

San Vicente Creek & Fitzgerald Marine Reserve Fecal Indicator Bacteria TMDL

Project Definition



**REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION**

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1. Background Information

1.1 Introduction

This Project Definition represents the first step in the process of developing a Fecal Indicator Bacteria (FIB) Total Maximum Daily Load (TMDL) for the Pacific Ocean at the Fitzgerald Marine Reserve and San Vicente Creek. This report outlines pertinent background information and presents an initial analysis of the potential sources of FIB in the catchments draining to these water bodies. In addition, the applicable bacteria objectives are stated and potential management measures are proposed. This report represents the initial TMDL project “snapshot”; all of these topics will be further analyzed and developed through subsequent steps of TMDL development.

1.2 Project Scope

This TMDL project addresses FIB impairments in two Clean Water Act (CWA) section 303(d)-listed water bodies: the Pacific Ocean at the Fitzgerald Marine Reserve (Reserve) and San Vicente Creek (Creek), which drains into the Reserve. A description of these water bodies is provided below.

1.3 Fitzgerald Marine Reserve

The James V. Fitzgerald Marine Reserve is a 402-acre natural resource area on the north coast of San Mateo County. The Reserve was created in 1969 to protect the mosaic of habitats and tremendous diversity of marine life that exists in the area. The Reserve is under joint custodianship of the County of San Mateo Parks and Recreation Division and the California Department of Fish and Wildlife. Its regional location is shown in Figure 1. Adjacent to the southern boundary of the town of Moss Beach, the Reserve is approximately 7 miles north of Half Moon Bay and 15 miles south of San Francisco via Highway 1. It extends 3 miles south from Point Montara to the southern end of Pillar Point and 1,000 feet west into the ocean from the mean high tide line. The Reserve includes 370 acres of intertidal and subtidal marine habitat below the high tide line and 32 acres of upland coastal bluffs with elevations up to 100 feet. The intertidal zone, which contains rocky reefs at sea level and pocket beaches, is one of the most biodiverse intertidal regions in the state, renowned for its richness and diversity. Accessible at low tide, the reefs receive high levels of recreational use because of their close proximity to the San Francisco Bay Area’s dense population centers. The reefs within the Reserve form ten distinct areas, but are generally referred to as Moss Beach Reef to the north and Frenchman’s Reef to the south. The mission of the Reserve is to preserve, protect and interpret the resources within the Reserve for the people of the State of California (SMCDP 2002).

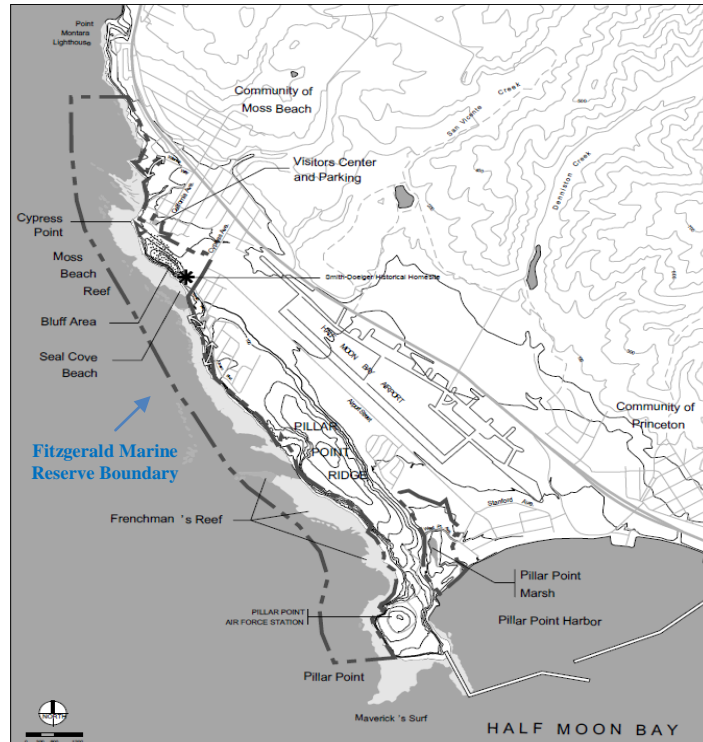


Figure 1. Fitzgerald Marine Reserve, Coastal San Mateo County
Source: SMCDP, 2002

The Reserve is both a “federally-designated Marine Life Sanctuary” and an “Area of Special Biological Significance” (ASBS), designated by the State Water Resources Control Board (State Water Board). The concept of “special biological significance” recognizes that certain biological communities, because of their value or fragility, deserve very special protection, consisting of preservation and maintenance of natural water quality conditions to the extent practicable. In addition, in 2009, California Department of Fish and Wildlife designated the Reserve as a Marine Life Protected area, which gives the Reserve the highest level of protection by prohibiting taking of any marine life.

Visitor use at the Reserve tends to be concentrated during periods of low tide on weekends, when more than 2,000 visitors per day may visit the reefs. In 1993, the peak year for visitation recorded by the Reserve staff, more than 135,000 visitors came to the Reserve (SMCDP 2002).

1.4 San Vicente Creek

San Vicente Creek is one of the three streams that flow to the Fitzgerald Marine Reserve (Figure 2). Its catchment is 1,170 acres, or approximately 1.8 square miles (CCC 2008). The length of all forks of the Creek is 5.4 miles. It originates from two main perennial forks on Montara Mountain at about 1,700 feet elevation. The two forks form steep ravines and converge at 400 feet elevation, where they are joined by a tributary at about 1,600 feet downstream continuing down to the ocean.

Land in the catchment is primarily owned privately or by the Golden Gate National Recreation Area (GGNRA). It largely consists of open space on the steep hillsides, with floriculture, pasture, and stables on the alluvial-valley bottom. The lower catchment is urbanized in the vicinity of the Reserve. San Vicente Creek is culverted under Etheldore

Road, Highway 1, Marine Boulevard, and Cypress Avenue before discharging into the Reserve via a culvert at Seal Cove.

The identified nonpoint sources of bacteria pollution that may be affecting San Vicente Creek water quality are: horse manure, pet waste, human waste (e.g., from faulty septic systems and leaky sanitary sewer lines), and wildlife waste (SFEI 2013). In addition to these nonpoint sources, stormwater runoff and dry weather flows are potential point sources of pollution that can carry bacteria to the Creek from the nonpoint sources listed above. Quantitative information regarding the magnitude of bacterial loading from these sources is not available.

There are two commercial equestrian facilities (i.e., horse boarding facilities) in the catchment, located upstream of Etheldore Road. Bacteria loading from these is likely to be occurring due to their location and waste storage in close proximity to the Creek.

Within the catchment, unlined roadside ditches convey urban runoff containing bacteria from a variety of sources directly into the Creek.

1.5 Dean Creek

Dean Creek is another stream that drains to the Reserve. It is located to the northeast of the Reserve parallel to Sunshine Valley Road and flows between the intersection of California Avenue and Cove Street to a beach, and then into Kelp Cove, just north of the main entrance to the Reserve. The Dean Creek catchment is approximately 360 acres (CCC 2008).

1.6 Montara Creek

Montara Creek also drains into the Reserve. Its catchment is approximately 1,085 acres. The Creek is fed by several springs at its headwaters with a flow of about 70 GPM. Montara Creek has discontinuous summer flows through a swale or very shallow alluvial channel for about 1,000 feet on the valley bottom. The valley bottom of Montara Creek is farmed, except for a spring fed 1.5 acre wetland and riparian corridor along the Creek. Downstream from the wetland, the Creek channel becomes increasingly evident. From this point downstream, the Creek flows continuously during summers and winter dry spells, likely gaining flow from alluvial seepage as it descends to where the north fork joins the south fork of Montara Creek. Downstream of this confluence, the channel is well defined. In the past, about 2800 feet downstream of the confluence, a florist operated an on-line permanent dam and small reservoir (agricultural pond); however, they are no longer believed to be in business (CCC 2008).



Figure 2. Fitzgerald Marine Reserve ASBS Catchment and Streams
Source: SFEI, 2013

1.7 Climate

The Reserve area has a maritime Mediterranean climate with distinct wet and dry seasons. Most of the area's precipitation is recorded during the months of November through April. Virtually all precipitation occurs as rain, although fog accounts for a small percentage. Precipitation in the Reserve catchment ranges from approximately 18 inches per year in the lowest elevations to 38 inches per year in the headwaters of San Vicente Creek (SMCDP 2002).

1.8 Land Use

Table 1 lists the land uses in the Montara, Dean, and San Vicente Creek subcatchments, which drain to the Reserve (CCC 2008).

Table 1. Land Uses in Catchments Draining To the Reserve

Land Use	Creeks and Catchments		
	Montara Creek	Dean Creek	San Vicente Creek
Agriculture	X	X	X
Confined Animal Facilities	X	X	X
Equestrian Facilities	X	X	X
Equestrian Uses	X	X	X
Row Crop/Flower Farms	X		X
Airport, Light Industrial			X
Estuarine Habitat	X	X	X
Institutional	X		X
Municipal Water Sources, Reservoir	X		X
Neighborhood Commercial		X	
Open Space	X		X
Public recreation-Marine Reserve, Parks, Beach	X	X	X
Residential-Medium Density	X	X	X
Residential-Medium High Density	X		X
Residential-Very Low Density	X		X
Riparian Corridor	X	X	X
Rural Dirt Roads	X	X	X
Septic Systems	X	X	X
State Highway	X	X	X
Trails	X	X	X
Wetlands	X	X	X
Wildlife Refuge, Reserve		X	X

2. 303(d) Listing Information

The Reserve was listed for impairment of the water contact recreation beneficial use due to high levels of fecal coliform, total coliform, and enterococcus indicator bacteria during the 2002 303(d) listing cycle. San Vicente Creek was listed for impairment of water contact recreation beneficial use due to high levels of coliform bacteria, also during the 2002 303(d) listing cycle (State Water Board 2014). These listings are summarized in Table 2.

Table 2. 303(d) Listing Information for Fitzgerald Marine Reserve and San Vicente Creek

Water Body	Listing Cycle	Pollutant / Water Quality Objective (WQO) Type	Number of Samples	% of Samples Exceeding WQOs	Monitoring Date Range
San Vicente Creek	2002	Total Coliform/ (Median) ^a	25	100%	Oct. 1998- Sep. 2000
		Total Coliform/ (Single Sample Maximum) ^b	38	3%	
		Fecal Coliform/ (Geometric Mean) ^c	22	100%	
		Fecal Coliform/ (Single Sample Maximum)	22	100%	
		E. Coli/ (Single Sample Maximum)	6	100%	Jun. 2000- Sep. 2000
Fitzgerald Marine Reserve	2002	Total Coliform/ (Single Sample Maximum)	49	43%	May. 1998- Oct. 2000
		Fecal Coliform/ (Geometric Mean)	49	16%	
		Fecal Coliform/ (Single Sample Maximum)	37	73%	

- a. The median is usually calculated based on the five most recent samples from each site during a 30-day period.
- b. The “single sample maximum” means that no sample can exceed the corresponding water quality objective value.
- c. The geometric mean is a type of average, which indicates the central tendency or typical value of a set of numbers. It is calculated by multiplying all the numbers in a data group, and taking the nth root of the total. For bacteria samples, the geometric mean is usually calculated based on the five most recent samples from each site during a 30-day period.

3. Key Fecal Coliform Bacteria (FIB) Sources

3.1 Introduction

This section provides our understanding of the potential sources of bacteria in the Fitzgerald Marine Reserve’s catchment. These sources have been identified based on elevated bacteria levels at and/or downstream of the source, documentation of inadequately treated human waste discharges from sanitary sewer systems (as reported by the responsible sewer agencies (Table 3)), and the findings of a microbial source tracking (MST) study conducted in 2012. The following sections summarize the MST study and its findings, and discuss each one of the identified sources.

3.2 Microbial Source Tracking Study

In 2012, an MST study was collaboratively conducted by the San Francisco Estuary Institute (SFEI) and researchers from the University of California, Davis (UCD). This study was conducted as part of the Fitzgerald ASBS Pollution Reduction program; a multi-faceted program designed to reduce pollutant loading and protect beneficial uses of the Reserve. The main goal of this MST study was to provide information about the primary sources of

FIB within the Reserve watershed and to assist with the selection of appropriate Best Management Practices (BMPs) to reduce fecal pollution.

The MST study consisted of two parts: FIB monitoring, to identify potential sources of FIB in different reaches of creeks draining to the Pacific Ocean in the vicinity of the Reserve, and investigate seasonal and land use-related spatial trends; and a genetic analysis of host-associated Bacteroidales,¹ conducted by UCD researchers, to determine whether human, bovine, dog, and horse sources were contributing to fecal contamination.

Findings

The results of the FIB monitoring conducted by SFEI showed that FIB concentrations in the five drainages were elevated during both the dry and wet seasons and often exceeded water quality objectives for water contact recreation. FIB concentrations were generally lower in the dry season than in the rainy season. In Martini and Kanoff Creeks, the less urbanized watersheds, FIB levels were lower than the more urbanized watersheds of Montara, Dean, and San Vicente Creeks. Due to the study design and limited timeframe, consistent spatial trends in FIB concentrations related to specific land use types were not detected. One notable increase in FIB occurred in Montara Creek during January 2012 rainy season event, when *E. coli* and *Enterococcus* levels were approximately six times higher at the terminus of Montara Creek, right before it discharged into the Pacific Ocean, in comparison to the next site upstream. Increases were also observed between these sites during the two dry season events. This observation suggests that land uses located between these two sites contribute a relatively significant amount of bacteria to the Reserve during both wet and dry seasons. However, since there are several land use types within this reach of Montara Creek, the primary contributing source could not be identified (SFEI 2013).

The results of the genetic analysis conducted by UCD showed that concentrations of the universal Bacteroidales marker, derived from all warm-blooded animals, increased during rain and were generally lower in the dry season. Increased levels of Bacteroidales were significantly higher in the wet season event in comparison to the first flush event. Differences in first flush and the rainy season event could be due to differences in microorganism survival related to environmental conditions such as temperature, differences in source loading related to the degree of ground saturation, groundwater levels, resulting runoff, observed streamflow at the beginning of the storm season versus the end of the storm season, and/or the resuspension of sediment and release of microorganisms from sediment and biofilm as the result of higher streamflow and turbulence (SFEI 2013).

Of the four host-specific markers that were analyzed (dog, horse, bovine, and human), dog-associated Bacteroidales was the most frequently detected host marker in the water, as well as in sediment and biofilm at all sites in the wet season. However, the dog-associated marker was less frequently detected during the dry season and first flush event. The bovine-associated marker was detected in water, sediment, or biofilm at all sites during the rainy season, most notably in Kanoff and San Vicente Creeks, but was not detected during the dry season or first flush events. Horse-associated Bacteroidales were found at high

¹ Bacteria of the Bacteroidales order are commonly found in the feces of humans and other warm-blooded animals. Although these organisms can be persistent in the environment, the presence of Bacteroidales in water is an indication of fecal pollution and the possible presence of enteric pathogens. Since different host species (e.g., human, dog, horse, bovine) have different types of Bacteroidales associated with them, the detection of DNA from Bacteroidales bacteria in the environment can be used to determine the origin of the fecal pollution.

concentrations in water in Dean and San Vicente Creeks during rain in the wet season. The horse marker was also detected at all sites during the dry season, but did not appear to be a predominant source of fecal contamination. This conclusion was drawn based on the fact that horse-associated Bacteroidales constituted less than 5% of universal Bacteroidales concentrations. Human-associated Bacteroidales were detected in water at all sites during the first flush event, but were not present during the dry season and were only detected in two samples during the rainy season event. During the dry season, at all sites except Montara Creek, less than 5% of the universal Bacteroidales concentrations were made up of the tested host-specific markers, which indicates that uncharacterized fecal sources, such as wildlife or other domestic animals, likely contributed a large amount of fecal pollution (SFEI 2013).

Study Design

The FIB monitoring was conducted from January 2012 through October 2012 in Montara, Dean, San Vicente, Martini, and Kanoff Creeks. Although Martini and Kanoff Creeks do not drain to the Reserve, they are located immediately to the north of the Reserve boundary and were included in the study.

The sites were located within the unincorporated communities of Montara and Moss Beach. The watersheds are rural in nature, although there are small commercial and medium to high density residential areas located within all of the watersheds, except for Martini Creek. A large portion of the watersheds is open space, including McNee Ranch State Park and Rancho Corral de Tierra, part of the Golden Gate National Recreation Area managed by the National Park Service.

SFEI monitored FIB, including total coliform, *Escherichia coli* (*E. coli*), and *Enterococcus*, at multiple locations within each creek during two rainy season monitoring events (January 20, 2012 and March 14, 2012) and two dry season monitoring events (July 9, 2012 and August 15, 2012).

Researchers from the UCD collected samples from the same five creeks at sites located immediately upstream of the confluences with the Pacific Ocean during a rainy season monitoring event (March 14, 2012), a dry season monitoring event (July 9, 2012), and during the first flush (October 22, 2012), and conducted genetic analysis of host-associated Bacteroidales to determine the contribution of human, bovine, dog, and horse sources to fecal contamination. They performed Quantitative Polymerase Chain Reaction (qPCR) assays to measure the relative amount of genetic materials from various host-associated Bacteroidales in a particular water sample. They then used a probabilistic model to estimate the concentration of host-associated Bacteroidales in each sample.

Genetic Analysis Method Limitations

Due to confounding factors such as the dilution and degradation rates of Bacteroidales genetic materials targeted by this method, detection frequency takes precedence over the magnitude of genetic material detection. While several good host-associated markers exist for the major non-human sources, these methods have some limitations. For example, not all fecal hosts (e.g. chicken, marine mammals) have corresponding validated markers or will have markers developed in the near future. In addition, practitioners may not be able to discern the dominant source. The relative magnitudes of the qPCR signal cannot be used to determine which source is dominant, because qPCR signal magnitudes are unreliable due to dilution, degradation, and differential concentrations of markers between species (SCCWRP 2013).

Identified Sources

The MST study has identified the following significant FIB sources in the watershed:

- Human waste (e.g., from faulty septic systems, faulty sanitary sewer lines, faulty private sewer laterals, sanitary sewer overflows, and trash)
- Dog waste (e.g., from pet dogs)
- Horse waste (e.g., from commercial horse facilities, private residences with horses, and riding trails)
- Waste from other confined animal facilities and livestock
- Wildlife waste
- Stormwater runoff (transporting bacterial pollution from all of the above sources).

The MST study also detected some bovine-specific genetic markers. However, since there are no bovines present in any of the catchments that were studied, the general belief is that these markers likely originated from deer. Apparently, the marker used to detect bovine bacterial input is not specific enough and can cross detect bacteria from deer (SFEI 2013). Another possibility is that the detected bovine bacteria originated from cow/steer manure fertilizers used by property owners in the study area.

Study Recommendations

The MST study provides useful information for understanding and control of fecal contamination sources in watersheds draining into the Pacific Ocean in the vicinity of the Reserve, including the San Vicente Creek watershed. The highest FIB levels were measured during the wet season. This study identifies human, dog, horse, and bovine as sources of fecal contamination. Of these, dog markers appear to be the most prevalent marker detected during the wet season. While the study does not characterize all potentially significant sources of fecal pollution in these watersheds, such as wildlife or other domestic animals, it does provide useful information to guide the selection of BMPs to reduce fecal pollution.

The study makes the following recommendations for further work:

- “Continue MST within the five watersheds including:
 - Additional monitoring for the existing host-associated *Bacteroidales* markers used in this study (increased sites and sampling frequency);
 - Genetic analysis using new host-associated markers or improved MST techniques (i.e., Phylochip or techniques to distinguish between intact and impaired cells allowing for determination of the age of fecal pollution), as available; and,
 - Implementation of a bacterial tracer experiment
- Implementation of an education and outreach program to address dog waste
- Implementation of BMPs to address horse waste
- Investigation of potential sources of bovine contamination including research on:
 - Presence of cows within the watersheds
 - Contribution potential from applied manure compost and level of use within the watersheds
 - Specificity of the bovine-associated marker

- Development of a project to investigate the condition of septic systems and provide education and outreach on proper maintenance

Development of a plan to investigate the potential for source contributions related to the sanitary sewer system. If needed, a future project could include a system condition assessment, enhanced program for maintenance and leak/overflow prevention, and public education and outreach on proper sewer lateral maintenance (SFEI 2013).”

3.3 Sanitary Sewer Systems

Sanitary sewer systems convey sanitary and other wastes from residences and businesses in the Reserve’s catchment via the collection system to the Sewer Authority Mid-Coastside (SAM) wastewater treatment plant for treatment, prior to discharge to the Pacific Ocean west of Pilarcitos Creek, south of the Reserve. The sanitary sewer services for the residences and commercial properties within the Reserve’s catchment are provided by three entities: the Montara Water and Sanitary District (MWSD), the Granada Sanitary District (GSD), and SAM² (Figure 4). The MWSD provides water, sanitary sewer, and solid waste disposal services to the coastal communities of Montara, Moss Beach, and adjacent areas located north of Half Moon Bay and south of Pacifica. As of 2010, MWSD provided 1,928 sewer connections to an estimated population of roughly 5,300 within its jurisdiction, of which approximately 90% are estimated to be for residential properties (MWSD 2011). Staff estimates that approximately 75% of the total MWSD sewer connections are located within the Reserve’s catchment, with roughly 5-10% located within the San Vicente Creek subcatchment.

The GSD is responsible for the sewage collection system and disposal for residences and businesses in the unincorporated areas of El Granada, Princeton, Princeton-by-the-Sea, Clipper Ridge, Miramar, and the northern portion of the City of Half Moon Bay. The District serves approximately 2,500 sewer connections, of which only a very small number is located within the Reserve’s catchment.

SAM owns and operates the regional collection, transmission, and wastewater treatment system for the area. It owns and operates the regional wastewater treatment plant and an eight-mile transmission line, (the Intertie Pipeline System – IPS) connecting the three member agencies to the plant (Figures 3 and 4). The system also includes three main pumping stations and an ocean outfall, where final effluent is discharged to the Pacific Ocean, at the Monterey Bay National Marine Sanctuary, south of the Reserve.

SAM’s transmission system has 1.9 miles of gravity pipeline and 5.8 miles of force main. The flows at the pump stations range from an average of approximately 0.18 million gallons per day (MGD) at the lowest flow station to an average of approximately 0.93 MGD at the highest flow station.

SAM’s service area includes a population of approximately 22,000 people. The service area encompasses roughly 12 square miles, with about 6 square miles (or 50% of the total) within the City of Half Moon Bay, in San Mateo County. In the unincorporated area, 3 square miles (or 25% of the total) lie within El Granada, and 3 square miles (or 25% of the total) lie within Montara (SAM 2008).

² In 1976, MWSD, the Granada Sanitary District, and the City of Half Moon Bay (which is not within the Reserve’s catchment), formed SAM in a Joint Exercise of Powers Agreement (JPA). SAM is a public agency created to meet the wastewater transmission and treatment service requirements of each community within its three member agency boundaries.

Each of the member agencies owns and operates its individual collection systems, including local pump/lift stations. As such, there are no individual connections to the SAM system. SAM provides for the overall transmission and treatment/disposal of the sewage collected within each member agency's service area. SAM also provides contract services to its member agencies to operate and maintain the collection systems, which include over 75 miles of sewer pipelines and 17 lift stations. However, the member agencies plan and implement all capital improvement projects, repairs and new construction within their respective service areas (SAM 2008).

Sanitary sewer systems can potentially contribute FIB to the Reserve and San Vicente Creek via sanitary sewer over flows. This is discussed in Section 3.5 below.

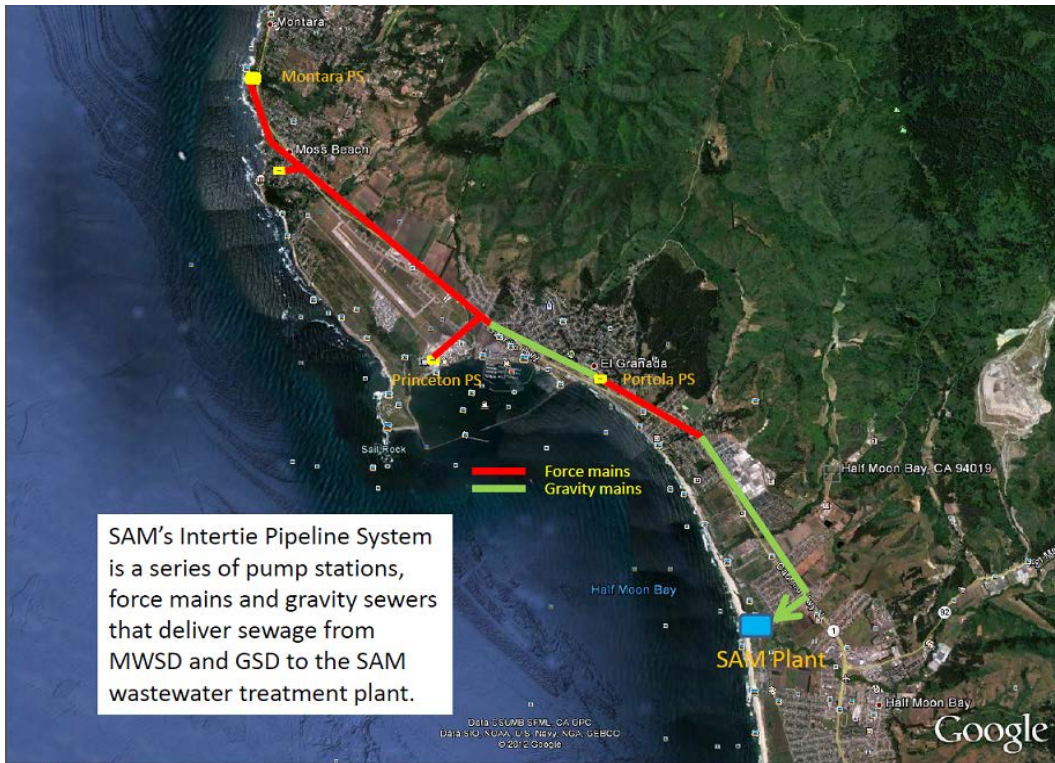


Figure 3. Sewer Authority Mid-Coastside's Sanitary Sewer System Map
Source: SAM, 2012

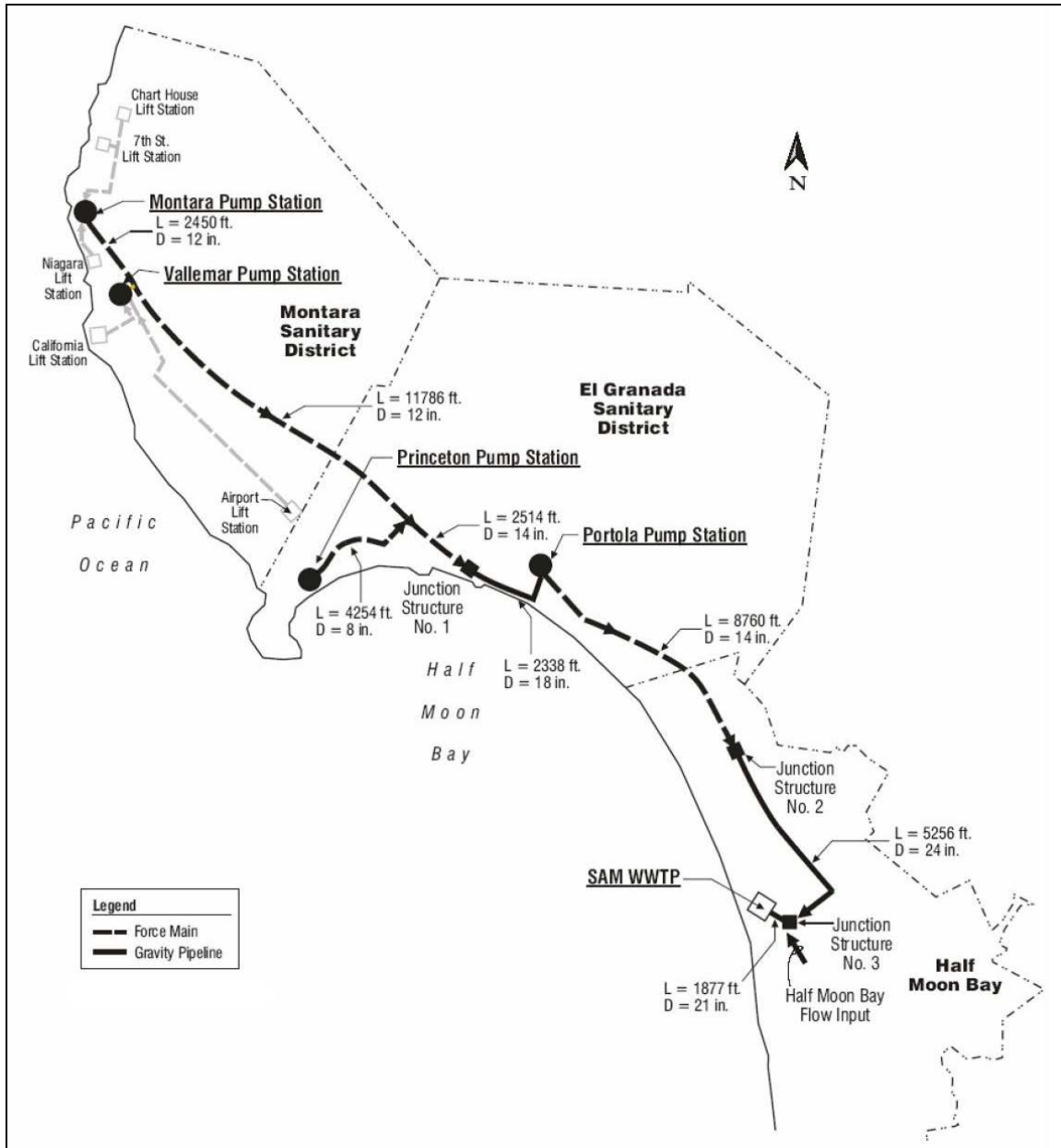


Figure 4. Sewer Authority Mid-Coastside Sewer Intertie Pipeline System Schematic
 Source: EAS, 2009

3.4 Private Sewer Laterals

Private sewer laterals (the proper maintenance, functioning, and, if needed, replacement of which are the responsibility of the private home or business owners) connect plumbing in a home or business to the public sewer main, which is usually located in the street (Figure 5). If not inspected, maintained, or repaired properly, private sewer laterals can discharge untreated sewage to the nearby surface waters, either directly or via stormwater runoff.

Currently, neither the County nor the local sanitary sewer districts are believed to have any ordinances or codes regulating private sewer laterals. MWSD code contains a section for maintenance of sewer laterals that states: “the construction, installation, maintenance, repair and replacement of Side Sewers, Lateral Sewers, and Building Sewers shall be, and

are the responsibility, at no cost to the District, of the owner of the Parcel served thereby” (Chapter III, Article 5, Section 1100).

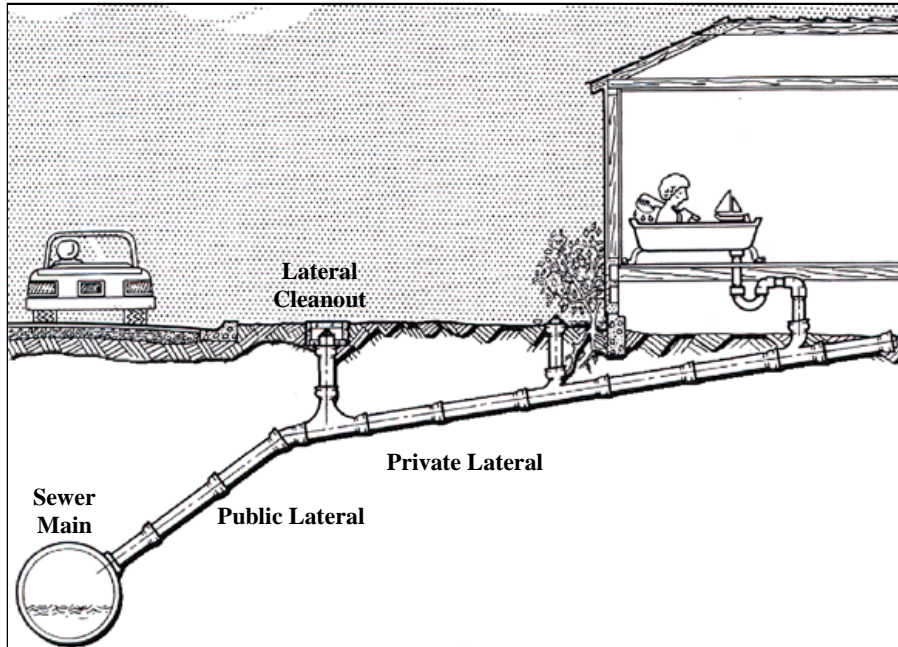


Figure 5. Schematic Drawing of Public vs. Private Sewer Laterals

3.5 Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) from the sanitary sewer collection systems are a potential source of bacteria pollution to San Vicente Creek and Fitzgerald Marine Reserve because they discharge in locations from which they have flowed, or could flow, to San Vicente Creek and the Reserve. Sanitary sewer overflows can occur during and after rainstorms when stormwater infiltrates sanitary sewers and overloads system capacity. In addition to the wet-weather sanitary sewer overflows, sewer line blockages and breaks can result in short-term discharges of untreated human waste.

In August 2006, the U.S. Environmental Protection Agency (U.S. EPA) issued an NPDES Compliance Evaluation Report to SAM. The report described the existing SAM system and the SSOs that occurred through 2005, and made recommendations to eliminate SSOs. The report stated that the SAM sewer system does not have sufficient capacity to convey peak flows during the winter rains. The capacity shortages are manifested most noticeably in large-volume overflows at the Montara Pump Station and from manholes upstream of the Portola Pump Station. Heavy wet weather flows can also cause spills within the member agencies' systems. The largest spills, however, have historically occurred when heavy wet weather flow reached bottlenecks in the SAM Intertie Pipeline System at the Montara and Portola Pump Stations (ESA 2009).

Capacity assessment studies conducted by SAM indicated that the capacity problems stem primarily from excess infiltration and inflow (I/I) in the member agencies' sewer systems (ESA 2009). Capacity limitations caused by I/I can be managed either by reducing I/I, conveying the excess flow through larger sewers and storage basins, or a combination of these basic approaches.

SAM conducted a separate series of studies to evaluate wet weather flows in the Intertie Pipeline System and developed recommendations for relieving capacity restrictions in the system. The studies made general recommendations to install off-line flow storage, expand the capacity of the system downstream of the Portola Pump Station, and/or conduct a comprehensive I/I evaluation and corrective measures in each of the member agency collection systems (ESA 2009).

The Portola Pump Station is considered a bottleneck due to inadequate capacity of the Intertie Pipeline System downstream. SAM evaluated alternatives consisting of storage facilities of varying capacities, additional pipelines, and pump station improvements. Finally, SAM selected an alternative that consists of construction and operation of a 200,000-gallon underground wet weather flow retention basin at the Portola Pump Station (ESA 2009). That project was completed in 2012 and is expected to reduce the number and magnitude of SSOs within the Reserve’s catchment. However, due to the relatively dry weather since its completion, the retention basin has not yet been put to use, except for maintenance activities.

Table 3 summarizes information about sanitary sewer overflows from 2007-2013 from the publicly-owned portions of the Montara, El Granada, and SAM sanitary sewer systems that service the properties within the Reserve’s catchments. During this period, 51 sanitary sewer overflows with a total volume of 156,732 gallons were reported. Of this amount, a reported 151,815 gallons of wastewater reached surface waters.

Table 3. Summary report of Sanitary Sewer Overflows (SSOs) for sanitary sewer collection systems within catchments draining to the Fitzgerald Marine Reserve (Jan. 2007- May 2013)

Total Number of SSO Incidents	51
Largest SSO Volume (gallons)	132,710
Smallest SSO Volume (gallons)	1
Total Volume of SSOs (gallons)	156,732
Total Volume Reaching Surface Water (gallons)	151,815

3.6 Onsite Wastewater Treatment Systems (OWTS) (Septic Systems)

Onsite wastewater treatment systems are used to primarily treat domestic wastewater from a home or business and return treated wastewater back into the receiving environment by employing subsurface disposal. They are typically referred to as septic systems, because most involve a septic tank for partial treatment. The most common and traditional septic systems consist of a septic tank that gravity flows to a soil adsorption field for final treatment and dispersal. The septic tank allows particulate matter to settle to the bottom of the tank so that large solids do not plug the drain field. Final treatment and dispersal of the wastewater takes place in the soil absorption field (leach field). Septic systems that are poorly installed or maintained, faulty, improperly located, or are in close proximity to water bodies are potential sources of indicator bacteria to surface and ground waters. Figure 6 shows the location of existing septic systems within the Reserve’s catchment, as of 2005. Staff estimates the total number of septic systems in the catchment, from Figure 6, to be around 125, with only a few of them located within the San Vicente Creek subcatchment area. The number and distribution pattern of the septic systems in the

Reserve's catchment suggest that they can potentially be a significant source of bacterial pollution in the Montara and Dean Creeks subcatchments, but probably less so in the San Vicente Creek subcatchment.

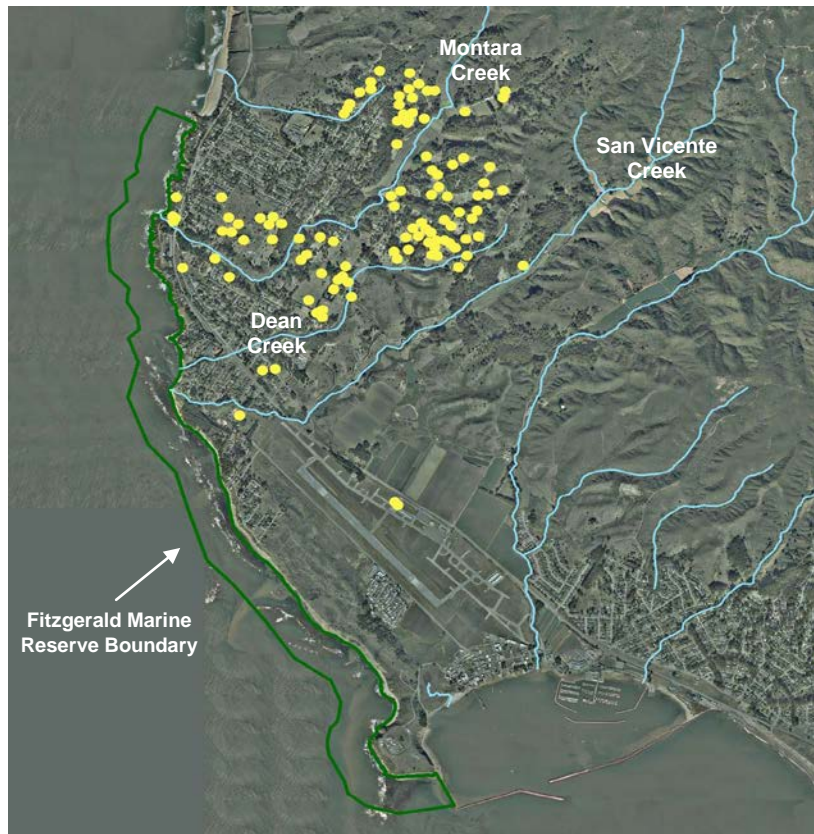


Figure 6. Septic system locations within Fitzgerald Marine Reserve catchments
Source: SMCPD, 2005

3.7 Horse Facilities and Riding Trails

Horse waste consists of manure and urine generated by horses. It contains pathogens and other pollutants that can contaminate surface and ground waters and result in human illness if ingested. The average horse produces about 45 pounds of waste each day. This waste can reach waterways through direct deposit or via runoff after rain events. Horses are present at three commercial horse boarding facilities within the Reserve's catchments. Two of these facilities, the Moss Beach Ranch and the Ember Ridge Ranch, are located in the San Vicente Creek subcatchment, and the third one, the Renegade Ranch, is located within the Dean Creek catchment. In addition, there are numerous private properties with a small number of horses for private use. The San Mateo County Resource Conservation District (SMCRCD) is believed to have the most complete and up-to-date information about the number and location of these facilities. However, at this time, they do not have the resources to locate, compile, and share this information.

In addition to the horse facilities, there are multiple riding trails within the catchment. If horses and their waste are not properly managed on trails and at staging areas, they could contribute indicator bacteria through direct deposit and/or surface runoff into nearby water bodies.

3.8 Stormwater Runoff

Stormwater runoff can be a significant source of indicator bacteria, delivering bacteria present in the waste of domestic pets, wildlife, livestock, litter, and spilled sewage to water bodies. The Reserve receives runoff from storm water discharges emanating from 38 points along the Reserve's shoreline (CCC 2008). San Mateo County conducted reconnaissance in 2007 to document the sources of the discharges. Of the 38 total discharges, 1 was a U.S. Air Force discharge near Pillar Point, 8 were natural seeps and gullies, 3 were creeks, 9 were discharges from private property, and 17 were municipal discharges from County-maintained or related facilities (CCC 2008).

3.9 Wildlife

A variety of wildlife such as deer, birds, and rodents resides in the catchments draining to the Reserve and San Vicente Creek. Directly-deposited and runoff-delivered wildlife waste can be a source of indicator bacteria to the receiving water bodies. No accurate information as to the magnitude and geographic distribution of this waste source is available. Marine birds are also present in and near the Reserve and San Vicente Creek mouth. Because of the great variety, complex distribution and dispersal patterns, and fluctuating populations of both terrestrial and marine wildlife, it is difficult to assess their exact impact on the water quality of the Reserve and San Vicente Creek.

4. Water Quality Data Analysis Strategy

Ample dry and wet season beach water quality monitoring data for the stations at Moss Beach (in the Reserve) and at the mouth of San Vicente Creek are available from 1998 through June 2013. Additionally, SMCRC staff have indicated that they may be able to provide some historical bacteria data for San Vicente Creek, once they have had the opportunity to locate and organize their data files.

A spreadsheet analysis will be performed to assess current water quality conditions during both dry and wet season periods. Percent exceedances of applicable bacteria water quality objectives at the Reserve and Creek will be calculated for both dry and wet season periods and will be compared to appropriate site-specific exceedance frequencies (i.e., from applicable reference systems) and to the California Listing Policy's exceedance thresholds (State Water Board 2004).

5. Applicable Standards

The State Water Board has established water quality standards to protect recreational users in ocean waters from bacterial contamination. These water quality standards are contained in the State Water Board's Water Quality Control Plan for Ocean Waters of California (Ocean Plan) and are summarized in Table 4 (State Water Board 2009). The Ocean Plan water quality standards are the applicable standards for the water contact recreation beneficial use at the Reserve.

Sample Type	Indicator	Standards ¹
Single Sample Maximum	Total Coliform	10,000
	Total Coliform ²	1,000
	Fecal Coliform	400
	Enterococci	104
30-day Geometric Mean	Total Coliform	1,000
	Fecal Coliform	200
	Enterococci	35

¹ Number of organisms or colonies forming per 100 ml of water

² If the ratio of fecal to total coliform exceeds 0.1

In fresh waters, such as San Vicente Creek, the existing San Francisco Bay Basin Water Quality Control Plan (Basin Plan) water quality objectives for coliform bacteria for water contact recreation apply. These objectives are presented in Table 5 (Water Board 2014).

Beneficial Use	Fecal Coliform (MPN ^b /100 mL)	Total Coliform (MPN/100 mL)
Water Contact Recreation	Log mean < 200 90 th percentile < 400	Median < 240 No sample > 10,000

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

b. Most Probable Number (MPN) is a statistical representation of the results of the standard coliform test.

The above ocean and Freshwater standards may change during the course of this TMDL project. On November 26, 2012, the U.S. EPA released new water quality criteria for protection of the recreational uses in both ocean and fresh water. The State Water Board expects to consider the new U.S. EPA criteria by the end of the 2014 calendar year. If they are adopted, they would likely apply to these waters, superseding the existing objectives.

6. Potential Management Measures

The MST study has made a number of recommendations regarding applicable management measures for controlling FIB discharges in the watershed. These recommendations are as follows:

- Implement an education and outreach program to address dog waste;
- Implement BMPs to address horse waste;
- Investigate potential sources of bovine contamination, including research on:
 - Presence of cows within the watersheds
 - Contribution potential from applied manure compost and level of use within the watersheds
 - Specificity of the bovine-associated marker;
- Develop a project to investigate the condition of septic systems and provide education and outreach on proper maintenance; and,
- Develop a plan to investigate the potential for source contributions related to the sanitary sewer system. If needed, a future project could include a system condition

assessment, enhanced program for maintenance and leak/overflow prevention, and public education and outreach on proper sewer lateral maintenance (SFEI 2013).

More-detailed management measures for control of FIB discharges to the Creek and Reserve could include:

- Implementation of an inspection program for all animal (e.g., horse) facilities (e.g., implementation and enforcement of the County Confined Animals Ordinance (SMCPBD 2009);
- Requirement for animal facilities to obtain coverage under the Water Board's General Waste Discharge Requirements (WDRs) for Confined Animal Facilities, Order No. R2-2003-0093 (CAF Order) (Water Board 2003)³;
- Requirement for San Mateo County, as the Municipal Regional Stormwater Permit (MRP) permittee having jurisdiction over the Reserve's catchment area, to implement bacteria control measures, such as:
 - education and outreach for pet owners, residents, and business owners to prevent pet waste discharges;
 - dog waste collection receptacles and a system for waste disposal/operation and maintenance of the collection measures;
 - various stormwater runoff treatment measures, as appropriate;
- Development and implementation of a new or enhanced inspection, repair, improvement, and maintenance program for municipal sanitary sewer systems. Some specific examples of measures included in such program are:
 - Development and implementation of an enhanced system-wide cleaning program for the collection system and the collection system's ancillary equipment;
 - Development and implementation of an enhanced root control program;
 - Development and implementation of a program to detect and eliminate illicit discharges;
 - Completion of a condition assessment of 100% of the collection system;
 - Completion of a system evaluation and capacity assurance plan;
 - Preparation and implementation of a capital improvement plan;
 - Development and implementation of a private sewer lateral replacement program;
- Sanitary sewer agencies' compliance with the General Statewide WDRs for Sanitary Sewer Overflow Order (Order No. 2006-0003, revised by Order No. 2008-0002). All public entities that own or operate sanitary sewer systems that are greater than one mile in length that collect and/or convey untreated or partially treated wastewater to a publicly owned treatment facility in the State of California are required to apply for coverage under these WDRs. The WDRs contain provisions for sanitary sewer overflow (SSO) prevention and reduction measures, including development and implementation of sanitary sewer system management plans (SSMPs). Further, the WDRs prohibit any SSO that results in a discharge of untreated or partially treated wastewater to waters of the United States, or creates a nuisance as defined in Water Code Section 13050(m). In addition, the WDRs require the dischargers to take all feasible steps to eliminate SSOs and to properly manage, operate, and maintain all parts of the collection system. Lastly, the WDRs include a monitoring and reporting plan that establishes monitoring, record keeping, reporting, and public notification requirements for the dischargers.

³ Water Board staff is currently in the process of updating and preparing for reissuance the existing CAF Order. The revised Order is anticipated to be considered by the Water Board for adoption by November 2014.

- Development and implementation of an ordinance or code to address inspection, repair, and maintenance of private sewer laterals; and
- Implementation of a new or enhanced inspection, repair, and maintenance program for OWTS (septic systems).

7. Key Stakeholders

Key stakeholders in the Reserve and San Vicente Creek subcatchment are:

- San Mateo County, as a MRP permittee
- San Mateo County Public Works Department
- San Mateo County Environmental Health Department
- San Mateo County Parks Department
- San Mateo County Resource Conservation District
- Sanitary sewer collection and transmission system owners/operators (SAM, MWSD, and Granada Sanitary District)
- Homeowners
- Septic system owners
- National Park Service (GGNRA)
- Horse facility owners and operators
- Commercial property owners
- Environmental groups (e.g., San Mateo Surfrider, Heal The Bay, San Francisco Baykeeper, etc.)
- Fitzgerald Marine Reserve visitors
- Farmers (e.g., flower farms)

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