Domingo, J.W.; Simpson, J.M.; Scott, G.I.; and Reasoner, D. J. 2002. *Microbial Source Tracking: Where Are We Now and Where Are We Going?* Paper presented at the National TMDL Science and Policy conference, Phoenix, Arizona, November 13-16, 2002.

Smith, P., Marin County Environmental Health Services. July 9, 2004. Personal communication.

State Water Board (California State Water Resources Control Board). May 2004. *Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program.* Sacramento: California Environmental Protection Agency.

Taylor, Robert, County of Marin GIS specialist. November 14, 2002. Personal communication.

TBSTAC (Tomales Bay Shellfish Technical Advisory Committee) (O'Connell, L.; Langlois, G.; and Hopkins, D.). 2000. *Tomales Bay Shellfish Technical Advisory Committee Final Report: Investigation of Nonpoint Pollution Sources Impacting Shellfish Growing Areas in Tomales Bay, 1995–96.* Olema, California.

Tiedemann, A.R.; Higgins D.A.; Quigley, T.M.; Sanderson, H.R.; and Marx, D.B. 1987. Responses of Fecal Coliform in Streamwater to Four Grazing Strategies. *Journal of Range Management* 40:322–329.

U.S. EPA. 1985. *Rates, Constants, and Kinetics in Surface Water Quality Modeling.* Athens, Georgia: Environmental Research Laboratory, Office of Research and Development. EPA/600/3-85/040.

U.S. EPA. 2001. *Protocol for Developing Pathogen TMDLs*. 1st. ed. Washington, D.C.:

Office of Water. EPA 841-R-00-002, pp. 1-1; 7-1.

U.S. EPA. 2002 *On-site Wastewater Treatment Systems Manual*. Washington, D.C. Office of Water, Office of Research and Development. EPA/625/R-00/008, pp. 1-4, 1-5.

U.S. EPA. 2002. *Implementation Guidance for Ambient Water Quality Criteria for Bacteria*. Public Review Draft, May 2002, p. 2.

University of California Cooperative Extension. 2005. *Amazing But True… Facts about Agriculture in Marin County*. Agricultural and Natural Resources Fact Sheet. Available online at http://ucce.ucdavis.edu/files/filelibrary/1410/5235.pdf. Active link as of December 20, 2005.

USGS (United States Geological Survey). 2004. *Study Urges Caution in Contaminant Source Tracking.* News Release, Dec. 6, 2004. Reston, Virginia: Office of Communication. Available at http://wv.usgs.gov/pr2016m.html. Active link as of December 19, 2005.

Water Board (California Regional Water Quality Control Board, San Francisco Bay Region). 1995. *Water Quality Control Plan for the San Francisco Basin*. Oakland, California.

Water Board (California Regional Water Quality Control Board, San Francisco Bay Region). 2001. *Controlling pathogens in Tomales Bay, California. Total Maximum Daily Load: Sources and Loadings*. Progress report. Oakland, California.

Water Board (California Regional Water Quality Control Board, San Francisco Bay Region). 2004. *Watershed Management Initiative Integrated Plan Chapter*. Oakland, California.