includes data for multiple Fdatsheets in R3 for Morro Bay

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Support Document for
Morro Bay
Total Maximum Daily Load
For pathogens
(Including Chorro and Los Osos Creeks)

State of California
Central Coast Regional Water Quality Control Board
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List of Acronyms and Abbreviations

Bay	Refers to Morro Bay, the waterbody
BMPs	Best Management Practices
Cal Poly	California Polytechnic State University, San Luis Obispo
CAO	Clean-up and Abatement Order
CCAMP	Central Coast Ambient Monitoring Program
CCMP	Comprehensive Conservation and Management Plan
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CMC	California Men's Colony Wastewater Treatment Plant
CSLRCD	Coastal San Luis Resource Conservation District
CWC	California Water Code
DHS	California Department of Health Services
E. coli	*Escherichia coli* bacteria
FDA	United States Department of Health and Human Services Food and Drug Administration
LOCSD	Los Osos Community Services District
MF	Membrane Filter
Morro Bay	This will mean the actual Bay and not the City of Morro Bay unless specified.
MBHD	Morro Bay Harbor Department
MBNEP	Morro Bay National Estuary Program
MPN	Most Probable Number
MS4s	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
NPS	Non Point Source
NRCS	Natural Resources Conservation Service
QAPP	Quality Assurance Project Plan
Regional Board/RWQCB	Regional Water Quality Control Board (Region 3)
SCS	Soil Conservation Services
Shellfish Committee	Morro Bay Shellfish Technical Advisory Committee
SLO	San Luis Obispo
TMDL	Total Maximum Daily Load
UCCE	University of California Cooperative Extension
USCG	United States Coast Guard
WDR	Waste Discharge Requirements
WWTP	Waste Water Treatment Plant
Volunteer Program/VMP	Morro Bay National Estuary Program's Volunteer Monitoring Program

1. Regulations Requiring TMDLs

A TMDL is the loading capacity of a pollutant that a water body can accept while protecting beneficial uses. Normally, TMDLs are expressed as loads (pollutant concentration multiplied by the volumetric flow rate), but in the case of pathogens, it is more logical for the TMDL to be based only on concentration. TMDLs can be expressed in terms of either mass per time, toxicity or other appropriate measure [40 CFR §130.2(I)]. A concentration based TMDL makes more sense in this situation because the public health risks associated with recreating in, or eating shellfish from contaminated waters increases with organism concentration and pathogens are not readily controlled on a mass basis. Therefore, as other regional boards have done (RWQCB-R7, 2001), we are establishing a concentration-based TMDL for pathogens in Morro Bay. This concept will be discussed in more detail in Load Allocations (section 5).

"Typical" TMDL equation:

$$TMDL = \sum(\text{Point Sources}) + \sum(\text{Nonpoint Sources}) + \sum(\text{Background / Natural Sources}) + (\text{Margin of Safety})$$

Pathogen TMDL equation:

$$TMDL = \text{Concentration} = \text{Concentration(point sources)} + \text{Concentration(nonpoint sources)}$$

Morro Bay is listed as "impaired water" for pathogens under Section 303(d) of the Clean Water Act, and is scheduled for a TMDL. While Chorro and Los Osos Creeks are not currently listed as "impaired waters" for pathogens, this analysis considers the creeks as conduits for sources of pathogens and identifies the need to control upstream concentration. An impaired waterbody can be defined as a creek, estuary, or any body of water where beneficial uses are threatened. Water quality data from several sources established the need to adopt a TMDL and were also used to develop this TMDL including: United States Environmental Protections Agency's (USEPA) National Monitoring Program, California Department of Health Services (DHS), a study guided by the Morro Bay Shellfish Technical Advisory Committee (Shellfish Committee) and conducted by California State Polytechnic University at San Luis Obispo (Cal Poly) (funded by the State Board), reconnaissance work done by the Regional Water Quality Control Board (Regional Board) and the Morro Bay National Estuary Program (MBNEP), MBNEP Volunteer Monitoring Program (Volunteer Program), Tetra Tech's Bacterial Loading and Circulation Study and the California Men's Colony (CMC) Waste Water Treatment Plant. This data provides a basis for the TMDL.

2. Problem Statement

In Morro Bay (see Figure 1), elevated levels of fecal coliform present a potential health threat to aquatic animals that live in the Bay, and people who utilize the Bay for recreational purposes and consume shellfish cultivated in the Bay. Elevated levels of fecal coliform are also an economic threat to those who depend upon the resources of the Bay for their livelihood. Elevated levels of fecal coliform are present and indicate that other pollutants such as bacterial, viral or cyst-forming pathogens may be present. Human and animal illnesses can result from eating seafood that has been contaminated by these pathogens. Illness can also result from coming in contact with water or accidentally ingesting water in contaminated areas.

Throughout this document, reference may be given to fecal or total coliform bacteria (the indicator organisms which regulatory standards are based on) and/or pathogens (for which no

regulations exist, although these are the actual organisms we are trying to avoid) and bacteria, in general. All three of these words may be used in this document. It is important to note that reference to fecal/total coliform means a reference to data taken or a number which we are trying to meet for numeric targets. A higher concentration of fecal coliform strongly *implies* that the potential for pathogens to be present is higher. Therefore, when "reducing the amount of pathogens (or bacteria)," is mentioned for example, the mechanism for measuring this will be analyzing the amount of fecal coliform present.

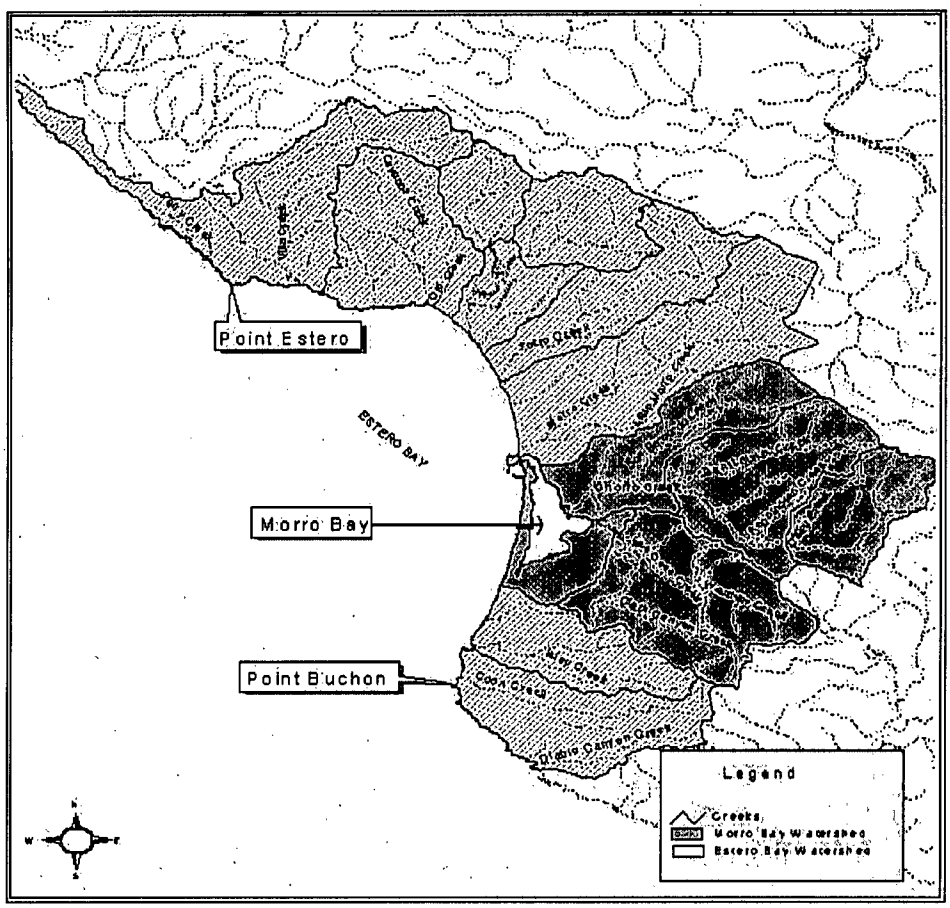

Figure 1: The Setting of Morro Bay

Source: MBNEP, 2000a. Figure 1.1, p.1-4

2.1. Beneficial Uses

Water quality standards set forth in Region 3's Water Quality Control Plan (Basin Plan) include the identified beneficial uses of a waterbody and the water quality objectives for those uses.

Morro Bay itself is the body of water listed on the 303(d) list. The Morro Bay Estuary is the portion of Morro Bay that is in proximity to the creeks. Chorro and Los Osos Creeks are not listed but are also impaired by pathogens. They are tributaries to Morro Bay and need to be

evaluated as sources of Morro Bay's impairment. Numerous beneficial uses have been identified for Morro Bay and these two creeks (and various tributaries to these two creeks) that drain the watershed. The listed beneficial uses for the waterbodies within the Morro Bay watershed are shown in Table 1.

Table 1: Identified Uses of Inland Surface and Coastal Waters of the Morro Bay Watershed.

Waterbody Name	MAR	NAV	MUN	AGR	IND	GWR	REC1	REC2	WILD	COLD	WARM	MIGR	SPWN	BIOL	RARE	EST	FRSH	COMM	AQUA	SHELL
Inland Surface Waters																				
Morro Bay Estuary					√		√	√	√	√		√	√	√	√	√		√	√	√
Chorro Creek			√	√		√	√	√	√	√	√	√	√	√	√		√	√		
Dairy Creek			√	√		√	√	√	√	√		√	√		√			√		
San Luisito Creek			√	√		√	√	√	√	√		√	√		√			√		
San Bernardo Creek			√	√		√	√	√	√	√		√	√		√			√		
Los Osos Creek			√	√		√	√	√	√	√	√	√	√		√		√	√		
Warden Lake Wetland				√		√	√	√	√		√		√		√			√		
Coastal Waters																				
Morro Bay	√	√			√		√	√	√						√			√		√

Source: Regional Water Quality Control Board, Basin Plan 1994

Marine Habitat (MAR): Uses of water that support marine ecosystems.

Navigation (NAV): Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Municipal and Domestic Supply (MUN): Uses of water for community, military, or individual water supply systems including, but not limited to drinking water.

Agricultural Supply (AGR): Uses of water for farming, horticulture, or ranching.

Ground Water Recharge (GWR): Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Wildlife Habitat (WILD): Uses of water that support terrestrial ecosystems.

Migration of Aquatic Organisms (MIGR): Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms.

Preservation of Biological Habitats of Special Significance (BIOL): Uses of water that support designated areas of habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance.

Freshwater Replenishment (FRSH): Uses of water for natural or artificial maintenance of surface water quantity or quality which includes a water body that supplies water to a different type of water body.

Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms.

Aquaculture (AQUA): Uses of water for aquaculture or mariculture operations.

Industrial (IND): Uses of water for industrial activities that do not depend primarily on water quality.

Water Contact Recreation (REC1): Uses of water for recreational activity involving body contact with water, where ingestion of water is reasonably possible.

Non-Contact Water Recreation (REC2): Uses of water for recreation activities involving proximity to water, but not normally involving bodily contact with water, where ingestion of water is reasonably possible.

Cold Fresh Water Habitat (COLD): Uses of water that support cold water ecosystems.

Warm Fresh Water Habitat (WARM): Uses of water that support warm water ecosystems.

Spawning, Reproduction, and/or Early Development (SPWN): Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Rare, Threatened, or Endangered Species (RARE): Uses of water that support habitat necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Estuarine Habitat (EST): Uses of water that support estuarine ecosystems.

Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter feeding shellfish for human consumption, commercial, or sport purposes.

2.2. Regulatory Standards

According to the Basin Plan,

> "Controllable water quality shall conform to the water quality objectives contained herein. When other conditions cause degradation of water quality beyond the levels or limits established as water quality objectives, controllable conditions shall not cause further degradation of water quality.
>
> Controllable water quality conditions are those actions or circumstances resulting from man's activities that may influence the quality of the waters of the State and that may be reasonably controlled."

- The Central Coast Regional Board's Basin Plan has numeric water quality objectives for bacteria for the following beneficial uses:

Shellfish Harvesting (SHELL):
At all areas where shellfish may be harvested for human consumption, the median total coliform concentration throughout the water column for any 30-day period shall not exceed 70/100 mL, nor shall more than 10% of the samples collected during any 30-day period exceed 230/100 mL for a five-tube decimal dilution test or 330/100 mL when a three-tube decimal dilution test is used.

Water Contact Recreation (REC-1):
Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100mL, nor shall more than 10% of all samples exceed 400 MPN per 100mL.

Non-Contact Water Recreation (REC-2):
Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 2000 MPN per 100mL, nor shall more than 10% of all samples exceed 4000 MPN per 100mL.

- The DHS' standards for fecal coliform are as follows[1]:

These numbers are derived from the United States Department of Health and Human Services Food and Drug Administration (FDA), which operates a specific regulatory program directed at shellfish known as the National Shellfish Sanitation Program (1990). If these standards are not attained, the growing areas will be shut down on either a conditional or restricted basis. These standards are for shellfish harvesting in Morro Bay. For water quality samples taken and evaluated on a monthly basis, no more than 10% of the samples shall exceed 43 MPN/100 mL for fecal coliform; or the geometric mean of the samples shall not exceed 14 MPN/100 mL for fecal coliform. There is also a total coliform standard in which the geometric mean MPN of the water shall not exceed 70 per 100 mL and not more than 10 percent of the samples exceed a MPN of 230 per 100 mL for a five-tube decimal dilution test, however in California, the fecal coliform standard is most often used. There is no pre-harvest standard for shellfish meat samples, but the FDA recommends post-harvest guidance that the samples shall not exceed 230 MPN/100 grams for fecal coliform.

The Department of Health Services also has a set of standards for water contact recreation. These are commonly referred to as AB 411 standards because Assembly Bill 411 mandated that State Department of Health Services "adopt regulations establishing minimum standards for the sanitation of public beaches." Should these standards be violated, the beach will be posted as unsafe for recreational contact (see bullet below for details of AB 411 standards).

- The San Luis Obispo County Environmental Health Services standards for bacteria are as follows:

San Luis Obispo County of Environmental Health has jurisdiction over recreational areas and uses the state's standards. The standards are based on single grab samples. In salt water, if a single sample exceeds any of the following, repeat sampling will be conducted to determine the extent and persistence of the exceedance: 1) total coliform concentration shall not exceed 10,000;

[1] See California Department of Health Service's Management Plan for Commercial Shellfishing in Morro Bay, California August 2001 for more specific information

or 2) total coliform concentration shall not exceed 1,000 if the ratio of fecal/total coliform exceeds 0.1; or 3) fecal coliform concentration shall not exceed 400 per 100 mL; or 4) enterococcus concentration shall not exceed 104 per 100 mL. In fresh water: 1) total coliform concentration shall not exceed 10,000; or 2) fecal coliform concentration shall not exceed 400 per 100 mL; or 3) enterococcus shall not exceed 61 per 100 mL or; 4) *E. coli* concentration shall not exceed 235 per 100 mL. Should these standards be exceeded, the County will post the affected beach as unsafe for water contact recreation.

2.3. Indicator Organisms

Fecal coliform is a group of indicator organisms. The presence of these organisms is presumed to be indicative of fecal contamination and subsequently indicates the potential for pathogenic organisms carried by fecal material to be present. Historically, standards to protect water quality and public health relied mainly on fecal coliform concentrations. Recently, enterococcus, along with fecal coliform (and sometimes *E. coli* in fresh waters) is being used as an indicator organism as well, especially in areas that have a lot of contact recreation. The National Shellfish Sanitation Program relies on coliforms to evaluate the water quality of shellfish growing areas. Much debate surrounds the issue of whether fecal coliform or enterococcus is the best indicator to use at this point. Some may argue that enterococcus may be a better indicator organism while others say fecal coliform is superior. There are no conclusive studies performed in California that suggest enterococcus is a better indicator organism than fecal coliform at the time of this writing. If during the reevaluation of the TMDL, better indicator organisms or pathogenic organisms themselves are routinely being used in evaluating water quality and new standards put into place for these organisms, the TMDL will be modified accordingly.

2.4. Watershed/Waterbody Conditions

Morro Bay is a natural embayment located on the central coast of California about 60 miles north of Point Conception and about 100 miles south of Monterey Bay (Figure 1). The contributing watershed area for Morro Bay is estimated to be 48,450 acres (USDA, SCS, 1989a). Chorro Creek drains 65 percent of the watershed and Los Osos Creek drains the remaining 35 percent. The watershed's highest elevation is 2,763 feet above sea level and its farthest point from the Bay is approximately 10 miles. The primary land uses are agriculture, urban lands, and multi-use public lands (MBNEP, 2000, pp. 2-11 draft). The geology of the watershed is a mix of igneous, metamorphic and sedimentary rock less than 200 million years old. Debris landslides, soil creep, and large slumps occur within this terrain, usually triggered by intense rainstorms (USDA, SCS, 1989, p. 2).

The Bay originally had a larger opening to the ocean that was closed in 1911. This closure, that connected the "rock" to the mainland, may have had an effect on the natural flushing of the Bay and could be affecting water quality. However, the details of the hydrogeology and the social implications of what would happen should the man made connection be removed are beyond the scope of this report.

2.5. Impacts to Beneficial Uses

Shellfish harvesting, recreation and *perhaps* pathogenic impacts to marine animals (specifically sea otters, Miller 2002) have been adversely affected in Morro Bay. Basin Plan water quality

objectives and DHS standards associated with these beneficial uses have been exceeded in the Bay and the creeks that feed the Bay.

Regarding specific beneficial use impacts in Morro Bay, the ones that are relevant to bacteria are as follows:

Shellfish Harvesting: In Morro Bay, oysters have been harvested since the 1930's and 1940's. The first oyster lease was established in 1932, and shortly thereafter, Morro Bay became the leading oyster-producing area in the state (Sharpe, 1974). Recently, portions of the Bay's oyster beds have been closed for harvest by the DHS per FDA's National Shellfish Sanitation Program standards because of high fecal coliform levels. DHS downgraded a portion of the lease to a "Prohibited" shellfish growing area due to the unpredictable degradation of water quality in the area. Water quality station 13 (M-614-01, Parcel 1) is prohibited and is closed to shellfish harvesting. Water quality station 12 (M-614-01, Parcel 1) is closed the entire months of November and December (DHS, 1996, 2001). Water quality station 11A (M-614-02, Parcel 2) is closed the entire months of January, February and March. In other areas, the DHS requires the Morro Bay certified shellfish grower to shut down "Conditionally Classified" areas for five to twelve days when significant rainfall occurs and not harvest on portions of this lease area to reduce the risk of potential illness from eating contaminated shellfish. These closures are consistent with the current growing area management. The re-classification of the growing areas greatly reduces the economic viability of the shellfishing operation thereby diminishing the shellfish resource value of the Bay established historically.

In addition to commercial shellfishing, gathering shellfish for consumption must be protected as well. Individuals may gather shellfish from various parts of the Bay for consumption. If levels of fecal coliform are above regulatory standards, the chance of getting sick from eating the shellfish increases. Shellfish gathering for sport is an important distinction from commercial shellfishing because gathering shellfish for sport can occur at any spot in the Bay (outside the oyster lease areas).

Water Contact Recreation: The Bay is widely used for kayaking, boating, beachcombing, windsurfing, surfing, wading, hunting, and fishing. Recreation and tourism also play a large part in the area's economy. In Morro Bay, water quality has exceeded safe water/body-contact standards as defined by the Regional Board's Basin Plan water quality objectives and the DHS' standards for water/body-contact recreation. Elevated levels of fecal coliform are indication that the Bay may be unsafe for swimming or other forms of water contact activities. The San Luis Obispo County Department of Health Services has responded to elevated levels of total and fecal coliform in the late 1990's by posting advisory warnings based on DHS' standards (in response to AB 411), to avoid water contact in portions of Morro Bay. The data Health Services used to post the Bay was based on data collected by the Regional Board (Michel, pers. comm., 2002).

2.6. Data That Defines the Problem

Sampling results from the Bay in shellfish growing areas indicate elevated levels of fecal coliform at times (DHS, 1996, 2001, Anthony, 1987, National Monitoring Program 1993-2001, Cal Poly, 2002). Looking at Figure 2, we can see that the concentration of fecal coliform in the Bay has increased through time and with increasing frequency. The largest concentration of fecal coliform tends to be during the rainy season (National Monitoring Program, Reconnaissance work by Regional Board, DHS); however, often there are elevated levels during periods of no rain as well. DHS has had to close some of the oyster growing areas to harvesting because of

these *unpredictable* levels of fecal coliform during periods of no rain. These closures affect the beneficial use of shellfishing in the Bay.

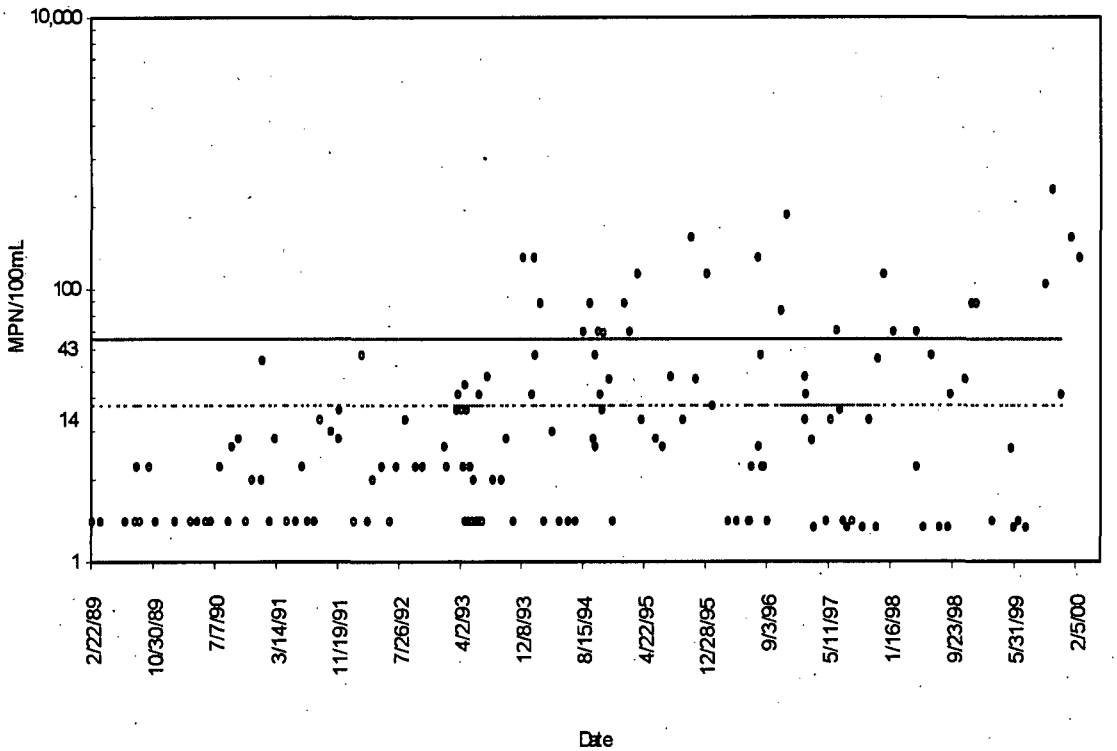

Figure 2: Graph showing the rise in levels of bacteria in Morro Bay oyster lease 13 (lines equals DHS regulatory values of 14 and 43 MPN/100 mL for fecal coliform).
Source: DHS.
Note: Data from 1997 to present represent data collected from a "prohibited" area.

Water quality sampling results from the watershed indicate elevated levels of fecal coliform (National Monitoring Program, 1993-2001, Cal Poly, 2002). These were taken in Chorro and Los Osos Creeks over a period of ten years through the National Monitoring Program. As Figure 3a shows for portions of Chorro Creek, it appears that over half the time, fecal coliform concentrations are above regulatory values (200 MPN/100 mL) for contact recreation. Similarly, in Figure 3b, Los Osos Creek demonstrates that it too is above the regulatory limit (200 MPN/100 mL) about half the time. These elevated levels represent a potential human/animal health threat.

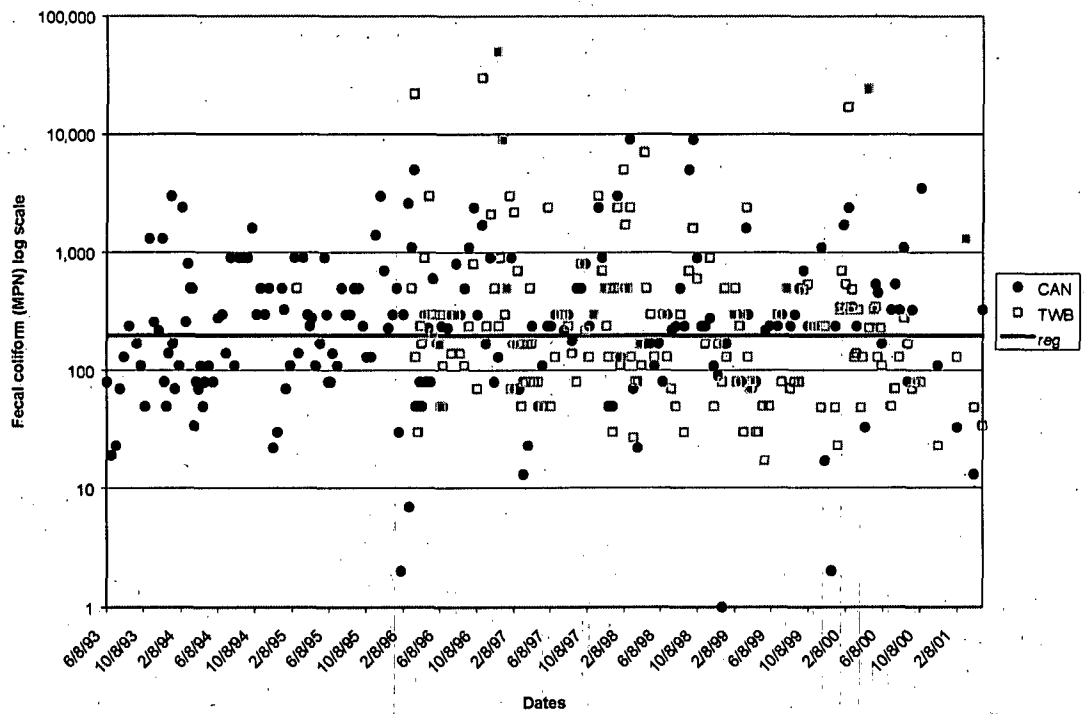

Figure 3a: Graph showing levels of fecal coliform at the mouth of Chorro Creek (TWB) and upstream (CAN) (line equals regulatory value of 200 MPN, REC-1 water quality objective, for fecal coliform).
Source: National Monitoring Program

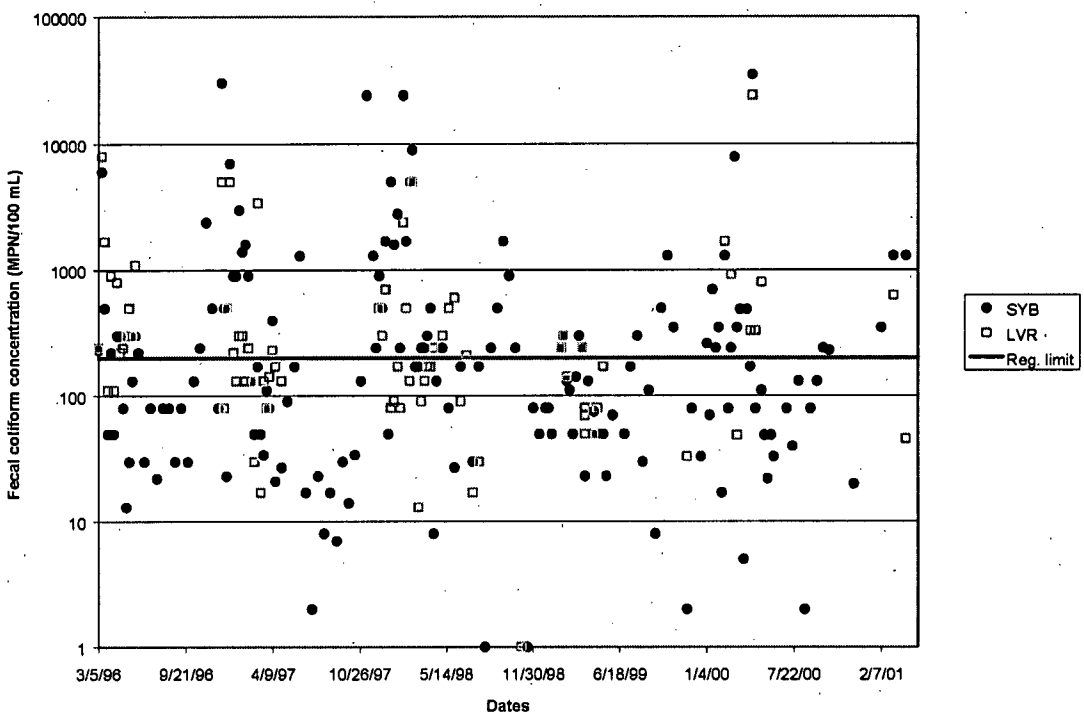

Figure 3b: Graph showing levels of fecal coliform at the mouth of Los Osos Creek (SYB) and upstream (LVR) (line equals regulatory value of 200 MPN, REC-1 water quality objective, for fecal coliform).
Source: National Monitoring Program

Another constant input to the Bay are surfacing groundwater sites (seeps) on the Bay shoreline of the community of Los Osos. Sampling from these seeps indicate extremely high concentrations of fecal coliform on a consistent basis, during periods of wet and dry weather (Cal Poly, 2002). As can be seen in Figure 4, the concentration of fecal coliform is almost always above the regulatory standard for contact recreation.

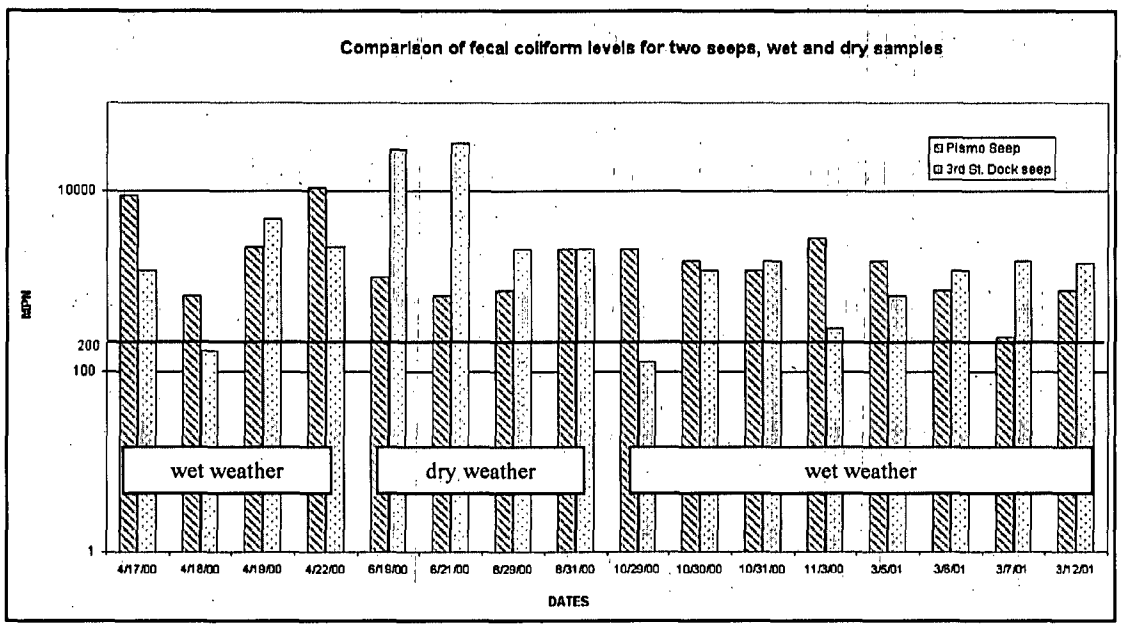

Figure 4: Fecal coliform concentrations of 3rd Street Dock and Pismo seeps (lighter bars indicated dry weather sampling, line equals water quality objective of 200 MPN, REC-1 beneficial use standard, for fecal coliform).
Source: Cal Poly DNA study data, 2002.

2.7. Seasonal Considerations

Data indicates that Chorro and Los Osos Creeks may be contributing more bacteria to the Bay during higher flow periods (Tetra Tech, 1999) than during low flow periods. Cal Poly confirmed this finding through their report from 1999-2001 (Cal Poly, 2002). This data implies that during periods of wet weather, a flushing action occurs that carries fecal coliform from all potential sources, point/nonpoint/background or natural, in the watershed and regularly causes exceedances of water quality objectives.

3. Numeric Targets

3.1. Introduction

The Regional Board, the DHS, and the San Luis Obispo County Department of Environmental Health all have different standards they use to assess whether beneficial uses are being protected. This TMDL uses both Regional Board and DHS standards as numeric targets.

Based on the various regulations as listed in section 2.2, this TMDL will focus on achieving the DHS' standards of fecal coliform concentrations for shellfish growing areas in the Bay because they are the most conservative and are the most protective of the beneficial use of shellfishing. The Basin Plan's total coliform standards will not be used because 1) fecal coliform standards are more stringent and therefore more protective of water quality, and 2) total coliform standards in the Basin Plan are not currently used to manage the shellfish growing areas by DHS. DHS uses fecal coliform standards to determine whether or not a growing area should be open or closed so

therefore, monitoring for fecal coliform would be more protective of the beneficial use of shellfishing, since that is the numeric objective that determines whether the public may consume the shellfish. Fecal coliform standards in the Basin Plan will be used in the fresh water bodies that empty into the Bay. DHS' standards will not be used in these water bodies.

Although California is being strongly encouraged by the Environmental Protection Agency to include enterococcus among the indicator organisms of fecal pollution, enterococcus will not be included in this TMDL at the present time. This is because there are currently no standards in either the Basin Plan or the Enclosed Bays and Estuary Plan that address a body of water such as Morro Bay. State Board is currently performing studies to determine which water quality objectives for enterococcus and other bacterial indicator organisms should be included in this Plan.

3.2. Targets

The proposed numeric targets for this TMDL are as follows:

1) Fecal coliform standard that DHS uses to regulate the growing areas, for the Bay (see Table 2)
2) Fecal coliform standard that the Regional Board uses for water contact recreation, for Creeks and seepage (see Table 3)

Bay

The beneficial use of Shellfishing has the strictest regulatory values. Since DHS uses these numbers to protect oysters harvested in California Department of Fish and Game (CDFG) leases, numeric targets in the Bay will be the same numbers DHS uses in the lease areas (see Table 2).

The beneficial use of shellfishing includes not only commercial shellfishing as mentioned above, but also the gathering of shellfish for personal consumption or sport purposes. Since this type of gathering occurs outside the CDFG leases, this beneficial use needs to be protected in these areas as well. Therefore, outside the commercial leases, and inside the Bay, the numeric targets as presented in Table 2 will apply as well. The standard set forth in Table 2 is also protective of contact recreation as the standard is even stricter than the fecal coliform standard for contact recreation. There are other standards that could have been relied upon (e.g., San Luis Obispo County Department of Environmental Health), however, DHS standards are most protective of water quality. That is, the beneficial use of shellfishing corresponds with much lower numeric targets than the beneficial use of recreational contact. Therefore, the beneficial use that corresponds with lower numeric targets (shellfishing) will be used.

Table 2: Numeric targets for Morro Bay, based on regulations that DHS follows

Fecal Coliform	
Geometric Mean	**Maximum**
14 MPN/100 mL[a]	43 MPN/100 mL[b]

a: Based on the geometric mean of monthly sampling evaluated over an annual and triennial basis
b: No more than 10% of total samples may exceed this number when evaluated over an annual and triennial basis
Source: United States Department of Health and Human Services Food and Drug Administration's National Shellfish Sanitation Program 1990

Creeks and Seeps

The numeric targets for all creeks and the groundwater seeps that flow into Morro Bay will be based on water contact recreation standards, as they are the appropriate standard for the highly accessible waters of the Creeks and seeps (see Table 3). The creeks are considered highly accessible because many areas have a road that runs next to the body of water. There are also some areas that are very close to picnic and camping areas. The seeps are considered highly accessible because they are on the shoreline of Los Osos in and area where during low tide one is able to walk along the shoreline. Since these areas are highly accessible to human contact, they need to be protected.

Table 3: Numeric targets for the tributaries to Morro Bay, based on Basin Plan regulations

Fecal Coliform	
Geometric Mean	**Maximum**
200 MPN/100 mL[a]	400 MPN/100 mL[b]

a: Geometric mean of not less than five samples over a period of 30 days
b: Not more than 10% of total samples during a period of 30 days exceed
Source: Regional Water Quality Control Board, Basin Plan 1994

4. Source Analysis

4.1. General Overview

Many agencies have been involved in the determination of bacterial sources for Morro Bay. The DHS has evaluated the potential sources of bacteriological contamination to shellfish growing waters of the Morro Bay. The Regional Board (Anthony 1987) has also assessed the contributions of bacteria from the various sources for the protection of shellfish harvesting and recreation. The MBNEP has developed numerical models of the bay in an effort to identify sources.

According to the MBNEP's Comprehensive Conservation and Management Plan for Morro Bay, potential sources of bacteria to Morro Bay include but are not limited to the following:

- Discharged effluent (such as during a wastewater treatment plant failure)
- Malfunctioning sewer lifts, line leaks, breaks, and backups
- Leaking and/or failing septic systems
- Domestic animal waste
- Waste from marine animals & wildlife

- Urban runoff
- Runoff from rangeland & cattle operations
- Illegally moored boats with inadequate waste disposal capabilities
- Birds

The major sources of bacteria were suspected to be from (1) background, which includes bird, wild animals and sea mammals, (2) non-point sources which include humans, septic systems, cattle and other farm animal, and domestic pets, and (3) point sources which may possibly include, CMC (wastewater treatment plant) the City of Morro Bay (stormwater and wastewater treatment plant – lift stations in the watershed) and the community of Los Osos (stormwater).

While these agencies and others have partnered during the last several years in identifying sources of bacteria in the Bay, this task has been difficult. This in part is due to the inability of the indicator, fecal coliform, to differentiate between sources of bacteria. Because of this, a DNA fingerprinting study was conducted through the Shellfish Committee[2] to aid in further differentiating between the sources as part of the TMDL source analysis. Cal Poly, in association with Dr. Samadpour from the University of Washington conducted the study from 1999 to October 2001. The final report was submitted to the Regional Board May 2002.

4.2. DNA Analysis of *E. coli* Bacteria

Based on the aforementioned data (National Monitoring Program, DHS, Anthony), excessive levels of bacteria were a known problem in the Bay and its tributaries. The question remained; what are they coming from? To answer the question of what, the Shellfish Committee decided to use DNA "fingerprinting" of *E. coli*.

E. coli is a well-known type of fecal coliform bacterium that lives in the intestines of warm-blooded animals. Different *E. coli* species are preferential to different animal hosts. Using this premise, a DNA fingerprint of a certain *E. coli* isolate found in a field sample (water, sediment, or oyster tissue) can be matched to *E. coli* known to inhabit a particular animal's intestines. Dr. Samadpour has a DNA library of over 75,000 strains of *E. coli* collected from known sources.

Based on the DNA fingerprints, the Shellfish Committee could determine what groups of animals were depositing this bacterium. By collecting a large number of *E. coli* from sites around the Bay, we were able to gain a better understanding of the sources of fecal coliforms affecting the water quality of oyster growing areas.

4.2.1. Sampling Plan Set-up

Timing of DNA Sample Collection

Cal Poly (along with occasional Regional Board and DHS' help) collected samples during three wet events and two dry events. The three wet events were classified as wet events if more than 0.4 inches of rain fell within a 24-hour period. This protocol was based on DHS' conditions for closing the oyster growing areas during rain events. The samples were collected on what was

[2] The Regional Board established the Morro Bay Shellfish Technical Advisory Committee in 1997 in response to the downgrading of a portion of the shellfishing lease due to water quality impairment. This group convened per the Shellfish Protection Act of 1993 (California Water code Sections 14950-58) and worked to determine the nature, source and scope of the problem and recommended remedial actions (see Implementation and Monitoring plan for recommended remedial actions).

designated as "day one" and "day three." These were defined as the first and third day of the shellfish harvesting area closure. The two dry events were collected during periods of dry weather (i.e. no rain, 72-hours before sampling). Day one and day three were simply the first and third day of sampling.

DNA Sites

Five sites were initially chosen to be "DNA" sites (see Figure 5). The sampling crew collected water and sediment from these five sites along with oyster tissue from the three Bay sites. Later, as additional funds became available, two seeps in Los Osos were added as DNA sites. Only water was sampled from the seeps. These seeps were sampled three months after the last of the other sites were sampled. Samples were taken over 20 dry weather days, which were randomly spread out over three months.

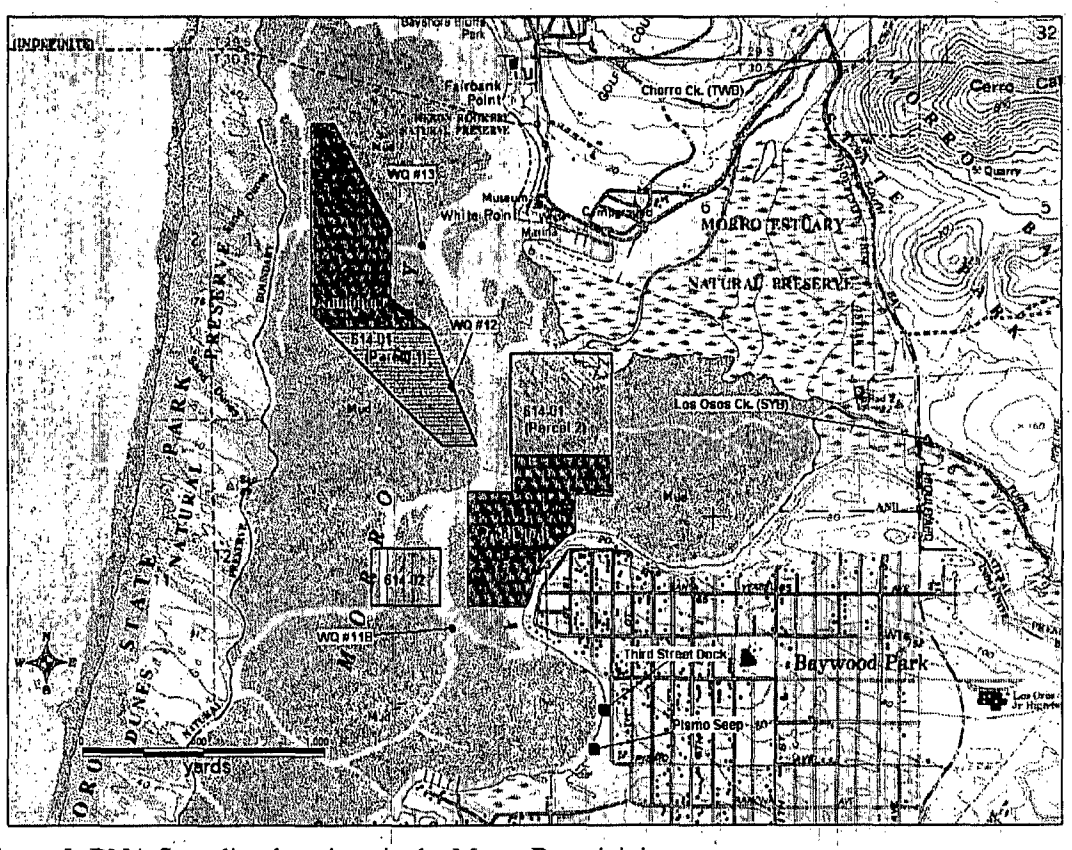

Figure 5: DNA Sampling locations in the Morro Bay vicinity
Source: Department of Health Services, 2001

MPN sites

Surface water and seep samples were taken throughout the watershed and in the Bay for Most Probable Number (MPN) per 100 mL of fecal coliform counts during wet and dry events.

There was a third dry season study based in area 13. This area covers the northern most portion of the shellfish growing area lease and is comprised of fifteen distinct sites, commonly referred to as the "grid at station 13" (see Figure 6). This is an area that has been downgraded to a

"Prohibited" shellfish growing area since 1996. This classification is due to the unpredictable degradation of water quality in the area. Fifteen sites were sampled over a period of twenty-five days during a "dry" period.

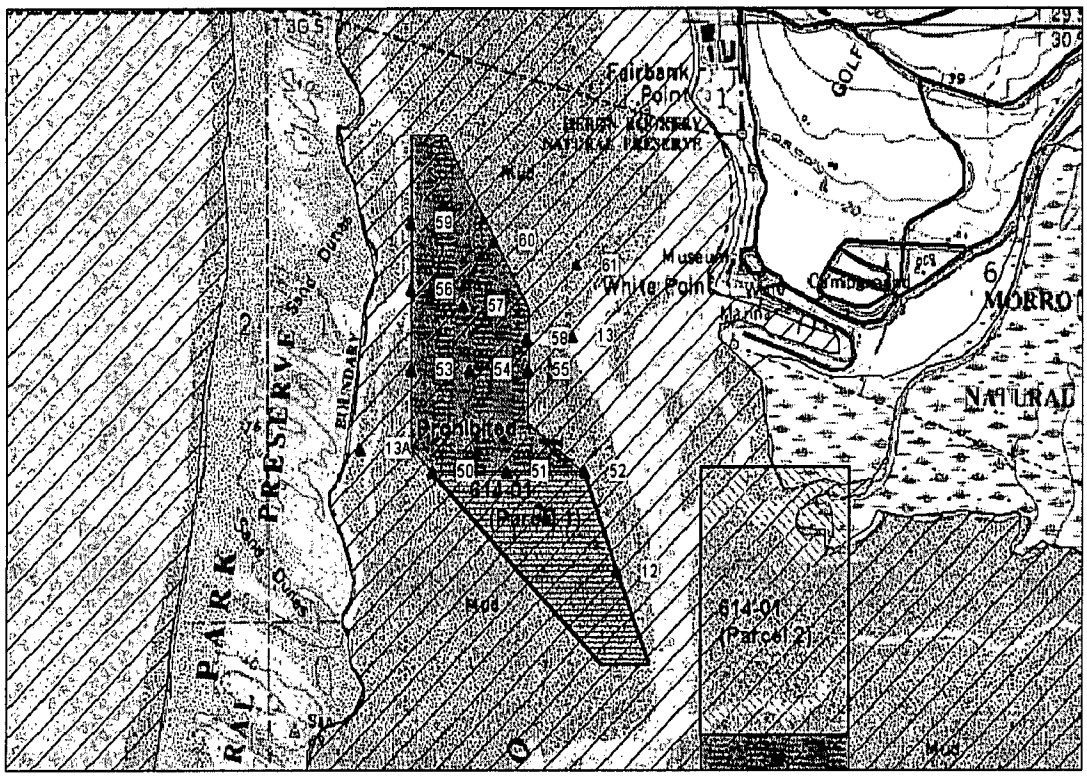

Figure 6: Map of "the grid at station 13."
Source: Department of Health Services, 2001

Quality Assurance/Quality Control Plan

A Quality Assurance/Quality Control Plan (QA/QC) is defined as a planned system of verification activities designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. The QA/QC plan focused on four different areas: reproducibility, clone isolation frequency, inter-lab variation in counting MPN, and MPN compared to the Membrane Filtration Method.

4.2.2. Results/Discussion:

Quality Assurance/Quality Control Plan

The QA/QC plan met the standards of quality within a desired level of confidence. Briefly, reproducibility was 100%, clone isolation frequency analysis determined that isolating only one strain per filter would be best, inter-lab variation was well within acceptable variation, and it was

determined that the Membrane Filtration counts can be readily converted to MPN counts with the appropriate formula[3].

FECAL COLIFORM – MPN PORTION

Fecal Coliform, Water Samples -Wet
Based on the three wet season sampling periods, fecal coliform counts in the creeks were consistently above regulatory values on the first day of rainfall (geometric mean 3,265 MPN/100 mL for Chorro Creek and 9,764 MPN/100 mL for Los Osos Creek). They dropped fairly quickly and on the day the shellfish beds were scheduled to reopen (five days later), they were *usually* at levels below Basin Plan standards however, certain creek sites remained high, even by the fifth day (geometric mean 189 MPN/100 mL for Los Osos Creek and 106 MPN/100 mL for Chorro Creek for the fifth day).

Fecal coliform counts in the Bay followed a similar pattern. Usually on the first day of rainfall, the fecal coliform counts were extremely high (geometric mean ranged between 374 and 175 MPN/100 mL for the Bay sites) and by the third day, all counts had reduced significantly and were below 14 MPN/100 ML (geometric mean was about 5 MPN/100 mL for all sites).

Fecal Coliform, Water Samples - Dry
Fecal coliform counts taken during dry periods in the creeks were lower compared to wet times, however, often exhibited a level of fecal coliform above some regulatory standards (geometric mean 280 MPN/100 mL for Los Osos Creek and 130 MPN/100 mL for Chorro Creek).

Fecal coliform counts taken during the two dry events in the Bay did not exhibit levels over any standard[4].

Fecal Coliform – Oyster Tissue
Fecal coliform counts jumped around at high levels of concentration during wet events. The relationship was not consistent. Sometimes the level of fecal coliform was high the first day and dropped significantly by the third day while other times the first day was relatively low in fecal coliform and the third day was higher. This variation may be due to differing amounts of rainfall and consequently, the flow of the creeks.

Fecal coliform counts were always well below the federal standard of 230 MPN/100 grams of meat during dry periods of sampling.

Fecal Coliform – Sediment
Fecal coliform concentrations in the sediment exhibited a similar pattern to the oysters. Wet season sampling did not show a consistent pattern and dry season sampling showed low numbers of fecal coliform.

Loading
Although Chorro Creek has a larger flow than Los Osos Creek, it appears that Chorro and Los Osos Creek contribute nearly equal loads of fecal coliform to the Bay (Cal Poly, 2002). Chorro

[3] Details can be found in the Cal Poly 2002 study.
[4] Based on the Cal Poly, 2002 study, during the two dry sampling periods, the growing areas were in compliance with DHS regulations. However, based on sampling that occurs throughout the year, by the growers and by DHS, the areas are not always in compliance during periods of dry weather. See also the specific "grid at station 13" portion of the Cal Poly study that shows a couple of the sites in area 13 were out of compliance during periods of dry weather.

Creek has a higher load of fecal coliform during the dry season and Los Osos Creek has a higher load during the wet season. It appears that rain events greatly increase coliform counts for short periods of time.

The seeps in Los Osos also contribute to fecal coliform loading to the Bay. From the available data, it appears the seeps contribute up to about two orders of magnitude less than the creeks (see Table 4)

Table 4: Yearly loading of fecal coliforms (MPN/yr) for Los Osos Creek, Chorro Creeks and groundwater (the seeps).

Flow (L/yr)	**Minimum (1993-1994)**	**Mean (1993-2000)**	**Maximum (1997-1998)**
Los Osos Creek	1.19E+09	1.57E+10	1.94E+10
Chorro Creek	2.66E+10	3.06E+10	6.19E+10
Groundwater		8.93E+08	
Load (MPN/yr)			
Los Osos Creek	1.46E+13	2.29E+14	2.45E+14
Chorro Creek	1.10E+14	1.31E+14	2.63E+14
Groundwater		2.42E+12	

The Grid at Station 13
Two sites out of the fifteen sites were over the regulatory limit during the study. Observation during sampling indicates that birds may be responsible.

DNA FINGERPRINTING

A total of 1,659 *E. coli* strains were isolated. Of these, 1,235 were identified. 424 were classified as unknown, which means there was no match in Dr. Samadpour's "library." A 74% matching rate is a high percentage for this type of work.

The *E. coli* ribotypes matched to birds, domestic animals (cats and dogs), livestock (cows, horse, sheep and pigs), humans and wild animals (includes terrestrial and marine). Table 5 shows the specifics of how these sources were broken out.

When results were summed over the entire study the largest fractions of *E. coli* came from four sources: bird (22%), human (17%), bovine (14%) or dog (9%). Birds were the largest source of *E. coli* in the bay waters, Los Osos Creek, 3rd St. Dock seep, sediment and oysters. Bovine sources contributed the majority of *E. coli* in Chorro Creek and humans contributed most at Pismo Seep.

As was mentioned above, Chorro Creek has the highest proportion of livestock sources. This is logical as Chorro Creek has a large amount of rangeland encompassing its watershed. The majority of the *E. coli* in the livestock classification came from cows.

The seeps have the highest proportion of *E. coli* from human sources. Not only were bacteria detected in the seeps, but the values are very high (range: 130 – 35,000 MPN/100 ML, geomean: 1,600 MPN/100 ML), with humans contributing the most of any source. So while the seeps appear to contribute about 1/100th the amount of fecal coliform compared to the creeks, they contribute a greater proportion of human fecal coliform.

When the results were compared seasonally (i.e., between wet and dry studies), contributions from various sources remained the same. In other words, the four main contributors as listed above were the four main contributors of *E. coli* in the samples whether the samples were collected during dry weather samples or wet weather samples. For example, birds had the highest percent contribution and that statement remains for both wet and dry samples.

The oyster tissue itself seems to be the most impaired by bird sources. However, because of low numbers of *E. coli* isolated from the oysters, this number is not statistically different from the Bay water.

No DNA fingerprints from the seeps were found in oyster tissue. This could be due to the fact that oyster tissue and seeps samples were taken at different times of the year. There were DNA fingerprints from the seeps that were found in the Bay water so there is a strong likelihood that the flow from the seeps does reach the Bay sites.

Overall Conclusions

Birds contribute significantly to fecal coliforms that contaminate the oysters in Morro Bay and can be grouped into the "natural background category." Human, livestock and domestic animal sources of fecal coliforms are also large contributors to coliform levels in Morro Bay waters and can be grouped into the "controllable category." Although the proportion of human coliforms is high in the seeps and is a contributor of fecal coliform, the impact to the Bay water from the seeps appears to be less than that of Los Osos and Chorro Creeks.

Limitations of the DNA Fingerprinting Study

The results from the DNA fingerprinting study are extremely valuable in helping us identify the sources of fecal contamination in the Bay and the tributaries. However, it is important to keep in mind that what was studied is a subset of a subset of a subset. In the large grouping of bacteria, fecal coliform is a subset of bacteria. *E. coli* is a subset of the fecal coliform group. In this study, only a portion of the *E. coli* coming out of the watershed was captured. Therefore, although there are relative percent contributions attached to the water samples, this method is <u>not strictly quantitative</u>. The numbers reported are not an exact number of *E. coli* coming out of the watershed, but rather an estimation of the relative contribution each source makes. Based on our sampling plan, we feel fairly confident that the data represents an accurate picture, but we cannot make absolute numeric statements about it.

It is important to make this distinction because loading of fecal coliform cannot be coupled with the DNA fingerprints at this point in time. So although we have a good idea of loading from certain areas, and also a good idea of the sources that are contributing, we cannot combine the two and make a blanket statement such as, "this organism contributed 25% of the bacteria to the Bay." There is simply no way to make this type of statement and one must be careful to not draw conclusions like this from the available data.

Table 5. Sources of *E. coli* found at each site where samples were taken.

SITE	Total *E. coli*	Avian	Pigeon	Crow	Sea Gull	Duck	Duck/Goose	Goose	Bovine	Horse	Sheep	Porcine	Canine	Dog	Cat/Dog	Cat	Feline	Human	WWTP Sludge	Marine Mammal	Sea Lion	Seal	Deer	Deer/Elk	Fox	Rabbit	Opossum	Raccoon	Rat	Rodent	Unknown
Bay 11b	233	40	0	1	12	2	0	2	32	8	0	0	3	13	0	0	1	51	2	3	4	2	3	0	0	0	0	2	2	3	47
%(Total at site)		17	0	<1	5	1	0	1	14	3	0	0	1	6	0	0	<1	22	1	1	2	1	1	0	0	0	0	1	1	1	20
%(Known)		22	0	1	6	1	0	1	17	4	0	0	2	7	0	0	1	27	1	2	2	1	2	0	0	0	0	1	1	2	n/a
Bay 12	203	23	0	0	13	0	1	2	30	3	0	0	6	17	0	0	3	33	0	2	4	3	2	0	1	0	2	0	0	3	55
%(Total at site)		11	0	0	6	0	<1	1	15	1	0	0	3	8	0	0	1	16	0	1	2	1	1	0	<1	0	1	0	0	1	27
%(Known)		16	0	0	9	0	1	1	20	2	0	0	4	11	0	0	2	22	0	1	3	2	1	0	1	0	1	0	0	2	n/a
Bay 13	169	31	0	0	13	0	1	2	31	6	0	0	0	14	0	4	0	19	0	2	1	2	1	1	0	1	0	1	0	3	36
%(Total at site)		18	0	0	8	0	1	1	18	4	0	0	0	8	0	2	0	11	0	1	1	1	1	1	0	1	0	1	0	2	21
%(Known)		23	0	0	10	0	1	2	23	5	0	0	0	11	0	3	0	14	0	2	1	2	1	1	0	1	0	1	0	2	n/a
Chorro Creek	301	34	0	1	8	0	0	3	93	11	2	0	10	18	5	0	6	38	0	0	0	0	8	0	0	0	5	2	0	7	50
%(Total at site)		11	0	<1	3	0	0	1	31	4	1	0	3	6	2	0	2	13	0	0	0	0	3	0	0	0	2	1	0	2	16
%(Known)		14	0	<1	3	0	0	1	37	4	1	0	4	7	2	0	2	15	0	0	0	0	3	0	0	0	2	1	0	3	n/a
Los Osos Creek	333	65	3	2	5	1	0	5	26	5	0	1	6	39	0	2	9	63	0	0	0	0	8	2	0	5	1	3	1	6	75
%(Total at site)		20	1	1	2	<1	0	2	8	2	0	<1	2	12	0	1	3	19	0	0	0	0	2	1	0	2	<1	1	<1	2	23
%(Known)		25	1	1	2	<1	0	2	10	2	0	<1	2	15	0	1	3	24	0	0	0	0	3	1	0	2	<1	1	<1	2	n/a
Oysters	91	31	0	0	3	0	0	0	11	0	0	0	1	3	0	0	1	5	0	2	0	1	0	0	0	0	0	2	0	0	31
%(Total at site)		34	0	0	3	0	0	0	12	0	0	0	1	3	0	0	1	5	0	2	0	1	0	0	0	0	0	2	0	0	34
%(Known)		52	0	0	5	0	0	0	18	0	0	0	2	5	0	0	2	8	0	3	0	2	0	0	0	0	0	3	0	0	n/a
Sediment	158	22	0	0	2	0	0	0	8	2	0	0	6	3	0	0	0	13	0	3	9	0	1	0	0	1	0	0	0	3	85
%(Total at site)		14	0	0	1	0	0	0	5	1	0	0	4	2	0	0	0	8	0	2	6	0	1	0	0	1	0	0	0	2	54
%(Known)		30	0	0	3	0	0	0	11	3	0	0	8	4	0	0	0	18	0	4	12	0	1	0	0	1	0	0	0	4	n/a
3rd St. Dock Seep	76	20	0	0	1	0	0	0	0	0	0	0	3	3	0	3	0	14	0	0	0	0	0	0	0	0	0	0	0	2	30
%(Total at site)		27	0	0	1	0	0	0	0	0	0	0	4	4	0	4	0	19	0	0	0	0	0	0	0	0	0	0	0	3	39
%(Known)		43	0	0	2	0	0	0	0	0	0	0	7	7	0	7	0	30	0	0	0	0	0	0	0	0	0	0	0	4	n/a
Pismo Seep	95	13	0	0	1	0	0	0	0	0	0	0	1	6	0	1	6	46	0	0	0	0	0	0	0	0	2	0	0	4	15
%(Total at site)		14	0	0	1	0	0	0	0	0	0	0	1	6	0	1	6	48	0	0	0	0	0	0	0	0	2	0	0	4	16
%(Known)		16	0	0	1	0	0	0	0	0	0	0	1	8	0	1	8	58	0	0	0	0	0	0	0	0	3	0	0	5	n/a
ALL SITES	1659	279	3	4	58	3	2	14	231	35	2	1	36	116	5	10	26	282	2	12	18	8	23	3	1	7	10	10	3	31	424
%(Total)		17	<1	<1	3	<1	<1	1	14	2	<1	<1	2	7	<1	1	2	17	<1	1	1	<1	1	<1	<1	<1	1	1	<1	2	26
%(Known)		23	<1	<1	5	<1	<1	1	19	3	<1	<1	3	9	<1	1	2	23	<1	1	1	1	2	<1	<1	1	1	1	<1	3	n/a

4.3. Point Source Contributions

All *potential* point sources of fecal input must be considered in the Source Analysis. Considering the additional data discussed below as well as the data from the aforementioned DNA study, it appears that the only "point source" contribution is from storm water discharge. Existing wastewater treatment plants could be a potential source when a malfunction occurs but do not appear to increase the concentration of bacteria in the watershed per their current operations and compliance with existing permits.

4.3.1. Stormwater

Storm water is listed here as a point source, because although the water comes from "non point sources," when funneled into storm drain and concentrated into pipes, it becomes a point source and the federal regulations control these discharges under the National Pollutant Discharge Elimination System. The City of Morro Bay is responsible for the storm water within the city limits and the Los Osos Community Services district is responsible for the storm water within their community limits. Based on existing literature and Regional Board sampling that took place between 1994-1997 in Morro Bay and Los Osos storm drain culverts, we can conclude that stormwater contributes a high concentration of bacteria to the Bay. Based on the Tetra Tech study (1999), stormwater contributes a relatively large percent to the fecal coliform problem (see Figure 8).

The DNA study found *E. coli* from human, bird and pet wastes are in the Bay. Stormwater *may be* one of the primary vehicles by which these wastes are transported.

4.3.2. Wastewater Treatment Plants (not currently considered contributing point sources)

Morro Bay/Cayucos Wastewater Treatment Plant

The Morro Bay/Cayucos wastewater treatment plant is situated north of the City of Morro Bay (outside of the watershed), and discharges advanced primary treated effluent into the ocean. The discharge point is north of the Bay, outside of the mouth (see Figure 7). In 1985, bacterial contamination was shown to be entering from the ocean, and the City of Morro Bay's wastewater treatment plant was identified as the most probable source, since it did not disinfect its effluent. In April 1986, due to concerns about bacterial contamination, the CDFG and DHS closed Morro Bay to harvesting of shellfish in general. Shortly after, the City of Morro Bay initiated a chlorination process at its wastewater treatment plant and the prohibitions were removed (November 1986). A study conducted in 1986 (Anthony) concluded that since the upgrade to a chlorination process, the Morro Bay/Cayucos wastewater treatment plant is <u>not</u> a source of pathogens in the Bay. In addition to the 1986 study, the Cal Poly study found consistently low numbers of fecal coliform at the mouth of the Bay (2002).

Included in the source assessment for the Morro Bay/Cayucos wastewater treatment plant are the collections systems. Due to the maintenance plan that the operators follow, the system of double redundancy built into the pumping capabilities of the lift station so that if one pump fails the other pump will operate, the alarms set into the stations should key components of the station fail and that personnel are on-call for after hour emergencies, the collection system is not considered a suspected source.

California Men's Colony Wastewater Treatment Plant

The California Men's Colony (CMC) wastewater treatment plant is located within the Morro Bay watershed and discharges tertiary treated effluent into Chorro Creek (see Figure 7). CMC monitors the concentration of total coliform from the effluent 5 days/week. Based on this monitoring (CMC Annual Reports), it does not appear that CMC is affecting the concentration of coliform in the creek in any measurable quantity. However, a history of violations do exist, as the most recent enforcement action taken before the Regional Board on November 1, 2002 (R3-2002-0016, mandatory minimum penalties covering the periods March 1, 2001 – June 30, 2002) detailed with exceedances of total coliform being a portion of the violations. Any future indications of discharges would be reported through the monitoring and reporting program and tracked through exiting permit oversight. Should additional violations occur, their contribution will be acknowledged. The CMC is scheduled for an upgrade of their facilities, which should make events mentioned above become much less frequent. Given normal operating conditions, this TMDL is not considering CMC as a source of pathogens.

Monarch Grove – Wastewater Treatment Plant

Monarch Grove is a small wastewater treatment plant located in Los Osos. They have a Waste Discharge Requirement as they reclaim water from a small housing development and use that water to irrigate a golf course. Treated water has low to nondetectable amounts of total coliform and is not viewed as a source of pathogenic input into Morro Bay.

4.4. Non-point Sources

4.4.1. Human Input

Fecal input from humans increases fecal coliform/pathogenic concentration into the water, with human *E. coli* being the second highest source of *E. coli* in the Bay according to the DNA study. When human fecal contaminated water enters the Bay, there is a potential for those that come in contact with it to be exposed to a number of pathogens of human concern.

Source Locations

- Illegally moored boats with inadequate waste disposal capabilities
- Live aboard boaters in the Bay
- Failing/overloaded septic systems in Los Osos and other locations throughout the watershed
- Trailer Parks
- Homeless people
- Agricultural workers not provided with adequate facilities

<u>Illegally moored boats with inadequate waste disposal</u>
Illegally moored boats are boats that are not abiding by boating laws that protect the Bay. Since they are not following the law for the placement of their boat, it may be possible that they are not following the rules for proper waste disposal either. The illegally moored boats are not observed to be moving to pump-out stations with the same frequency as those that are legally moored. The DNA study found human sources in the Bay and these boats might be a source.

<u>Live aboard boaters in the Bay</u>
Boats moored legally in the Bay may be a source. Although those boats have obtained a permit from the City of Morro Bay Harbor Department regarding proper waste disposal, and other

various forms of instruction, these boats may still contribute human waste. The Harbor Department feels that the majority of the boats are obeying the rules laid out by the City but it is difficult to know for certain because the Harbor Department does not have the resources for constant surveillance.

Failing/overloaded septic systems in Los Osos and other locations throughout the watershed
It is clear that there are septic systems in Los Osos that are failing/overloaded based on sampling surfacing groundwater seeps in Los Osos. Fecal coliform counts were extremely high compared to standards (range: 130 MPN – 35,000 MPN/100 mL, geometric mean: 1,600 MPN/100 mL) and the major source in the DNA study was human. This provides a strong correlation that there are some septic systems that are contributing to the pathogen load in the Bay.

As for other septic systems in the upper watershed, they are viewed as a potential source for two reasons. One, there has been no program set up to check and maintain these systems, so the possibility of some of the systems having problems is relatively high. Secondly, the DNA study found human sources in the creeks and these septic systems may be part of the cause.

Trailer Parks
Currently, Trailer Park's wastewater operations are regulated by the Department of Architecture. Because the Department of Architecture does not actively pursue the regulation of trailer parks and because there is a mobile home park just above the sampling point where the DNA of human *E. coli* was found, there is a strong possibility that trailer parks may be a source of fecal contamination of the Bay.

Homeless people
Based on visual observation of homeless encampments in the watershed, with no facilities for disposing of human waste, homeless people are a possible source of fecal material entering the creeks and subsequently the Bay. The DNA study found human sources in the Bay and creeks and homeless encampments might be a source.

Agricultural workers not provided with adequate facilities
Human fecal material has been found in the creek beds close by agricultural areas. Workers not provided with adequate waste disposal options may use the creek beds. Although human waste near agricultural fields does not prove it was the workers, this possible human source will be investigated.

The source locations listed above are areas where we will target the reduction of human fecal discharges.

4.4.2. Livestock

Livestock grazing has the potential to cause detrimental effects on the beneficial uses of the water by increasing the fecal coliform concentration in the water column (EPA 1993). Fecal input from cattle, measured by percent contribution of *E. coli*, was the third highest source contribution in the Bay according to the DNA study. Numerous studies show that livestock grazing increases fecal coliform counts over background (Gary et al., 1983; Tiedeman, 1987). Bacterial counts increase after cattle are released in a pasture and remain high after cattle are removed (Stephenson and Street, 1978; Jawson et al., 1982).

The primary mechanism for bacterial contamination appears to be direct deposition or transport of fecal material to the stream via overland flow. Once these bacteria reach the stream, bottom sediment may act as a reservoir. These bacteria may become resuspended when stream flow increases or when animals walk through streams (Sherer, *et al.*, 1982).

Baxter-Potter and Gilliland (1988) found that the proximity of fecal contamination is significant. If bacteria cannot be transported by overland flow, their contribution to the water will be minor. Therefore, it can be logically deduced that if cattle are kept out of the stream and a sufficient riparian buffer is maintained, the chances of bacteria reaching the water are much less.

Source Locations

- Runoff from rangeland and cattle operations

Runoff from rangeland and cattle operations was documented in the DNA study. All cattle operations in the watershed are a possible source. Public and Private Landowners are owners of these areas. Figure 7 illustrates where the rangeland, and other land uses, are in the watershed.

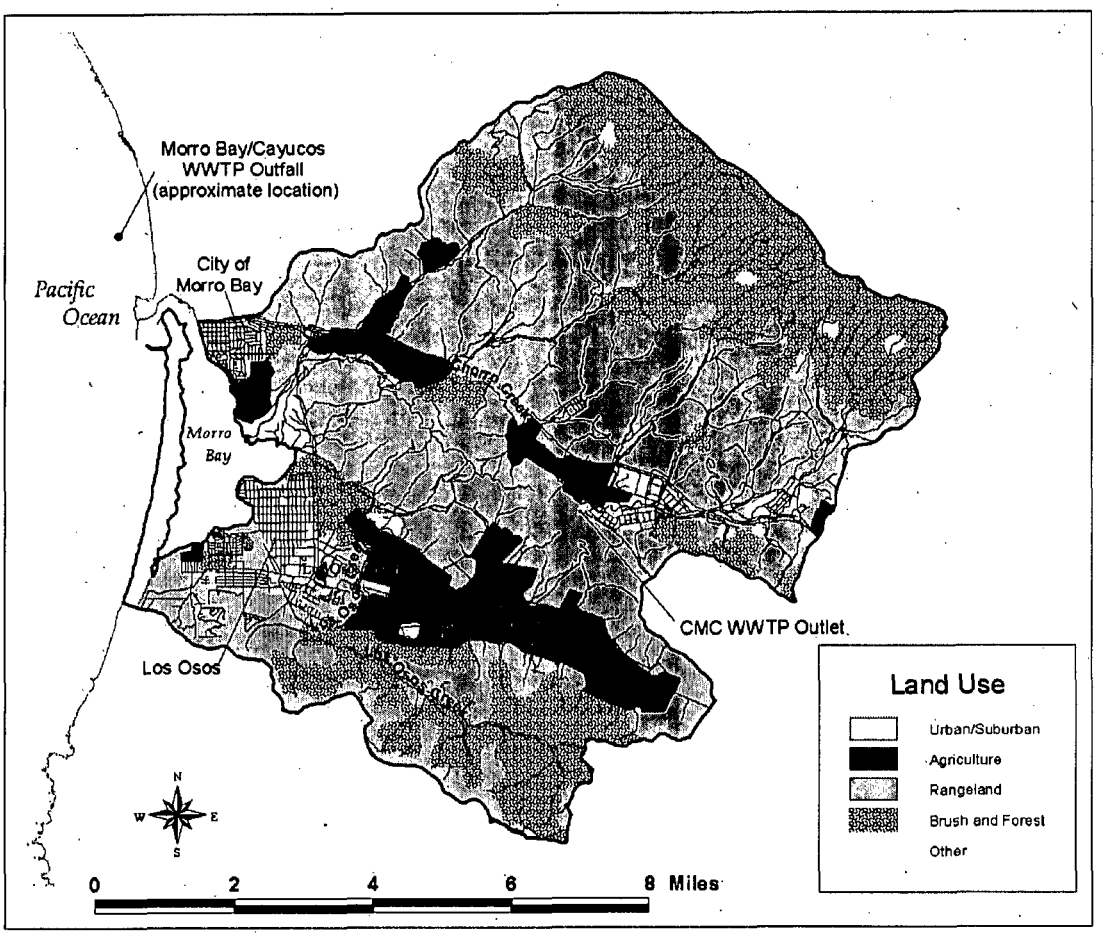

Figure 7: Land use map of the Morro Bay watershed[5]

[5] See below table for a breakdown of the percent land use contribution in the watershed:

Subwatersheds	Land uses					
	Rangeland	Brushland	Woodland	Agriculture	Urban	Other
Chorro Creek %	62.8%	17.0%	8.7%	6.1%	5.4%	
Los Osos Creek %	37.3%	3.3%	16.8%	18.8%	16.9%	6.8%

4.4.3. Domestic Animals

Pet cats and dogs that defecate near a storm drain or creek increase the likelihood that their fecal material may be transported to the Bay if it is not cleaned up. Feral cats and dogs are also a direct source for pathogenic input into the Bay with dogs being the fourth highest source of *E. coli* according to the DNA study (cats contributed about 3% of the total sources). Waste from these animals may carry pathogens that cause human or marine animal health problems. The issue of sick/dying otters *may* be closely linked with the pathogens found in cat waste (Miller 2002).

Source Locations

- Pets in the watershed
- Urban runoff
- Feral cats/dogs

4.4.4. Birds and Wild Animals

Birds and wild animals are a significant contribution of fecal material into the Bay. These sources are natural and there is nothing that should be done to prevent their deposition into the Bay. A certain level of bacteria is normal and part of a natural ecosystem. These animals will be considered as natural background. Although these animals are being regarded as natural background, birds and other wildlife do carry pathogens (Converse, 1999) and this fact will not be overlooked.

With regard to natural sources, it should be noted that a large percentage of the *E. coli* was coming from birds. Wild animals (terrestrial and marine mammals) were also contributors of *E. coli* coming into the Bay, to a lesser degree, as they contributed significantly less than all other sources.

Source Locations

The potential sources/areas of birds and wild animals are throughout the watershed and cannot readily be pinpointed to a single location.

5. Total Maximum Daily Load and Allocations

A TMDL is the loading capacity of a pollutant that a water body can accept while protecting beneficial uses (USEPA 1991). Normally, TMDLs are expressed as loads (pollutant concentration multiplied by the volumetric flow rate), but in the case of pathogens, it is more logical for the TMDL to be based only on concentration. TMDLs can be expressed in terms of either mass per time, toxicity or other appropriate measure [40 CFR §130.2(I)]. A concentration based TMDL makes more sense in this situation because the public health risks associated with recreating in, or eating shellfish from, contaminated waters scales with organism concentration, and pathogens are not readily controlled on a mass basis. Therefore, as other regional boards have done (RWQCB-R7, 2001), we are establishing a concentration-based TMDL for pathogens in Morro Bay.

As can be seen in Tables 6 and 7, the TMDL is the same set of concentrations as what was proposed in the numeric targets section.

Table 6: TMDL for Morro Bay

Fecal Coliform	
Geometric Mean	**Maximum**
14 MPN/100 mL[a]	43 MPN/100 mL[b]

a: Based on the geometric mean of monthly sampling evaluated annually and triennially
b: No more than 10% of total samples may exceed this number when evaluated annually and triennially

Table 7: TMDL for the tributaries, Chorro and Los Osos Creeks

Fecal Coliform	
Geometric Mean	**Maximum**
200 MPN/100 mL[a]	400 MPN/100 mL[b]

a: Geometric mean of not less than five samples over a period of 30 days
b: Not more than 10% of total samples during a period of 30 days exceed

5.1. Proposed Load Allocations

The TMDL will be applicable to all non-natural sources, depending on where the discharge is occurring (i.e. creek or Bay). These sources shall not discharge or release a "load" of bacteria that will increase the assimilative capacity of the water body above these load allocation. All areas of the creek will be held to these load allocations. Once the Los Osos sewer is in place, levels in the seeps and throughout the connection system shall not exceed these load allocations. The Bay itself will be held to these load allocations. Should all control measures be in place and fecal coliform levels remain high, investigation will take place to determine if the high level of fecal coliform is due to natural sources.

5.1.1. Creeks, Groundwater

In 1988, the Regional Board determined that Chorro Creek was the greatest single point source of bacterial contamination. Chorro Creek differs from Los Osos Creek in that it receives effluent discharge from the CMC wastewater treatment plant and has more acreage devoted to rangeland and cattle operations. Flows from Chorro Creek are also higher than flows from Los Osos Creek year round (Waddell, 2002).

The National Monitoring Program data (1998) indicate that both major creeks contribute bacteria to the Bay. According to Tetra Tech (1999), of the total bacteria loading into Morro Bay during a wet weather model simulation period, 48 percent came from Chorro Creek, 9 percent from Los Osos Creek, 42 percent from surface runoff, and less than one percent from groundwater[6], as illustrated in Figure 8.

The model was developed with a limited data set, so the value of the model simulations lie in the relative change in bacteria concentrations, rather than absolute percentages. Seasonal variations exist in the percent loading to Morro Bay. During dry weather periods, Chorro Creek contributes approximately 63 percent of the fecal coliform, with groundwater contributing 37 percent. In wet weather, Chorro Creek was predicted to contribute 48 percent and groundwater only 1 percent. Stormwater runoff was predicted to contribute 42 percent. Los Osos Creek was found to

[6] It should be noted that when "groundwater" is mentioned, this is inclusive of the surfacing groundwater, or seeps that enter the Bay along the shoreline. Failing/leaking/overloaded septic system effluent has been present in seeps (groundwater) during dry and wet weather and stormwater runoff during periods of wet weather.

contribute smaller amounts, with 2 percent and 9 percent in the dry weather and wet weather seasons respectively.

This type of modeling was somewhat consistent with the Cal Poly study (2002), which showed Los Osos Creek contributed more fecal coliform during the wet season and Chorro Creek contributed more during the dry season but when averaged over an entire year, the contributions were about equal. The Cal Poly study also predicted that the seeps seemed to add about one-hundredth the contribution of fecal coliform that the creeks add.

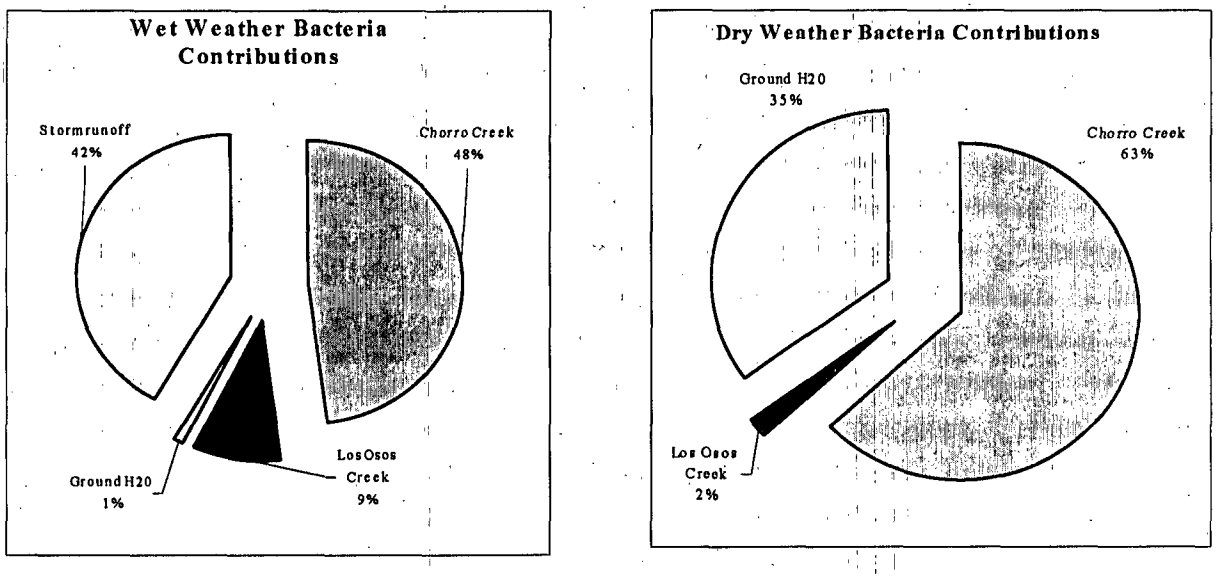

Figure 8: Relative Contribution of Fecal Coliform in Wet and Dry weather conditions.
Source: Tetra Tech Bacteria Loading Model, 1999

Due to the sporadic nature of rain, obtaining accurate flow measures through time can be difficult. Subsequently the contributions/loadings represented in Figure 8 are only estimates. It is challenging to make absolute numeric statements about a "model." Although absolute statements cannot be made, it is clear that all these water inputs are a source of bacteria to the Bay and must be addressed. In other words, it is not necessarily the size of the piece of the pie, rather that each of these areas has a piece of the pie that is important.

5.2. Margin of Safety

A margin of safety has been established implicitly through the use of protective numeric targets.

6. Linkage Analysis

The linkage analysis involves establishing the connection between the TMDL and pollutant load allocations and the protection of beneficial uses. This connection is established because the numeric targets are the TMDL. The numeric targets are protective of all the beneficial uses.

7. Public Participation

Public Participation for this TMDL has been through the Shellfish Committee. The Shellfish Committee has been very active in providing input for this TMDL. Shellfish Committee meetings have been public and notice of meetings has been provided in the newspaper as well as sent out to an interested parties list. Local stakeholders and regulatory agencies have been active participants in the Shellfish Committee. Additionally, the Regional Board has coordinated TMDL outreach through the MBNEP committees. Furthermore, the board hearing process for this TMDL provides additional opportunities for public participation. The period of record for the development of TMDL has been 1999-2002 and the years of water quality data collection 1989-2001.

8. Implementation Plan

8.1. Introduction

The overall intent of this Implementation Plan is to attain the numeric targets. This Implementation Plan describes existing regulatory controls and cites relevant sections of the California Water Code (CWC) establishing the Regional Board's authority to enforce the provisions set forth in the Implementation Plan. The Plan also describes the way in which the Regional Board will implement the TMDL in coordination with the MBNEP, DHS, the County of San Luis Obispo, the City of Morro Bay, the City of Morro Bay's Harbor Department and the Community of Los Osos and other entities to be mentioned.

The bacterial load to Morro Bay derives from nonpoint sources and point sources. As such, this Implementation Plan will initially rely on Tier-1 (self-determined) of the Three-Tier Framework for nonpoint source pollution control (CWC §13369), while incorporating concepts set forth in the Nonpoint Source Pollution Control Plan. The concept of "self-determined implementation" of Nonpoint Source control measures was developed to acknowledge the potential capability of landowners and resource manager to develop and implement workable solutions to Nonpoint source pollution control and to afford them the opportunity to solve their own problems before more stringent regulatory actions are taken.

For the point sources, the Implementation Plan relies on the implementation and enforcement of existing and future permits, existing and future Waste Discharge Requirements, and future waivers and/or Memorandums of Understanding, as discussed in detail in the following sections.

Section 13242 of the CWC requires that a plan of implementation be incorporated into the Basin Plan when the Regional Board adopts TMDLs. The Implementation Plan must include: 1) a description of the nature of the actions necessary to achieve the 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 monitoring and surveillance to be undertaken to determine compliance with the objectives. Pursuant to CWC §13141 and §13241, this Implementation Plan identifies available means for complying with the TMDL, evaluates the economic impacts of implementation of the TMDL, and identifies potential sources of funding for implementation actions identified herein.

The Basin Plan amendment process has been certified by the Secretary for Resources as "functionally equivalent to," and therefore exempt from, the California Environmental Quality Act (CEQA) requirement for preparation of an environmental impact report or negative declaration and initial study (CCR Title 14, §15251(g)). However, a CEQA-required

Environmental Checklist must be completed and is included in the Basin Plan Amendment package that will be considered for adoption by the Regional Board.

8.1.1. Watershed-Wide Implementation

The listing of Morro Bay and two principal tributaries prompted a watershed-scale analysis of excessive bacterial loading in this TMDL. Similarly, the Implementation Plan includes a broad selection of actions, which various entities have committed to implementing throughout the entire watershed. As the receiving water of all its tributaries, conditions in Morro Bay are a reflection of conditions in all tributaries, not just the two main tributaries, Chorro Creek and Los Osos Creek. Thus, load reductions are necessary in all major tributaries and from all non-natural sources that contribute to exceedances of the numeric targets. The TMDL, as a Basin Plan amendment, requires implementation throughout and in any appropriate waterbody in the Morro Bay Watershed. Compliance with this amendment will be determined by monitoring representative locations in certain tributaries and the Bay (see Monitoring Plan, section 9) and by tracking all implementation actions taken.

8.2. Implementation Actions to Reduce Bacteria

The Regional Board will implement the TMDL in coordination with the MBNEP (and other parties to be listed in Table 8a). The Comprehensive Conservation and Management Plan (CCMP) developed by a consortium of stakeholders, calls for the development and implementation of TMDLs in the Morro Bay watershed and identifies many water quality control and management actions to reduce bacterial loads.

Trackable Implementation Actions in this TMDL include both voluntary actions and those already required under existing or anticipated regulatory requirements. Voluntary actions will be taken by a variety of implementing parties (Section 8.2.1, Table 8a), while the required actions are to be taken by identified responsible parties (Section 8.2.2, Table 8b).

8.2.1. Trackable Implementation Actions to be Implemented per Tier-1 of the Nonpoint Source Three-Tiered Approach

Table 8a: Trackable Implementation Actions (Tier-1)

PROJECT NAME	ACTION	SCHEDULE	IMPLEMENTING PARTIES
Grazing Management (BACT-1)*	Implement grazing management measures that reduce bacterial levels	Ongoing - 2012	MBNEP, CSLRCD, Farm Bureau, UCCE, NRCS, Public/Private Landowners
Boat Management, Pump-outs (BACT-2)*	Upgrade pump-out facilities, provide new facilities, improve accessibility	2002-2005	MBHD
Remove unpermitted moorings (BACT-3)*	Remove illegal moorings, and/or implement regulations complete with permits and inspections	Ongoing - 2007	CDFG, MBNEP
Remove derelict boats (BACT-4)*	Remove abandoned, derelict boats and vessels in back bay	Ongoing - 2007	CDFG, MBNEP
Manage live aboard boating situation (BACT-5)*	Continue issuing permits to live aboards, continue with inspections	Ongoing - 2012	City of Morro Bay, USCG, CDFG, MBHD
Educate Public about proper boat waste disposal	Educate public about proper waste disposal	Ongoing - 2012	MBNEP, MBHD
Pet waste management (BACT-8)*	Create an off leash dog park, provide supplies to pick-up pet waste, ordinance	Ongoing -2012	MBNEP, City of Morro Bay, San Luis Obispo County
Septic System Maintenance	Inspect and maintain all septic systems throughout the watershed	2004 - continuous	San Luis Obispo County, LOCSD
Spay/neuter pets	Educate public to promote spaying and neutering pets	Ongoing -2012	Division of animal services
Reduce the number of feral dogs/cats	Reduce the number of feral dogs/cats	Ongoing - 2012	Division of animal services, feral cat caretakers

The above table was derived from suggestions made by the Shellfish Committee March 2002 meeting, per the Shellfish Protection Act of 1993 (California Water Code 14950-58). Through this legislation, the Shellfish Committee must recommend remedial actions to improve water quality in the impacted areas of the Bay. The Shellfish Committee agreed upon a list of remedial actions based on percent contribution to the Bay as determined in the DNA study. These actions reaffirm efforts identified previously by the Shellfish Committee in the MBNEP's CCMP. The Shellfish Committee reviewed the CCMP to identify the related actions. This list of actions will assist implementers in applying for funding from various sources.

Grazing Management Measures

Morro Bay Watershed Enhancement Program
In 1987, the Coastal San Luis Resources Conservation District obtained funding through the California State Coastal Conservancy to develop the Morro Bay Watershed Enhancement Plan.

* These abbreviations and numbers correspond to actions in the MBNEP's Comprehensive Conservation and Management Plan (CCMP). The Shellfish Committee reviewed the CCMP to draw upon efforts previously identified.

The U.S. Department of Agriculture and the U.S. Environmental Protection Agency (USEPA) have also contributed funding for the enhancement of the Morro Bay Watershed for education and technical assistance programs in the watershed region. To date, over 245 conservation practices have been installed in the watershed through technical and financial assistance provided through the MBNEP.

The Coastal San Luis Resources Conservation District staff expects that in each year of implementation, the number and type of actions implemented would be similar to a typical year of the Morro Bay Watershed Enhancement Plan. A typical year of the Morro Bay Watershed Enhancement Plan resulted in the following actions:

Product/Practice	**Extent**
Ranch Conservation Plan	5 plans
Farm Conservation Plan	2 plans
Planned Grazing System	700 acres
Proper Grazing Use	700 acres
Deferred Grazing	450 acres
Grassed Waterway	1,500 feet
Critical Area Planting	4 acres
Lined waterway	150 feet
Filter Strip	1,500 feet
Vegetative Buffer Strip	1,200 feet
Stream Corridor Improvement	5,000 feet
Fish stream Improvement	500 feet
Livestock Exclusion	90 acres

The basis for this program is erosion and sediment control; however, these actions (management practices) will also result in some level of reduction in bacterial loading.

Farm Bureau Watershed Program
Since 1996, the San Luis County Farm Bureau has been working to develop watershed programs. The general purpose of the program is to develop and implement confidential voluntary, cost-effective, landowner/manager-directed programs for the identification and control of agricultural and ranching sources of pollution. A multi-county program is being developed to provide reasonable assurances that ranching sources of pollution will satisfy load allocations.

Morro Bay is a priority watershed for the Farm Bureau (Fitzhugh, 2000). Rangeland management is being offered to those interested in implementing water quality protection practices. The short course is designed to teach basic concepts of watersheds, nonpoint source pollution (NPS), self-assessment techniques, and monitoring. Attendance at these short courses presented to date has been high among the ranchers and growers, and has included a strong cross section of landowners in both the Chorro and Los Osos Sub watersheds. The Farm Bureau has stated that it will document watershed wide implementation and success of BMPs through a coordinated effort, with reporting on the health of the program in a watershed wide (as opposed to individual) monitoring program. The landowners or their designee will monitor, but the individual results are to be kept confidential to the individual, with only the general results and area program being reported outside the working group. This approach is acceptable, given that the activities are voluntary.

Regional Board Staff provide presentations at the University of California Cooperative Extension (UCCE) short courses to inform participants of the goals of the State's Nonpoint Source Plan and

the Three-Tier Framework for its implementation. The TMDL development and implementation process is also described by Board Staff for participants.

Water Quality Management Plan - Cal Poly
Three ranches owned and operated by Cal Poly are located in the Chorro Creek Watershed. The ranches are managed for grazing and cultivated for dry-land crops. They are a potential source of bacteria.

Ranch Water Quality Management Plans have been developed for these ranches and are now integrated into a Water Quality Management Plan for Cal Poly Land in San Luis Obispo Creek and Chorro Creek Watersheds. The plan identifies best management practices on the ranches to prevent bacterial loading. Implementation of these practices should result in reduced concentrations of fecal coliform in the creeks.

Boat Management

There are three separate entities that have responsibility for boating areas in Morro Bay: the City of Morro Bay Harbor Department, CDFG and California State Parks (State Parks).

The City of Morro Bay Harbor Department has jurisdiction over areas of the Bay which are within the City limit (and is now leasing the State Parks Marina). The Harbor Department has been instrumental in maintaining and upgrading pump-out stations as well as trying to improve the accessibility to the pump-out stations. The Harbor Department also has a program to "manage" the live aboard boating situation. A permit is required for those boats that plan on using their vessel as a primary residence for more than 60 days out of the year. When obtaining a permit, the Harbor Department inspects the vessel to insure that there is a Marine Sanitation Device, holding tank or portable toilet on board and makes sure the vessel is able to move. The Department has also helped out other entities with removing illegal moorings and derelict boats outside of their jurisdiction (and also when abandoned boats float into their area). Public education and outreach, through flyers and outreach, are also part of their program to educate the public on proper boat waste disposal. Managing the boating population and the associated actions are an ongoing effort within the Harbor Department.

CDFG's jurisdiction is for all <u>other</u> areas of Morro Bay that are outside the limits of the City of Morro Bay and outside the State Parks Marina and estuary area. CDFG has been working with the MBNEP to remove derelict boats and unpermitted moorings. In 1996, a sweep of the Bay removed about two-thirds of the identified derelict boats in the Bay. Future efforts propose to remove all remaining derelict boats and moorings, or equivalent measures, in conjunction with the MBNEP.

State Parks owns the marina and estuary area of the Bay but they are leasing the Marina to the Morro Bay Harbor Department. State Parks has stated they will participate in yearly meetings to coordinate implementation of this TMDL.

The MBNEP has done public outreach to the boating community and has been involved with many efforts of the above-mentioned agencies.

Regional Board staff will pursue clarification of boating contribution to the load and additional management measures may be encouraged or required, if necessary.

Future Septic Systems Maintenance Plan

The Regional Board is requiring counties to come up with a plan for the maintenance and inspection of septic systems. Typically, the Regional Board develops a memorandum of understanding with the appropriate County Department or Agency once the County has submitted an acceptable plan. By June 1, 2004, all memorandums of understanding are invalid.

AB 885 requires the State Water Resources Control Board, on or before January 1, 2004 (in consultation with many entities) to adopt specified regulations or standards for the permitting and operation of prescribed onsite sewage treatment systems that meet certain requirements. In the interim, Regional Board staff will work with County staff to develop and implement appropriate components of a septic system maintenance plan. After the State Board proposes septic system guidelines, the Regional Board will assure the county's plan is consistent with State Board guidelines and will likely ensure implementation of the plan by adopting a memorandum of understanding.

Pet Waste

Division of Animal Services is a division of the Sheriff's Department in San Luis Obispo County which aids in controlling the feral cat, stray dog and less often feral dog populations (Anderson, pers. comm., 2002). This service does not actively pursue the capture of feral cats, however will rent traps to the public and will pick up these traps if a capture is made. Feral and domestic cats are usually held for five days. Stray cats are placed up for adoption if unclaimed at the end of five days. Feral cats are eligible for adoption for a suitable home or a rescue agency. If no such placement can be identified, the animals are euthanized. There are several groups referred to as "feral cat caretakers" which participate in a program called trap/alter/release. These groups take feral cats, neuter/spay them and either release them from where they were captured, or they transplant them to a different location. These groups are caring for existing feral cats but their efforts are helping to reduce the general feral cat population (Rakestraw, pers. comm., 2002). The Division of Animal Services also participates in public education regarding the spaying/neutering of pets.

The City of Morro Bay has a pet waste ordinance that states, "no person owning, keeping or having in his or her care or control any dog shall knowingly fail, refuse or neglect to clean up any feces of the dog immediately and dispose of it in a sanitary manner whenever the dog has defecated upon any public property or the private property of another," (City of Morro Bay Municipal Code Section 7.08.025). Because the City has an ordinance, holding pet owners responsible for their pet waste is enforceable through the City's ordinance.

Controlling pet waste is not in the jurisdiction of the Community of Los Osos. This is because they are not a city but rather a California special district (Section 66,000 - CA Community Services District Laws). Therefore, any enforcement of pet waste must be through the County of San Luis Obispo.

The County of San Luis Obispo does not currently have a pet waste ordinance. Regional Board staff will pursue clarification of pet waste contribution to the load. Staff will work with the County of San Luis Obispo to develop a voluntary means of managing contributing pet waste in the County's jurisdiction as appropriate.

8.2.2. Trackable Implementation Actions Required of Responsible Dischargers Under Existing Regulatory Programs

In addition to the cooperative and voluntary implementation actions mentioned above, several implementation actions will be performed by responsible dischargers that currently possess, or are anticipated to be, under regulatory requirements (via other mechanisms, not as part of this TMDL's Implementation Plan). These include the County of San Luis Obispo, City of Morro Bay and Los Osos Community Services District. These entities are subject to requirements of stormwater NPDES permits. CMC and the City of Morro Bay/Cayucos wastewater treatment plants are subject to NPDES permits as well. Monarch Grove and the future Los Osos Community Services District (LOCSD) wastewater treatment plants along with Cal Poly have or will have Waste Discharge Requirements (WDRs). Table 8b identifies the specific actions required of these responsible dischargers. This TMDL does not impose any obligations upon the responsible dischargers to take these actions; rather, it merely describes their obligations under existing regulatory mechanisms. The TMDL will serve as a mechanism to "track" the progress of these actions, as they are already required for reasons other than the adoption of this TMDL.

Table 8b: Trackable Implementation Actions (under existing regulatory programs)

PROJECT NAME	ACTION	SCHEDULE	RESPONSIBLE DISCHARGERS
Phase II stormwater permit (CC-4)*	Incorporate actions to reduce bacteria loading into Morro Bay by implementing a stormwater management plan for the City of Morro Bay and the Community of Los Osos	March 2003 - 2008	City of Morro Bay LOCSD, San Luis Obispo County
Los Osos Community Waste Water Treatment Plant (NUTR-1)*	Construct and maintain a wastewater treatment plant	Ongoing - 2007	LOCSD

Stormwater Management

The Phase II municipal stormwater general NPDES permit, to be adopted by the State Water Resources Control Board, will identify Morro Bay and the community of Los Osos as dischargers of stormwater and require that they address bacteria as part of the "pollution prevention good housekeeping" minimum requirement in the federal regulations. They are to have a Stormwater Management Plan in place by March 8, 2003 and show progress toward implementation in subsequent years, until year five (2008) when full implementation is required.

The *Future* Los Osos Wastewater Treatment Plant – Waste Discharge Requirements

A Wastewater treatment plant in the community of Los Osos is scheduled to be completed within five years after construction begins. Construction is expected to begin in 2003. The LOCSD is ready to begin construction of the plant, however, at the time of this report, legal appeals have suspended progress. The LOCSD has continued to make progress with this project and once the appeal has been resolved, will initiate construction. The WDR for this treatment plant is tentatively scheduled to go before the Regional Board in December 2002. These WDRs will

* These abbreviations and numbers also correspond to actions in the MBNEP's Comprehensive Conservation and Management Plan (CCMP). The Shellfish Committee reviewed the CCMP to draw upon efforts previously identified.

necessarily implement all relevant water quality objectives, including fecal coliform, as required by Water Code 13263.

The LOCSD will also have a septic system maintenance plan for those houses that do not fall within the area to be sewered.

8.3. Existing Actions That Prevent Bacterial Loading

8.3.1. CMC Wastewater Treatment Plant

The CMC is currently meeting regulations set forth to control the quality of its discharge (in this case, total coliform concentration sampled 5 days/week). The effluent coming out of the wastewater treatment plant is well within the numeric targets and is not making a significant contribution to the concentration of bacteria in the creek. Any spills or releases are addressed under the permit (NPDES permit no. CA0047856).

8.3.2. Monarch Grove

Monarch Grove is a small wastewater treatment plant that serves a small housing development in Los Osos. It is a reclamation facility only. The plant does not discharge to waters of the state; rather the effluent is used to irrigate a golf course in the vicinity. Discharges to surface waters are prohibited by the Waste Discharge Requirements (WDID# 3 401057001, order number 93-081).

8.4. Regulatory Mechanism by Which TMDL Implementation is Assured

8.4.1. Three-Tier Framework for Nonpoint Source Pollution Control

The three-tier framework uses three different options of enforceable policies and mechanisms under the California Water Code to ensure implementation of the *"Plan for California's Nonpoint Source Pollution Control Program"* (NPS Program Plan). The options, or *tiers,* are presented in order of increasing stringency:

Tier One: Self-Determined Implementation of Management Practices
Tier Two: Regulatory-Based Encouragement of Management Practices
Tier Three: Effluent Limitations and Enforcement.

Through the Three-Tier Framework, the Regional Board acknowledges that many NPS problems are best addressed through the self-determined cooperation of stakeholders in improving their management practices (Tier 1). However, persistent NPS water quality problems not effectively resolved through self-determined action will be addressed through applicable regulatory programs and authorities (Tier 2 and Tier 3). Sequential movement through the tiers is not required of the Regional Board. Depending on the severity of the NPS problem, the Regional Board may move directly to the enforcement actions specified in Tier 3. Also, the Regional Board can choose to implement a combination of water quality control mechanisms from each of the Tiers as well as additional remedies (e.g., enforcement orders) as provided under the CWC.

The listing of Morro Bay as impaired by bacteria, is based on evidence of persistent nonpoint source water quality problems where full implementation of self-determined actions in the watershed have not been realized (e.g. grazing sources) or where Regional Board has already relied on regulatory action to require improvements (e.g. Los Osos Sewer). Additionally, Morro Bay is impaired due to point source pollution that is currently regulated in part with WDRs,

NPDES permits but will be regulated under additional mechanisms in the near future (Stormwater Phase II). This implementation plan relies upon Tier-1 for nonpoint sources and existing regulatory programs for point sources. As discussed in section 8.6 below, if this approach does not yield the desired results, a higher level of regulation may be necessary in the future.

Morro Bay is a unique watershed in that there is tremendous stakeholder involvement, many grants, a long history of commitment to water quality improvements and leadership from the County, city and Community Services District. It is for this reason that this TMDL is expecting to have success with using Tier-1 efforts.

8.4.2. Stormwater National Pollutant Discharge Elimination System Permits

The Storm Water Phase II Final Rule is the next step in USEPA's effort to preserve, protect, and improve waters polluted by storm water runoff. The Phase II program for municipal stormwater expands the Phase I program by requiring additional operators of Municipal Separate Storm Sewer Systems (MS4s) in urbanized areas, through the use of NPDES permits, to implement programs and practices to control polluted storm water runoff. General Permits issued by State Water Resources Control Board will cover these actions. General permit requirements include the submission of a Notice of Intent to comply with the permit and the submittal of Storm Water Management Plans.

Under the Storm Water General Municipal Permit, the community of Los Osos and the City of Morro Bay will be required to develop and submit Stormwater Management Plans to the Regional Board by March 10, 2003. Upon submittal of the Storm Water Management Plan and Notice of Intent the entities will be covered under the General Permit.

The Phase II Final Rule will require the community of Los Osos and the City of Morro Bay to develop, implement, and enforce a program to reduce pollutants in storm water runoff to their storm sewer system. The entities have the option of working cooperatively to submit a region-wide program, but are nonetheless required to implement the following measures:

- Public outreach and education
- Public involvement and participation
- Illicit discharge and elimination
- Good housekeeping/Pollution Prevention

The Regional Board will track progress of these entities through their compliance with Phase II municipal stormwater regulations.

8.4.3. Waste Discharge Requirements (WDRs)

The Regional Board, pursuant to CWC §13260, can adopt waste discharge requirements for any proposed or existing discharge of waste that threatens to cause or causes adverse effects to water quality, including nonpoint source discharges. Once issued, compliance and water quality protection are legal responsibilities of the WDR holder. Monarch Grove Wastewater Treatment Plant will continue to be managed via a WDR.

8.4.4. NPDES Permits for Wastewater Treatment Plants

NPDES permits dictate the level of coliform, among other pollutants, allowed in the effluent from treated discharges to surface waters. The permits regulate all discharge from the plant, collections systems (including lift stations), spills and releases. Any incidents (e.g. a failing sewer lift station) relating to the City of Morro Bay and CMC wastewater treatment plants will be dealt with under existing NPDES permits.

8.5. Schedule of Compliance

Regional Board staff estimate a timeframe of 10 years to achieve control of bacterial loading to the Bay and the creeks. The limiting factor on this timeframe is grazing management. Based upon the installation time of management practices, including fencing for example, 10 years were estimated as the minimum amount of time to ensure completion. All other actions (septic system maintenance, Los Osos sewer, storm water program, etc.) should be able to be in place with a 10-year time frame. Table 9 shows an implementation schedule.

Compliance is achieved initially by demonstrating through reporting mechanisms that implementation measures have been undertaken, and subsequently by showing that numeric targets are achieved through monitoring.

Table 9: Estimated Implementation Schedule for Morro Bay TMDL for Pathogens

At End of Implementation Year:	IMPLEMENTATION MILESTONE	MONITORING ACTIVITY	Chorro Creek TMDL	Los Osos Creek TMDL	Morro Bay TMDL
1	• RWQCB evaluates data collected over past year, evaluates progress on actions • Meet with VMP, MBNEP, LOCSD, City of MB, County of SLO, DHS, MBHD, State Parks, CDFG, Farm Bureau to discuss progress • LOCSD WWTP WDR issued • Submittal of stormwater management plan and permit coverage (City of MB, LOCSD)	Fecal coliform			
2	• RWQCB evaluates data collected; evaluates progress on actions				
3	• RWQCB evaluates data collected; evaluates progress on actions • Regional Board evaluates the monitoring of septic system maintenance in the watershed with the County of San Luis Obispo • RWQCB, MBNEP, VMP, LOCSD, City of MB, County of SLO, DHS, MBHD, State Parks, CDFG, Farm Bureau meet to determine TMDL progress.				
4	• RWQCB evaluates data collected; evaluates progress on actions				
5	• RWQCB evaluates data collected; evaluates progress on actions				
6	• RWQCB evaluates data collected; evaluates progress on actions • LOCSD sewer installed • RWQCB, MBNEP, VMP, LOCSD, City of MB, County of SLO, DHS, MBHD, State Parks, CDFG, Farm Bureau meet to determine TMDL progress				
7	• RWQCB evaluates data collected; evaluates progress on actions				
8	• RWQCB evaluates data collected and evaluates progress on actions				
9	• RWQCB evaluates data collected and evaluates progress on actions • RWQCB, MBNEP, VMP, LOCSD, City of MB, County of SLO, DHS, MBHD, State Parks, CDFG, Farm Bureau meet to determine TMDL progress		REC-1 standards achieved	REC-1 standards achieved	DHS Standards achieved
10	• RWQCB evaluates data collected and evaluates progress on actions				
	Load Reduction Achieved; Numeric Targets Achieved				

VMP – Volunteer Program

8.6. Demonstrating Progress

8.6.1. Measures of Success

The primary measure of success for implementation of this TMDL is attainment of the numeric targets. Other measures of success, including completion of trackable implementation actions, will be considered in evaluating implementation of the TMDL. Therefore two measures of success are proposed: 1) water quality monitoring indicating numeric target attainment, and 2) evidence of progress on trackable implementation actions.

Because it will be years before we are able to evaluate the effectiveness of implementation, in the initial phase of implementation the emphasis will be on demonstrating progress by tracking the completion of actions described in this Implementation Plan. Thus progress is achieved initially by demonstrating through reporting requirements that implementation measures have been undertaken, and subsequently by showing that numeric targets are achieved through monitoring. A complete description of compliance monitoring is presented in the next section, Monitoring Plan.

Regional Board, MBNEP staff, the City of Morro Bay, San Luis Obispo County, the LOCSD, DHS, California State Parks, CDFG, Farm Bureau along with other mentioned entities in Trackable Implementation Actions Tables, have agreed to meet on an on-going basis, at least annually, to discuss progress in implementation. In assessing the status of compliance, Regional Board staff will consider the degree to which the implementing or responsible party has implemented, or is implementing, bacterial control measures. Through scheduled reporting, implementing or responsible parties have agreed to provide the necessary information upon which staff will make the determination of compliance. Every three years, staff will consider possible changes to the actions and reporting requirements. Modifications may include proposing additional BMPs, or substitution of BMPs identified in this TMDL as Trackable Implementation Actions (Table 8a&b) or imposition of a regulatory approach through a future Basin Plan amendment should Tier-1, self-determined actions not be working.

The Implementation Actions identified in this Implementation Plan do not identify the specific management practices that will result in bacterial reduction. As such, the management practices developed through pursuit of the Implementation Actions are not intended to be independently enforceable by the Regional Board. Therefore, the Regional Board will rely on scheduled 3-year reviews to track Implementation Actions and the effectiveness of management practices to determine whether to continue with Tier-1, self-determined implementation. If progress toward bacterial reduction is not satisfactory, staff will develop a regulatory approach (rather than a Tier-1, self-determined approach) and present it to the Regional Board as a revised Basin Plan Amendment. Alternatively, if there are a limited number of significant sources that are not being addressed, the Board may consider exercising its authorities (e.g., inspections, monitoring, cleanup orders, or WDRs on a case-by-case basis).

8.6.2. Failure Scenarios

There are two "failure scenarios" in which implementation of the TMDL would be considered unsuccessful, and Regional Board action would be required. The first of these is a failure to achieve the numeric targets and corresponding load reductions while at the same time completing trackable implementation actions. Regional Board staff recognizes this outcome is a possibility, as there are continuous inputs of "natural sources." Under this failure scenario, the Regional Board's action would be to re-evaluate the management practices put into place, the numeric

targets, and implementation actions and to adjust them as necessary. Staff will consider information provided by responsible parties, including effectiveness monitoring data and percent completion. This scenario would not prompt enforcement action by the Regional Board and would be consistent with Tier-1, self-determined implementation of management practices.

There is nothing that should be done to keep the birds (or wild animals) out of Morro Bay (or portions of the creek). At this point, DHS' decision as to whether an oyster growing area is closed or open is based on fecal coliform concentration in the water. Even if all the fecal coliform in the Bay were from birds, the area would still be closed, based on the standard under this scenario. We do not know to what *extent* bacteria from birds could cause disease or infections of humans or other organisms at this point. As part of the reevaluation process of the TMDL, the Regional Board will have to address the question of what may happen if all controllable non-natural sources are controlled and there are still bacteria problems in the Bay.

The second failure scenario involves failure to meet numeric targets coupled with failure to achieve trackable implementation actions. Implementing parties may implement in-lieu practices that are expected to be of equivalent or greater effectiveness in reducing bacterial levels. However, should the implementing parties fail to implement such in-lieu practices, or fail to achieve trackable implementation actions, Regional Board staff will develop a regulatory approach (rather than Tier-1, self-determined approach) and present it to the Regional Board as a revised Basin Plan amendment.

Additional data, including effectiveness monitoring data and volunteer monitoring data will be collected in parallel with numeric targets data to better inform TMDL compliance evaluations and propose course corrections as necessary. This approach allows proceeding with BMP installation while additional monitoring data are collected to either strengthen the existing analysis or to provide a basis for reviewing and revising the TMDL. This "adaptive management" approach enables stakeholders to move forward with resource protection based on reasonably rigorous planning and assessment.

8.7. Cost

Porter-Cologne, Sections 13141 and Public Resources Code, Section 21159 (a)(3),(c), require that the Regional Board take "economic considerations," into account when establishing regulations for compliance with a TMDL. The Regional Board must analyze what methods are available to achieve compliance and the costs of those methods.

8.7.1. Cost of Trackable Implementation Actions

Costs associated with BMP implementation, operation, and maintenance will be incurred by implementing parties through the Morro Bay Siltation and Nutrient TMDLs. To the extent possible, these expenses will be offset with grants, loans, in-kind donations, and matching funds.

All the actions associated with this TMDL are already required by other Regulatory mechanisms or are existing efforts under a current voluntary effort. Therefore, this Implementation Plan does not generate new costs. The implementing agencies may decide that additional actions are warranted. Two examples of such self-imposed costs include the following:

- Improved boating management – Hiring another full-time staff person may be the only way for the Morro Bay Harbor Department to improve upon their current boating management. This would cost an estimated $80,000/year. In addition to the Harbor

Department, CDFG would most likely need additional resources as well. It is estimated that CDFG would also need an additional $80,000/year.

- Additional rangeland/agricultural BMPs – Because many of the BMPs will be covered under the nutrient and sediment TMDL, assigning all costs to voluntary actions under this TMDL would be inaccurate. Costs of keeping cattle out of the riparian areas throughout Morro Bay watershed can run upward of $10 million dollars. Assuming some of these costs will be the result of the two other TMDLs in the Morro Bay watershed for Nutrients and Dissolved Oxygen and for Siltation, staff will assume that additional "bacterial controls" will cost in the $2-3 million dollar range.

9. Monitoring Plan

9.1. Overview of the Plan

This Monitoring Plan identifies the frequency, location, protocols and implementing party for each water quality parameter being evaluated. Regional Board staff, DHS and the Volunteer Program, will perform water quality monitoring.

This Monitoring Plan was developed in coordination with the planning and implementation efforts of the MBNEP to develop a CCMP along with existing monitoring DHS performs. A monitoring program has been developed as part of the CCMP. A component of the MBNEP monitoring program is the Volunteer Program. Current funding that is part of a 319 grant extends to December 2003 and MBNEP intends to extend the program into the future. If/when the funding runs out for this program, the responsibility of sampling will be transferred to the Regional Board or other voluntary "partner" in water quality. While the goal of the MBNEP's monitoring program is to evaluate the effectiveness of implemented actions in the CCMP, some of the data and analyses planned by the MBNEP will provide information for the TMDL. Likewise, the data collected for the TMDL will be useful for the MBNEP in evaluating trends towards meeting bacterial reductions to Morro Bay.

The primary measures of success for implementation of this TMDL are attainment of the numeric targets, which are the waste load allocations. Other measures of success, including attainment of trackable implementation actions (e.g. BMPs), will also be considered in evaluating implementation of the TMDL. Therefore two types of monitoring are proposed: 1) water quality monitoring indicating numeric target attainment, and 2) monitoring of implementation of actions. Additionally, periodic evaluation (every three years following Basin Plan adoption) by the Regional Board of how individual targets indicate water quality improvements related to bacteria will be performed. The relationships between various targets will also be examined.

9.2. Monitoring Numeric Targets

Numeric targets were selected to represent attainment of the TMDL. Each of the bacteria numeric targets is discussed in the Numeric Targets section. Figures 9 and 10 illustrate monitoring sites that will be used to evaluate the numeric targets. Table 10 outlines the numeric target, along with the frequency, specific locations, protocols of sampling, and responsible party in order to verify that the TMDL is being achieved. As shown, the Regional Board, CCAMP, the Volunteer Program and the DHS are listed as the responsible sampling entity.

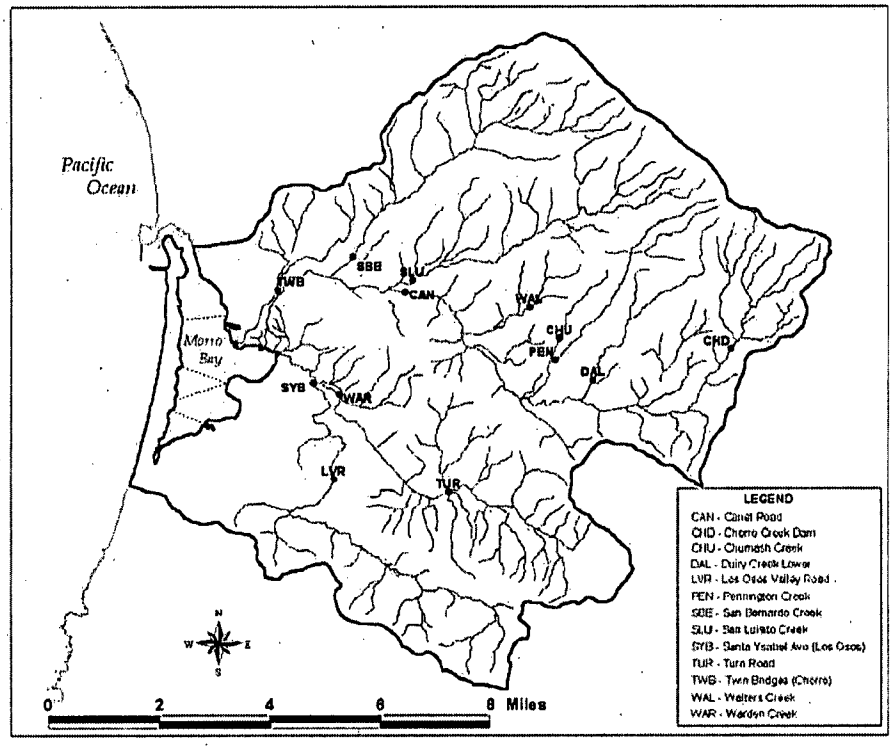

Figure 9: Monitoring sampling sites, Morro Bay watershed

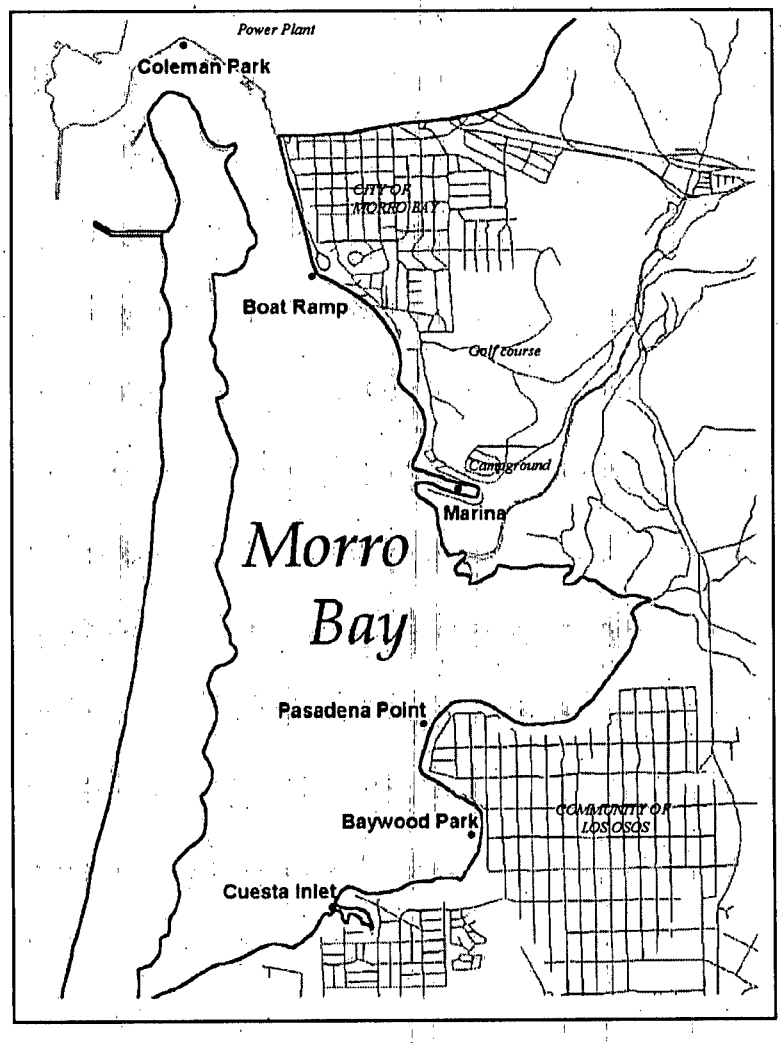

Figure 10: Monitoring sampling sites, Morro Bay

Table 10: Numeric target, sampling frequency, specific locations, protocols of sampling, and responsible party.

Constituent	Frequency	Desired Monitoring points	Protocol	Responsible Sampling entity
Fecal coliform	monthly	Chorro Creek (CAN*, TWB**), Los Osos Creek (TUR*)	EPA Methods as described in QAPP (1996) and CCAMP preserved for laboratory analysis	Regional Board (CCAMP)
E. coli (converting to fecal coliform)	monthly	Chorro Creek (CAN*, CHD, DAL, PEN, CHU, WAL, SLU, SBE) Los Osos Creek (TUR*, LVR, SYB, WAR) Bay sites (Cuesta Inlet, Baywood Park, Pasadena Point, Boat Ramp, Marina, Coleman Park)	IDEXX Colilert®-18	Volunteer Program†
Fecal coliform	monthly	Oyster growing stations	EPA methods	DHS/certified shellfish grower

*CAN and TUR will be taken by CCAMP until March 2003. At that time, the Volunteer Program will take over those sites.
**TWB will be taken by CCAMP indefinitely as part of the coastal confluence monitoring program
† The Volunteer Program will collect samples when they are able, however, volunteers may not always be able to collect samples and ultimately the responsibility of monitoring falls upon the Regional Board.

Sampling began (July 2002) and will continue during the duration of the TMDL implementation plan (10 years). As of October 2002, the six Bay sites are being collected and sites SYB, TUR, CAN, WAL, PEN and DAL. When more volunteers become available, the remaining sites will be sampled.

The Volunteer Program will monitor in stream *E. coli* concentrations using IDEXX Colilert®-18 including DAL, PEN, SLU, SBE, CAN, WAR, SYB, LVR, CHU, WAL and TUR (sites WAR and SYB should be measured on an outgoing tide as they are tidally influenced). The Volunteer Program will also be monitoring Bay water at sites Cuesta Inlet, Baywood Park, Pasadena Point, Boat Ramp, Marina, and Coleman Park. The Volunteer Program is using a test kit for *E. coli* because this is a quick and accurate way for volunteers to test *E. coli* concentrations. Converting *E. coli* concentrations into fecal coliform concentrations by multiplying the *E. coli* numbers by 1.2 (normally 80% up to 97% of fecal coliform are *E. coli*) is common practice. In order to provide quality assurance of all sites sampled (and also to provide a Morro Bay specific correlation factor between fecal coliform and *E. coli*), the Volunteer Program will also collect duplicate samples (10% of samples checked) to be analyzed for fecal coliform by the San Luis Obispo County Health Lab. If after one year of duplicate sampling, Regional Board staff considered the duplicates to be too different (i.e., more than 25% outside the 95% confidence interval), then the Regional Board will consider routinely sending all samples to the laboratory for analysis. If the Regional Board considers the duplicates to be within the desired margin of error, duplicates will continue to be taken by the Volunteer Program.

The CCAMP will be collecting at site TWB for fecal coliform indefinitely because it is part of the coastal confluence program. They will also collect samples from TUR and CAN until March 2003 as part of the regional cycle of sampling this year.

DHS will continue monitoring of the shellfish growing areas on a monthly basis (the second Tuesday of every month) for fecal coliform. Every year, DHS releases a Sanitary Survey report which is an evaluation of the growing areas. That report will be received and reviewed by the Regional Board each year to monitor the water quality in and around the oyster lease areas. The Regional Board will treat these sites as compliance points.

9.3. Monitoring Implementation Actions

The Regional Board will consider, in addition to water quality monitoring results, the degree to which the responsible party or cooperating stakeholder has implemented, or is implementing, bacterial control measures equivalent or identical to those identified in Tables 8a&b. Through scheduled reporting, responsible parties will provide the necessary information upon which staff will make the determination of compliance.

The Regional Board will track implementation with the voluntary assistance of the MBNEP, CMC, City of Morro Bay, Community of Los Osos, County of San Luis Obispo and DHS. Various entities, such as the County Farm Bureau and the Coastal San Luis Resource Conservation District, will assist by monitoring the number of BMPs implemented and by estimating the effectiveness of the BMPs. For example, the County Farm Bureau has stated that it will be responsible for coordinating with local landowners in establishing a self-monitoring program throughout the watershed. The Farm Bureau will report monitoring results on a sub watershed basis to maintain confidentiality of landowners. This coordinated effort will provide protocols to the participants to keep monitoring consistent and provide accurate data that will allow for the evaluation of implementation projects. The CSLRCD will also monitor implementation projects and BMPs through site inspections and will submit findings in an annual report to the MBNEP to assist in tracking.

Regional Board and MBNEP staff will review progress of implementation activities annually and will assess compliance every three years. This will be done by reviewing the CMC progress

reports, data from DHS and Volunteer Program's annual reports, which include the data and results collected for the program, reviewing the MBNEP's biennial review, and by discussing progress made with the City of Morro Bay, the Community of Los Osos and San Luis Obispo County. The biennial review is a comprehensive report whose scope includes monitoring, implemented projects, and BMP effectiveness. The biennial review will also include, but is not limited to, actions in the CCMP and any other actions in the watershed that contribute to increased health of the Bay and water quality.

9.4. Data Management

Regional Board staff and the MBNEP (including Volunteer Program) will provide data in a format compatible with the Central Coast Ambient Monitoring Program (CCAMP). CCAMP includes data from projects within the Regional Board's jurisdiction (northern Ventura to southern San Mateo counties). The availability of this data provides opportunities for valuable data comparisons between the Morro Bay Watershed and other similar areas. This database and selected analytic tools will be available on the Internet as well as linked to the Regional Board website. Regional Board staff will evaluate data to determine when appropriate bacterial levels are attained.

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