INTEGRATED MONITORING REPORT

PART C: STRESSOR/SOURCE IDENTIFICATION PROJECTS

Water Year 2014 through Water Year 2019

Submitted in compliance with Provision C.8.h.v of
NPDES Permit No. CAS612008 (Order No. R2-2015-0049)

SAN MATEO COUNTYWIDE
Water Pollution
Prevention Program

March 31, 2020

List of Acronyms

ACCWP	Alameda Countywide Clean Water Program
BASMAA	Bay Area Stormwater Management Agency Association
BMP	Best Management Practices
C/CAG	City/County Association of Governments
CCCWP	Contra Costa Clean Water Program
CEDEN	California Data Exchange Network
DO	Dissolved Oxygen
FIB	Fecal Indicator Bacteria
FSURMP	Fairfield Suisun Urban Runoff Management Program
IMR	Integrated Monitoring Report
MRP	Municipal Regional Permit
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NPDES	National Pollutant Discharge Elimination System
OES	Office of Emergency Services
OFEE	Oil Filled Electrical Equipment
PCBs	Polychlorinated Biphenyls
PG&E	Pacific Gas and Electric Company
QAPP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
RMC	Regional Monitoring Coalition
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFRWQCB	San Francisco Bay Regional Water Quality Control Board
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SSID	Stressor/Source Identification
SWAMP	Surface Water Ambient Monitoring Program
TMDL	Total Maximum Daily Load
UCMR	Urban Creeks Monitoring Report
USEPA	Environmental Protection Agency
WQO	Water Quality Objective
WY	Water Year

Table of Contents

List of Figures

List of Tables

List of Attachments

Attachment 1. BASMAA RMC Regional SSID Report

Attachment 2. Final Pillar Point Harbor Watershed Pathogen Indicator SSID Project Report

1.0 Introduction

This Integrated Monitoring Report (IMR) Part C: Stressor/Source Identification Projects, Water Year[1] (WY) 2014 through WY 2019 was prepared by the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP or Program). SMCWPPP is a program of the City/County Association of Governments (C/CAG) of San Mateo County. Each incorporated city and town in the county and the County of San Mateo share a common National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP). The MRP was first adopted by the San Francisco Regional Water Quality Control Board (SFRWQCB or Regional Water Board) on October 14, 2009 as Order R2-2009-0074 (SFRWQCB 2009; referred to as MRP 1.0). On November 19, 2015, the Regional Water Board updated and reissued the MRP as Order R2-2015-0049 (SFRWQCB 2015; referred to as MRP 2.0).

This report fulfills the requirements of Provision C.8.h.v of MRP 2.0 for comprehensively interpreting and reporting all Stressor/Source Identification (SSID) monitoring data collected since the previous IMR was submitted in 2014. As such, this report includes data collected during WY 2014 through WY 2019. The previous IMR included data collected during WY 2012 and WY 2013 (SMCWPPP 2014).

Monitoring data were collected in accordance with the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) Quality Assurance Project Plan (QAPP; BASMAA 2016a) and Standard Operating Procedures (SOPs; BASMAA 2016b). Where applicable, monitoring data were derived using methods comparable with those specified by the California Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Program Plan (QAPrP)[2]. The BASMAA QAPP and SOPs were revised twice, once in 2014 and again in 2016, to conform to MRP 2.0 and changes made to the SWAMP QAPrP. The changes made were minor, and overall methods and protocols remain similar.

Data presented in this report were submitted electronically to the Regional Water Board by SMCWPPP and may be obtained via the California Environmental Data Exchange Network (CEDEN).

1.1 SSID Requirements

Provision C.8 of the MRP requires that Permittees evaluate Creek Status and Pesticides and Toxicity monitoring data with respect to triggers defined in the MRP. Sites where triggers are exceeded may indicate potential impacts to Aquatic Life or other Beneficial Uses and are therefore considered as candidates for SSID projects. SSID projects are selected from the list of trigger exceedances based on criteria such as magnitude of threshold exceedance, parameter, and likelihood that stormwater management action(s) could address the exceedance. Pollutants of Concern monitoring results may be considered as appropriate.

---

[1] Most hydrologic monitoring occurs for a period defined as a Water Year, which begins on October 1 and ends on September 30 of the named year. For example, Water Year 2019 (WY 2019) began on October 1, 2018 and concluded on September 30, 2019.

[2] The current SWAMP QAPrP is available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/swamp_QAPrP_2017_Final.pdf

Both MRP 1.0 (SFRWQCB 2009) and MRP 2.0 (SFRWQCB 2015) allow Permittees to comply with the SSID requirements of Provision C.8 through a regional collaborative effort, their Stormwater Program, and/or individually. In June 2010, Permittees notified the Water Board in writing of their agreement to participate in a regional monitoring collaborative to address requirements in Provision C.8. The regional monitoring collaborative is referred to as the BASMAA RMC. In a November 2, 2010 letter to the Permittees, the Regional Water Board's Assistant Executive Officer (Dr. Thomas Mumley) acknowledged that all Permittees have opted to conduct monitoring required by the MRP through a regional monitoring collaborative, the BASMAA RMC. Participants in the BASMAA RMC are listed in Table 1.1.

Table 0.1. BASMAA Regional Monitoring Coalition (RMC) participants.

Stormwater Programs	RMC Participants
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, Los Altos Hills, and Los Gatos; Santa Clara Valley Water District; and, Santa Clara County
Clean Water Program of Alameda County (ACCWP)	Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, and Union City; Alameda County; Alameda County Flood Control and Water Conservation District; and, Zone 7
Contra Costa Clean Water Program (CCCWP)	Cities of Antioch, Brentwood, Clayton, Concord, El Cerrito, Hercules, Lafayette, Martinez, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, Walnut Creek, Danville, and Moraga; Contra Costa County; and, Contra Costa County Flood Control and Water Conservation District
San Mateo County Wide Water Pollution Prevention Program (SMCWPPP)	Cities of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and, San Mateo County
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City
Vallejo Permittees	City of Vallejo and Vallejo Sanitation and Flood Control District

The MRP requires that Permittees initiate a minimum number of SSID projects during the permit term. During MRP 1.0 (WY 2012 – WY 2015), as a regional collaborative, SMCWPPP and its RMC partners were required to collectively initiate a region-wide minimum of ten SSID projects, with a minimum of two assessing toxicity. During MRP 2.0, SMCWPPP and its RMC partners were required to collectively initiate a region-wide minimum of eight SSID projects, with a minimum of one assessing toxicity. During both permit terms, the RMC partners agreed to a population-based distribution of the required number of SSID projects among the Programs, with most projects conducted by individual Programs addressing local needs and one MRP 2.0 project conducted regionally. Through these agreements, SMCWPPP initiated two projects during MRP 1.0, one project during MRP 2.0, and participated in one regional project during MRP 2.0.

Provision C.8.e.ii of MRP 2.0 requires that all SSID project reports initiated during MRP 2.0 are presented in a unified, regional-level report. As such, the BASMAA RMC Regional SSID Report is included as Attachment 1.

SSID projects must identify and isolate potential sources and/or stressors associated with observed water quality impacts. They are intended to be oriented to taking action(s) to alleviate stressors and reduce sources of pollutants. Provision C.8.e.iii of MRP 2.0 describes a stepwise process for conducting SSID projects:

- Step 1: Develop a work plan for each SSID project that defines the problem to the extent known, describes the SSID project objectives, considers the problem within a watershed context, lists candidate causes of the problem, and establishes a schedule for investigating the cause(s) of the trigger. The MRP recommends study approaches for specific triggers. For example, toxicity studies should follow guidance for Toxicity Reduction Evaluations (TRE) or Toxicity Identification Evaluations (TIE), physical habitat and conventional parameter (e.g., dissolved oxygen, temperature) studies should generally follow Step 5 (Identify Probable Causes) of the Causal Analysis/Diagnosis Decision Information System (CADDIS), and pathogen indicator studies should generally follow the California Microbial Source Identification Manual (Griffith et al. 2013).

- Step 2: Conduct SSID investigation according to the schedule in the SSID work plan and report on the status of SSID investigations annually.

- Step 3: Conduct follow-up actions based on SSID investigation findings. These may include development of an implementation schedule for new or improved best management practices (BMPs). If a Permittee determines that municipal separate storm sewer system (MS4) discharges are not contributing to an exceedance of a water quality standard, the Permittee may end the SSID project upon written concurrence of the Executive Officer. If the SSID investigation is inconclusive, the Permittee may request that the Executive Officer consider the SSID project complete.[3]

[3] MRP 1.0 did not require that the Executive Officer concur in writing before an SSID project is determined to be completed.

2.0 SSID Projects Initiated by SMCWPPP

This section summarizes the results of SSID projects initiated or completed by SMCWPPP during WY 2014 through WY 2019.

During MRP 1.0, SMCWPPP initiated and completed two SSID projects in San Mateo Creek investigating low dissolved oxygen and pathogen indicators.

During MRP 2.0, SMCWPPP initiated one SSID project addressing pathogen indicators in the Pillar Point Harbor watershed. The Program also participated in a regional project addressing releases and spills of PCBs from electrical utility equipment (see Section 3.0).

2.1 San Mateo Creek Low Dissolved Oxygen SSID Project

Historical (2003) and more recent (2013) monitoring data collected in the vicinity of De Anza Park in San Mateo Creek showed dissolved oxygen (DO) concentrations below the water quality objective (WQO) of 7 mg/L for waters designated as cold water habitat. The affected creek reach is located in the lower 5-square mile portion of the watershed, which is characterized by residential and urban land uses, as well as modified creek conditions. In contrast, the upper 29-square mile watershed area (88% of the total watershed area) is generally undeveloped and drains to a system of reservoirs that are owned and operated by the San Francisco Public Utilities Commission (SFPUC) (Figure 2.1). Flow in the lower reaches of San Mateo Creek are controlled by releases from the Lower Crystal Springs Reservoir dam.

Dissolved oxygen concentrations measured in 2003 by the California Surface Water Ambient Monitoring Program (SWAMP) showed wide diurnal fluctuations in lower San Mateo Creek, consistent with excessive photosynthesis (SFBRWQCB 2007). Continuous water quality monitoring conducted by SMCWPPP in WY 2013 in compliance with MRP 1.0 confirmed wide daily fluctuations in DO at De Anza Park; however, the daily pattern was not consistent with excessive photosynthesis. Instead, the DO pattern suggested daily stratification of the pool, possibly as a result of low streamflow, high air temperatures, and cold groundwater seepage (SMCWPPP 2014).

The Program conducted a SSID project to address the potential water quality concerns related to low DO. Field investigations included continuous monitoring of DO and a creek walk to measure pool depths. Low concentrations of DO were not observed in San Mateo Creek at the De Anza Park station during WY 2014, WY 2015 (SMCWPPP 2016), or during follow-up monitoring in WY 2016 (SMCWPPP 2017). Results of the SSID investigation suggest that low DO conditions are no longer present or expected in the lower reach of San Mateo Creek along De Anza Park due to a new schedule of increased dry season releases of water from the upstream Crystal Springs Reservoir. These findings were confirmed through Creek Status Monitoring conducted in WY 2015. No additional management measures were recommended and the SSID project is considered complete.

The Final San Mateo Creek Low Dissolved Oxygen SSID Project Report was submitted to the Regional Water Board on July 9, 2015 and was also included with the Program's WY 2015 Urban Creeks Monitoring Report (UCMR; SMCWPPP 2016).

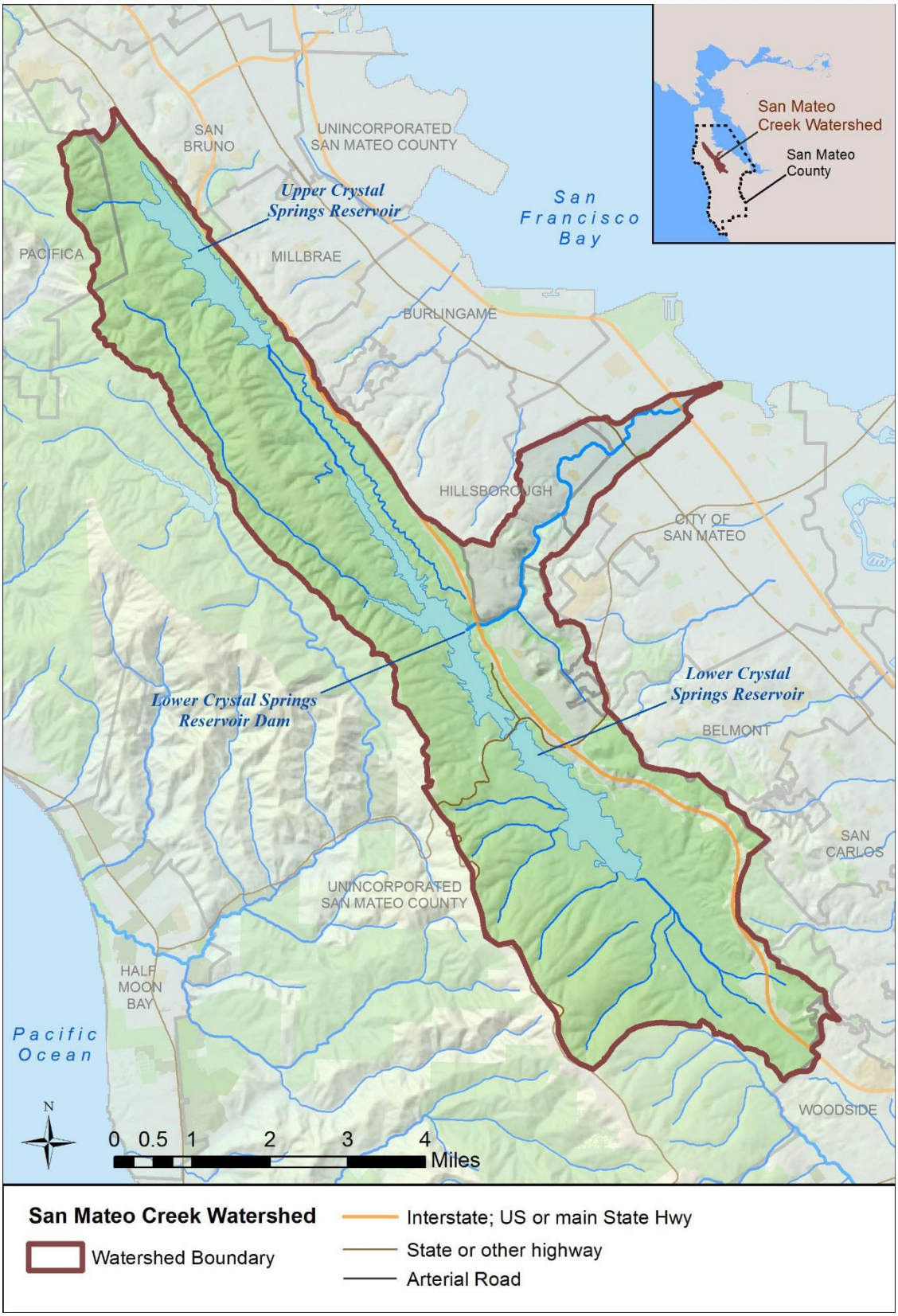


Figure 2.1. San Mateo Creek watershed, San Mateo County, CA.

2.2 San Mateo Creek Pathogen Indicator SSID Project

Monitoring data collected in 2003 and 2012 at stations in San Mateo Creek showed fecal indicator bacteria (FIB) at densities exceeding WQOs for waters designated as having water contact recreation (REC-1) Beneficial Uses. During WY 2014 and WY 2015 SMCWPPP conducted a SSID project to address this potential water quality concern. Results of the SSID investigation suggest that FIB are present at densities exceeding REC-1 WQOs in San Mateo Creek reaches downstream of Sierra Drive. However, noncontact recreation (REC-2) Beneficial Use WQOs are not exceeded. Microbial source tracking (MST) techniques suggest that human sources are present year-round and dog sources are present during and shortly after wet weather. Many other potential sources of FIB are present in the watershed and likely contribute to the FIB densities measured at sampling stations. These include uncontrollable sources such as wildlife and natural bacterial growth in the creek bed and conveyance system.

A number of management actions designed specifically or opportunistically to control bacterial sources are currently planned or are being implemented by municipalities in the San Mateo Creek watershed. These include control measures for pet waste (signage and public education), trash reduction efforts that may reduce nuisance wildlife, programs to address homeless encampments, and several improvements to the sanitary sewer conveyance system in response to a Cease and Desist Order. In addition, the City of San Mateo, Town of Hillsborough, San Mateo County, and SMCWPPP are working together to increase public education and outreach targeting pet waste in the San Mateo Creek watershed. Examples of recommended measures include installation of additional cleanup signs, dog bag dispensers, and trash receptacles at creekside parks. Local municipalities are also continuing actions to address homelessness begun through the Housing Our People Effectively strategy and Homeless Outreach Team program. However, even if human and dog sources are better controlled, results could still exceed WQOs due to uncontrollable sources such as wildlife and natural bacterial growth.

The Final San Mateo Creek Pathogen Indicator SSID Project Report was included with the WY 2015 UCMR (SMCWPPP 2016).

2.3 Pillar Point Watershed Pathogen Indicator SSID Project

The Pillar Point Watershed Pathogen Indicator SSID Project was triggered by fecal indicator bacteria (FIB) densities exceeding WQOs that have been measured in receiving waters and tributaries to Pillar Point Harbor. A SSID work plan (SMCWPPP 2018) was submitted with the SMCWPPP WY 2017 UCMR dated March 31, 2018. The work plan describes steps to investigate urban sources of fecal indicator bacteria in the Pillar Point Watershed. SMCWPPP implemented the work plan in WY 2018 and WY 2019 with assistance from and in close coordination with the San Mateo County Resource Conservation District (RCD). Consistent with Provision C.8.e.iii.(1)(g) of MRP 2.0, the study generally follows the *California Microbial Source Identification Manual* (Griffith et al. 2013).

The objective of the SSID study is to build on a Proposition 50 Clean Beaches Initiative Grant-funded study that was conducted by the RCD and University of California, Davis (UCD) in 2008 and 2011-12 (RCD 2014). The Proposition 50 Pillar Point Harbor Source Identification Project consisted of extensive water quality and hydrologic monitoring in the Harbor and its watershed, including collection of water, sediment, and biofilm samples during wet and dry weather for analysis of FIB (*E. coli* and enterococci) and bacteroidales associated with human, bovine, dog, horse, and avian sources. The RCD/UCD study indicated that high FIB measured at Pillar Point

beaches was likely due to influences from storm drains and creeks rather than from sources at the beaches and within the harbor itself.

The Pillar Point SSID project follows up on the Proposition 50 Pillar Point Harbor Source Identification Project and focuses on identifying spatial and temporal (seasonal) information about FIB sources from the MS4 through desktop and field investigations. Field investigations included grab samples collected at 14 stations located in five subwatersheds draining to Pillar Point Harbor (Figure 2.2). In most subwatersheds, the sample design included stations upstream of the MS4, within the MS4, and at the outlet to the Harbor. Sampling was conducted during two storm events and two dry season events in WY 2018. All samples were analyzed for FIB (*E. coli*) and human and dog bacteroidales genetic markers. Human and dog markers were selected to represent the most likely controllable anthropogenic sources. Desktop investigations conducted in WY 2018 and WY 2019 included development of a geodatabase to map potential bacteria sources and review of monitoring data collected by San Mateo County Environmental Health Services.

Results showed *E. coli* densities often exceed recommended WQOs for freshwaters designated as having water contact recreation (REC-1) Beneficial Uses (i.e., 320 cfu/100mL). However, FIB densities are highly variable and do not follow predictable seasonal patterns across all subwatersheds investigated. For example, two of the subwatersheds did not have higher wet weather FIB densities compared to dry season densities. A dearth of human and dog markers detected in this SSID study (particularly during the dry season) suggests that FIB conveyed by the MS4 may not be controllable. Instead, the primary sources of FIB within and conveyed by the MS4 appear to be uncontrollable wildlife (i.e., raccoons, deer, rodents) that are present in the MS4 and contributing areas. Regrowth of FIB in biofilms within the MS4, and subsequent shearing off of these materials is another likely source of FIB to receiving waters, though data limitations in this study preclude making evidence-based conclusions.

The Final Pillar Point Harbor Watershed Pathogen Indicator SSID Project Report was submitted to the Regional Water Board on October 28, 2019 and is included with this IMR as Attachment 2. The report documented management actions that are already being implemented along the coast and throughout the County that specifically or opportunistically reduce bacterial sources in stormwater runoff. These actions include stormwater and sewer infrastructure improvements, prohibition of non-stormwater runoff, trash controls, pet waste ordinances, pet waste cleanup stations, stormwater education and outreach, confined animal facility best management practices, and beach clean-ups.

Several additional bacterial control measures were recommended in the Final Project Report. Potential measures include installation of additional pet waste cleanup stations; continued education and outreach; investigations to identify locations within the MS4 where groundwater infiltration may be occurring (and subsequent repair); outreach to the owner(s)/operator(s) of the sewage collection system to understand and potentially improve operations, monitoring, and maintenance; and continued technical assistance to farms and ranches to promote water quality protection.

It is important to acknowledge that a) WQOs for FIB do not distinguish among sources of FIB and b) FIB detections do not necessarily correlate well with the presence of pathogens. Animal fecal waste is much less likely to contain pathogens of concern to human health than human sources, and FIB associated with biofilms likely does not indicate that pathogens are present. In most cases, human sources of fecal contamination are associated with REC-1 health risks rather than wildlife or domestic animal sources (USEPA 2012). Furthermore, even if controllable

bacteria sources (i.e., human and dog sources) are eliminated, FIB densities in receiving waters could still exceed WQOs due to wildlife and natural FIB growth in biofilms, sediment, and organic matter.

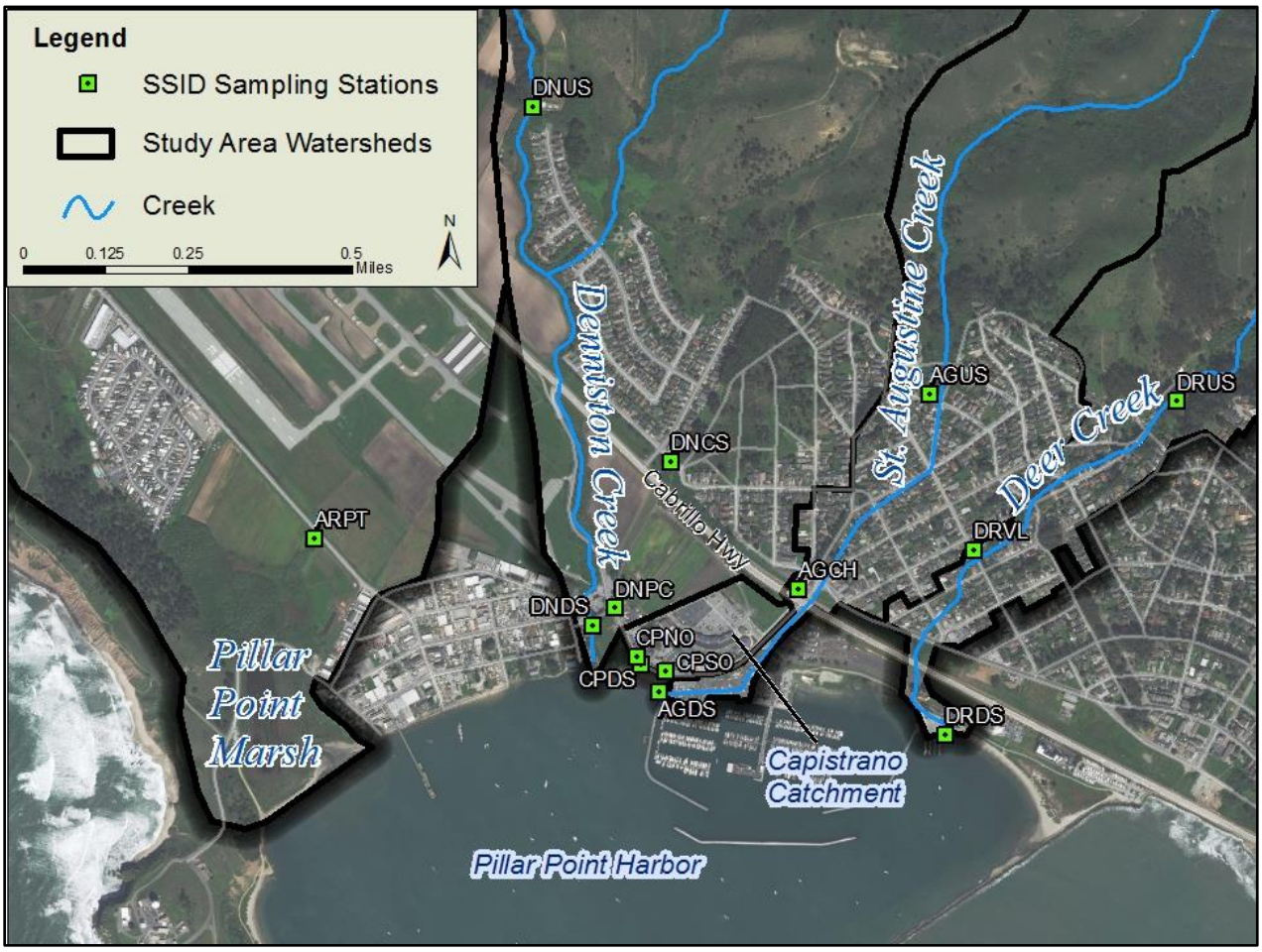


Figure 2.2. Pillar Point Watershed Pathogen Indicator SSID Project monitoring stations.

3.0 Regional PCBs from Electrical Utility Equipment

In late-2018, BASMAA contracted with EOA, Inc. to develop a work plan for a regional SSID project addressing releases and spills of PCBs from electrical utility equipment. The Regional SSID Project - Electrical Utilities as a Potential PCBs Source to Stormwater in the San Francisco Bay Area – was triggered by fish tissue monitoring in the Bay that led to the Bay being designated as impaired on the Clean Water Act (CWA) Section 303(d) list and the adoption of a TMDL for PCBs in 2008. Subsequent PCBs monitoring by the BASMAA RMC partners and the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) suggests that diffuse sources of PCBs are present throughout the region. One potential source of PCBs to stormwater is releases and spills from electrical utility equipment.

PCBs were historically used in several types of electrical utility equipment, some of which still contain PCBs. Although much of the PCB-containing equipment has been removed from service, some remains in use, and releases and spills from the equipment may be occurring at levels approaching the TMDL waste load allocation. However, the information currently available is not adequate to fully quantify the scope and magnitude of electrical utility applications as a source of PCBs to stormwater. The information gap is partially due to state and federal regulatory levels for reporting and clean-up of PCBs spills that are higher than the PCB levels needed to comply with the PCBs TMDL requirements. Furthermore, stormwater Programs have neither the authority to compel electrical utilities to provide information about spills, equipment replacement programs, and clean-up protocols, nor the authority to require additional controls. Therefore, BASMAA identified a need to develop and implement a regional SSID work plan to further understand the magnitude and extent of this potential PCBs source, and identify controls (if necessary) that could be put into place to reduce the water quality impacts of this source.

The work plan was submitted with each countywide stormwater program's WY 2018 UCMR. It presents a framework for working with the Regional Water Board, which does have jurisdictional authority over electrical utility companies. The overall goal for the regional SSID project is to investigate electrical utility equipment as a source of PCBs to urban stormwater runoff and identify appropriate actions and control measures to reduce this source. Building on the information presented by SCVURPPP (2018b), this project is designed to achieve the following three objectives:

1. Gather information from Bay Area utilities to improve estimates of current PCBs loadings to municipal separate storm sewer systems (MS4s) from electrical utility equipment, and document current actions conducted by utilities to reduce or prevent release of PCBs from their equipment;
2. Identify opportunities to improve spill response, cleanup protocols, or other programs designed to reduce or prevent releases of PCBs from electrical utility equipment to MS4s;
3. Develop an appropriate mechanism for municipalities to ensure adequate clean-up, reporting and control measure implementation to reduce urban stormwater loadings of PCBs from electrical utility equipment.

The information gained during this project will also provide data that municipalities can use to provide better estimates of PCBs load reductions that can be achieved through implementation of a regional control measure program for electrical utilities.

3.1 Overview of the Regional SSID Work Plan

The work plan identified 4 project tasks: (1) conduct a desk top analysis; (2) propose a source control framework for electrical utility equipment to reduce ongoing PCBs loads to the Bay in stormwater runoff; (3) Develop data inputs to better estimate PCBs load reductions that can be achieved via new source controls; and (4) develop an SSID project report. Each of these tasks are described in more detail below. Progress made to date is provided in Section 3.2.

3.1.1 Task 1: Desktop Analysis

The desktop analysis is designed to gather and evaluate information on electrical utility equipment in the Bay Area to provide the foundation for development of a comprehensive regional control measure program to reduce PCBs loads from this source. The desktop analysis includes the following five sub-tasks:

- **Subtask 1.1 Request information from electrical utility companies.**
  This task will seek the assistance and support of the Regional Water Board to: obtain information from non-municipally owned utility companies that is not publicly available but is needed to better understand the extent and magnitude of PCBs releases from Oil Filled Electrical Equipment (OFEE); identify the most appropriate actions to prevent or reduce releases from this source; and develop and implement effective reporting and control measures. For this task, the Regional Water Board will be asked to assist BASMAA in compelling electrical utility companies (e.g., PG&E) to provide the necessary information. A preliminary list of information that will be requested includes the following:

    - Spill reporting and notification procedures (both region-wide and location-specific);
    - Spill records NOT reported to the California Governor's Office of Emergency Services (Cal OES);
    - SOPs and other documentation used by electrical utilities and their contractors to guide spill response and cleanup actions when releases from OFEE occur;
    - SOPs and documentation, including analytical methods for PCBs used by electrical utilities and their contractors to identify and clean up regular leaks from OFEE during regular maintenance activities;
    - Measurement data on concentrations of PCBs in OFEE;
    - Maintenance records that document when and where PCBs-containing OFEE are removed from the system and how often PCBs containing equipment is inspected for leaks or spills;
    - Documentation of past programs to voluntarily remove PCBs-containing oils or OFEE – including what equipment was removed, and the locations from which it was removed; and
    - Documentation of where PCBs-containing OFEE were located in the past, and where they are currently located across the Bay Area.

  Additional data gaps may also be identified and added to the data request based on discussions with Regional Water Board staff and/or preliminary information provided by utilities.

- **Subtask 1.2 Assess current electrical utility data.**
  This task will review, tabulate and analyze the information provided by electrical utilities as a result of the Regional Water Board's request for information, in order to document the following:

    - Measurement data on PCBs concentrations and/or mass in OFEE;
    - Locations of PCBs-containing OFEE;
    - Quantity of PCBs-containing OFEE removed from service annually;
    - Occurrences of spills or releases from OFEE;
    - Current PCBs spill and cleanup reporting requirements; and
    - Current PCBs cleanup protocols.

- **Subtask 1.3 Improve estimates of PCBs loadings.**
  This task will combine the information provided in Subtask 1.2 with all existing data in order to develop improved estimates of current PCBs loadings from electrical utility equipment to MS4s in the study area. The quality of these estimates will partly depend on the quality of the data received from the utilities.

- **Subtask 1.4 Refine PCBs reporting requirements**
  This task will review all current reporting and notification requirements to identify any improvements or clarifications that the Regional Water Board could require of electrical utilities to provide the type of data needed to better quantify the amount of PCBs released from OFEE spills, and to help ensure that adequate cleanup actions are being implemented.

- **Subtask 1.5 Evaluate PCBs cleanup protocols**
  This task will review all documented cleanup protocols that are currently used by electrical utilities in order to identify any changes or improvements that could be recommended to further reduce the discharge of PCBs to the MS4 when releases occur.

3.1.2 Task 2: Develop Source Control Framework

Based on the results of the desktop analysis, this task will propose an appropriate framework for managing and implementing control measures to reduce PCBs from electrical utility equipment. The framework should include prescribed methods and procedures for unplanned spills and releases from OFEE, as well as a plan for continued reduction of PCBs from in-use OFEE, and potentially further identification and cleanup of historic release sites. The framework will likely include the following elements:

- Summary of the outcomes of the desktop analysis results, including:

    - Summary of information provided by electrical utilities;
    - Improved estimates of current PCBs loadings from electrical utility equipment based on information received;
    - Documentation of current spill clean-up and reporting actions, and existing programs for proactive removal of PCBs-containing oils and equipment conducted by electrical utilities;
    - Recommended PCBs spill and cleanup reporting requirements that the Regional Water Board could require of electrical utilities;

- Recommended improvements to PCBs spill cleanup protocol(s) that would reduce the discharge of PCBs to MS4s that the Regional Water Board could require of electrical utilities.
- Recommended approach to manage and control releases of PCBs from electrical utilities. The approach may include requirements the Regional Water Board could impose on electrical utilities in the Bay Area, such as new spill reporting and cleanup protocols.

3.1.3 Task 3: Develop methodologies to account for PCBs load reductions from new source control measures

BASMAA will further apply the results of the desktop analysis to develop data inputs to better account for the PCBs load reductions that can be achieved via the new clean-up and reporting protocols identified above in Task 2.

3.1.4 Task 4: Develop SSID Project Report

BASMAA will prepare a report describing the desktop analysis and outcomes. The report will summarize the information provided by electrical utilities and identify recommendations to modify or improve current control measures or management actions that will reduce PCBs released to MS4s. The Management Questions that will be addressed include:

1. What is the current magnitude and extent of PCBs stormwater loadings from electrical utility equipment and operations in the San Francisco Bay Area region?
2. Are there aspects of equipment or operational procedures that electrical utilities should be required to report to the Regional Water Board?
3. Are there additional spill and clean-up controls needed to reduce water quality impacts from the release of PCBs in electrical utility equipment?
4. Are there additional proactive activities needed to avoid releases of PCBs from electrical utility equipment?
5. What are the PCBs load reductions that can be achieved through implementation of a regional reporting and control measure program?

3.2 Current Status of the Regional SSID Project

Implementation of the regional SSID work plan began in WY 2019. The Work Plan focused on Pacific Gas and Electric Company (PG&E), the largest electrical utility operating in the MRP area, and the only utility that is not owned by a municipality. The work plan outlined a 2-step process to (1) conduct a desktop analysis using data from PG&E in order to better understand the extent and magnitude of PCBs releases from oil-filled electrical equipment (OFEE) and document current and past efforts to reduce PCBs in OFEE, and (2) propose a source control framework to potentially reduce ongoing PCBs loads to the Bay from electrical utility equipment. The project team developed a letter requesting assistance from the Regional Water Board and outlining the specific data that is needed from PG&E to complete this project. However, PG&E is currently in bankruptcy proceedings, and the outcomes of that process have not yet been determined.

Because of the current situation with PG&E, BASMAA developed a revised approach to the SSID project in early WY 2020 that focuses on municipally-owned electrical utilities in the MRP area. Although these municipally-owned electrical utilities represent a fraction of the electrical utility equipment and properties in the MRP area, BASMAA member agencies have a better opportunity to work with these utilities and gather the type of information needed to conduct the desktop analysis, albeit at a smaller scale. The revised approach will continue to implement the Regional SSID work plan but will focus exclusively on municipally-owned electrical utilities in the Bay Area. The revised approach implements the SSID work plan objectives to develop an appropriate source control framework to inform the development of practices to potentially reduce the release of PCBs from electrical utility equipment; and to develop estimates of PCBs load reductions that could be achieved through implementation of revised management practices, such as improved clean-up and reporting procedures.

In November and December 2019, BASMAA held a series of meetings with representatives from municipally-owned electrical utilities and associated municipal staff in the MRP area to discuss the project and information needs. Based on input provided during these meetings, BASMAA developed an information request for municipally-owned electrical utilities that was similar to the request sent to the Regional Water Board for PG&E data.

BASMAA intends to continue this project during WY 2020. The new request for information will be submitted to each of the municipally-owned electrical utilities in the MRP area in the near future. The BASMAA project team will proceed with the desktop analysis upon receipt of data from these utility partners. It is anticipated that the final project report will be submitted to the Regional Water Board with the Program's WY 2020 UCMR by March 31, 2021.

4.0 Recommendations

Overall, Permittees find that SSID monitoring provides valuable information to assist with identifying stressors and sources of water quality impacts. Although the SSID studies have found that the primary stressor sources are unrelated to municipal stormwater runoff and/or are inconclusive, they have resulted in a greater understanding of hydrology, water quality, and land use in the targeted watersheds, and the findings inform other aspects of management to improve the condition of local receiving waters. Continuation of SSID monitoring in the next permit should be considered, with the level-of-effort determined in a manner mindful of the overall costs of implementing Provision C.8 monitoring requirements and other provisions.

5.0 References

Bay Area Stormwater Management Agencies Association (BASMAA) 2017. Interim Accounting Methodology for TMDL Loads Reduced. Prepared by Geosyntec Consultants and EOA, Inc. March 2017.

Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition (RMC). 2016a. Creek Status and Pesticides & Toxicity Monitoring Quality Assurance Project Plan, Final Version 3. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 83 pp plus appendices.

Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition (RMC). 2016b. Creek Status and Pesticides & Toxicity Monitoring Standard Operating Procedures, Final Version 3. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 190 pp.

Griffith, J.F., Blythe, A.L., Boehm, A.B., Holden, P.A., Jay, J.A., Hagedorn, C., McGee, C.D., and Weisberg, S.B. 2013. The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches. Southern California coastal Water Research Project Technical Report 804.

San Francisco Regional Water Quality Control Board (SFRWQCB). 2009. Municipal Regional Stormwater NPDES Permit. Order R2-2009-0074, NPDES Permit No. CAS612008. 125 pp plus appendices.

San Francisco Regional Water Quality Control Board (SFRWQCB). 2017. Water Quality Control Plan (Basin Plan) for the San Francisco Bay Region. Updated to reflect amendments adopted up through May 4, 2017. http://www.waterboards.ca.gov/sanfranciscobay/basin_planning.shtml.

San Francisco Regional Water Quality Control Board (SFRWQCB). 2015. Municipal Regional Stormwater NPDES Permit. Order R2-2015-0049, NPDES Permit No. CAS612008. 152 pp plus appendices.

San Mateo County Resource Conservation District (RCD). 2014. Final Project Report. Pillar Point Harbor Source Identification Project. Clean Beaches Grant Program, Proposition 50. Agreement 07-574-550-2. January 2014.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2014. Part A of the Integrated Monitoring Report. Water Quality Monitoring. Water Years 2012 and 2013 (October 2011 – September 2013). March 15, 2014.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2015. Urban Creeks Monitoring Report, Water Quality Monitoring Water Year 2014. March 15, 2015.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2016. Urban Creeks Monitoring Report, Water Quality Monitoring Water Year 2015. March 31, 2016.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2017. Urban Creeks Monitoring Report, Water Quality Monitoring Water Year 2016. March 31, 2017.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2018. Urban Creeks Monitoring Report, Water Quality Monitoring Water Year 2017. March 31, 2018.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2019. Urban Creeks Monitoring Report, Water Quality Monitoring Water Year 2018. March 31, 2019.

Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). 2018. Potential Contributions of PCBs to Stormwater from Electrical Utilities in the San Francisco Bay Area. Overview and Information Needs. Prepared by EOA, Inc. September 2018.

USEPA. 2012. Recreational Water Quality Criteria. Office of Water 820-F-12-058. A Non-Predictive Algal Index for Complex Environments.

ATTACHMENTS

Attachment 1
BASMAA RMC Regional SSID Report

BASMAA Regional Monitoring Coalition
Regional Stressor/Source Identification (SSID) Report, prepared in compliance with Municipal Regional Stormwater NPDES Permit (MRP; Order No. R2-2015-0049) Provision C.8.e.iii
MRP 2.0 SSID Project Locations, Rationales, Status
Updated March 25, 2020

SSID Project ID	Date Updated	County/ Program	Creek/ Channel Name	Site Code(s) or Other Site ID	Project Title	Primary Indicator(s) Triggering Stressor/Source ID Project									Indicator Result Summary	Rationale for Proposing/Selecting Project	Current Status of SSID Project or Date Completed	EO Concurrence of project completion (per C.8.e.iii.(b))
						Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Pathogen Indicators	Other				
AL-1	3/23/20	ACCWP	Palo Seco Creek		Exploring Unexpected CSCI Results and the Impacts of Restoration Activities	X									Sites where there is a substantial difference in CSCI score observed at a location relative to upstream or downstream sites, including sites on Palo Seco Creek upstream of the Sausal Creek restoration-related sites, that had substantial and unexpected differences in CSCI scores.	The project will provide additional data to aid consideration of unexpected and unexplained CSCI results from previous water year sampling on Palo Seco Creek, enable a more focused study of monitoring data collected over many years in a single watershed, and allow analysis of before and after data at sites upstream and downstream of previously completed restoration activities.	In WY 2019, nutrient sampling, bioassessment, and additional DO and temperature monitoring were conducted. The final SSID progress report is included in ACCWP's March 2020 IMR, recommending project completion.	
AL-2	1/22/20	ACCWP	Arroyo Las Positas		Arroyo Las Positas Stressor Source Identification Project	X									CSCI scores below the threshold were recorded on Arroyo Las Positas in WYs 2016 and 2017. In 2017, one site exceeded the Basin Plan threshold for chloride. The creek is also listed on the 303(d) list for eutrophication and has an approved TMDL for Diazinon.	The Water Board is conducting sampling in the watershed as part of their TMDL development efforts and an SSID project will supplement those efforts and generate a better overall picture of stressors impacting the waterbody.	In WY 2019, ACCWP conducted bioassessments, nutrient sampling, and continuous monitoring at multiple locations within the watershed over the course of spring and summer months. The first SSID progress report is included in ACCWP's March 2020 IMR.	
CC-1	1/27/20	CCCWP	Lower Marsh Creek		Marsh Creek Stressor Source Identification Study									X	10 fish kills have been documented in Marsh Creek between September 2005 and September 2019. Low dissolved oxygen was proved to be the cause in the most recent (9/17/19) event; circumstances indicate low DO was a likely cause in many if not all of the prior events.	This SSID study addresses the root causes of fish kills in Marsh Creek. Monitoring data collected by CCCWP and other parties are being used to investigate multiple potential causes, including low dissolved oxygen, warm temperatures, daily pH swings, fluctuating flows, physical stranding, and pesticide exposure. During year 2 a pilot test of water storage and night-time flow augmentation was conducted by the City of Brentwood Wastewater Treatment Plant (WWTP).	The CCCWP SSID work plan was submitted in 2018. The Year 2 Status Report is included in CCCWP's March 2020 IMR. The study successfully concluded in Year 2. The final report will recommend project completion. Flow augmentation appears to be a viable means of avoiding lethally low DO in portions of the creek downstream of the WWTP.	

BASMAA Regional Monitoring Coalition
Regional Stressor/Source Identification (SSID) Report, prepared in compliance with Municipal Regional Stormwater NPDES Permit (MRP; Order No. R2-2015-0049) Provision C.8.e.iii
MRP 2.0 SSID Project Locations, Rationales, Status
Updated March 25, 2020

SSID Project ID	Date Updated	County/ Program	Creek/ Channel Name	Site Code(s) or Other Site ID	Project Title	Primary Indicator(s) Triggering Stressor/Source ID Project									Indicator Result Summary	Rationale for Proposing/Selecting Project	Current Status of SSID Project or Date Completed	EO Concurrence of project completion (per C.8.e.iii.(b))
						Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Pathogen Indicators	Other				
SC-1	3/24/20	SCVURPPP	Coyote Creek	NA	Coyote Creek Toxicity SSID Project						X				The SWRCB recently added Coyote Creek to the 303(d) list for toxicity.	This SSID study investigated the extent and magnitude of toxicity in an urban reach of Coyote Creek. Sediment samples (n=8) were collected during the dry season of 2018 and 2019. Samples were generally not toxic, with the exception of one sample that had low levels of toxicity (subsequent re-test of sample was not toxic). Sediment chemistry results were inconclusive (i.e., pesticide concentrations were not at levels suspected of causing toxicity). SSID Project results support similar findings from long term monitoring conducted by the SWAMP SPoT Program of reduced acute toxicity in Coyote Creek over the past 10 years.	The work plan was submitted with SCVURPPP's WY 2017 UCMR. A project report describing the results of the WY 2018 and WY 2019 monitoring and recommending project completion will be submitted with the WY 2019 IMR.	
SC-2	1/29/20	SCVURPPP	Lower Silver-Thompson Creek	NA	Lower Silver SSID Project	X								X	Low CSCI scores and high nutrient concentrations at a majority of bioassessment locations.	Evaluate potential causes of reduced biological conditions in Lower Silver-Thompson Creek. The SSID Project is investigating sources of nutrients and assessing the range and extent of eutrophic conditions (if present). The Project will evaluate association between stressor data (e.g., water chemistry, dissolved oxygen and physical habitat) and biological condition indicators (i.e., CSCI and ASCI scores)	The work plan was submitted with SCVURPPP's FY 18-19 Annual Report. It is anticipated to be a two-year project with the project report to be submitted with the WY 2020 UCMR.	
SM-1	3/24/20	SMCWPPP	Pillar Point / Deer Creek / Denniston Creek	NA	Pillar Point Harbor Bacteria SSID Project								X		FIB samples from 2008 and 2011-2012 exceeded WQOs.	A grant-funded Pillar Point Harbor MST study conducted by the RCD and UC Davis in 2008, 2011-2012 pointed to urban runoff as a primary contributor to bacteria at Capistrano Beach and Pillar Point Harbor. The study, however, did not identify the specific urban locations or types of bacteria. This SSID project investigated bacteria contributions from the urban areas within the watershed. In WY 2018, Pathogen indicator and MST monitoring was conducted at 14 freshwater sites during 2 wet and 2 dry events. Very few samples contained "controllable" source markers (i.e., human and dog). Additional field studies	The work plan was submitted with SMCWPPP's WY 2017 UCMR. A project report describing the results of the WY 2018 and WY 2019 investigations was submitted on October 28, 2019. RWQCB staff requested minor report changes prior to Executive Officer concurrence regarding project completion. A TMDL addressing bacteria in Pillar Point	

SSID Project ID	Date Updated	County/ Program	Creek/ Channel Name	Site Code(s) or Other Site ID	Project Title	Primary Indicator(s) Triggering Stressor/Source ID Project									Indicator Result Summary	Rationale for Proposing/Selecting Project	Current Status of SSID Project or Date Completed	EO Concurrence of project completion (per C.8.e.iii.(b))
						Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Pathogen Indicators	Other				
																were conducted in WY 2019 to understand hydrology and specific source areas.	Harbor is currently under development.	
FSV-1	1/16/20	City of Vallejo in assoc. with FSURMP	Rindler Creek	207R03504	Rindler Creek Bacteria and Nitrogen Study								X		E. coli result of 2800 MPN/100mL in Sept. 2017.	A source identification study is warranted in Rindler Creek due to the elevated FIB result, other (non-RMC) monitoring indicating elevated ammonia levels, and the presence of a suspected pollutant source upstream of the data collection point. Rindler Creek is a highly urbanized and modified creek that originates in open space northeast of the City of Vallejo. Monitoring is conducted just downstream of the creek crossing under Columbus Parkway; upstream of this site there is City-owned land that is grazed by cattle roughly from December-June.	Additional monitoring in the spring and summer of 2019 revealed consistently high levels of E coli and enterococci when cattle are present. A Work Plan is in development and will be submitted with the IMR in March 2020.	
RMC-1	3/24/20	RMC/ Regional	NA (entire RMC area)	NA	Regional SSID Project: Electrical Utilities as a Potential PCBs Source to Stormwater in the San Francisco Bay Area									X	Fish tissue monitoring in San Francisco Bay led to the Bay being designated as impaired on the CWA 303(d) list and the adoption of a TMDL for PCBs in 2008. POC monitoring suggests diffuse PCBs sources throughout region.	PCBs were historically used in electrical utility equipment, some of which still contain PCBs. Although much of the equipment has been removed from services, ongoing releases and spills may be occurring at levels approaching the TMDL waste load allocation. This regional SSID project is investigating opportunities for BASMAA RMC partners to work with RWQCB staff to: 1) improve knowledge about the extent and magnitude of PCB releases and spills, 2) improve the flow of information from utility companies, and 3) compel cooperation from utility companies to implement improved control measures.	The work plan was submitted with each Program's WY 2018 UCMR and implementation began in WY 2019. The work plan outlined a process for BASMAA RMC partners to work with RWQCB staff to better understand PCB releases from electrical utility equipment owned by PG&E and to propose a source control framework. Ongoing bankruptcy proceedings at PG&E stalled the process. Therefore, BASMAA is now reaching out to municipally-owned utilities. The SSID project is anticipated to be completed in June 2020.	

Attachment 2
Final Pillar Point Harbor Watershed Pathogen Indicator SSID Project Report

PILLAR POINT HARBOR WATERSHED PATHOGEN INDICATOR STRESSOR/SOURCE IDENTIFICATION (SSID)

Project Report

Prepared in support of Provision C.8.e of
the Municipal Regional Permit
(NPDES Permit # CAS612008)



SAN MATEO COUNTYWIDE
Water Pollution Prevention Program
Clean Water. Healthy Community.

October 18, 2019

EXECUTIVE SUMMARY

This report presents the results and recommendations of the Pillar Point Harbor Watershed Pathogen Indicator Stressor/Source Identification project. The project was conducted to address requirements in the San Francisco Bay Region Municipal Regional Permit (MRP) for discharges of stormwater runoff. Per MRP Provision C.8.e.ii, Stressor/Source Identification (SSID) projects are designed to identify and isolate potential sources and/or stressors associated with observed or potential impacts to aquatic life or other Beneficial Uses. SSID projects are intended to be oriented toward taking action(s) to alleviate stressors and reduce sources of pollutants.

This SSID project was triggered by fecal indicator bacteria (FIB) densities exceeding Water Quality Objectives (WQOs) in receiving waters and tributaries to Pillar Point Harbor. In an effort to understand the primary sources of fecal contamination at Pillar Point Harbor and to identify potential remediation strategies, the San Mateo Resource Conservation District (RCD) and University of California, Davis (UCD) implemented a Proposition 50 Clean Beaches Initiative Grant-funded study in 2008 and 2011-12 (RCD 2014). The Proposition 50 Pillar Point Harbor Source Identification Project consisted of extensive water quality and hydrologic monitoring in the Harbor and its watershed, including collection of water, sediment, and biofilm samples during wet and dry weather for analysis of FIB (*E. coli* and enterococci) and bacteroidales associated with human, bovine, dog, horse, and avian sources. The RCD (2014) study indicated that high FIB in the Harbor was likely due, in part, to influences from storm drains and creek.

This SSID project follows up on the Pillar Point Harbor Source Identification Project and focuses on identifying spatial and temporal (seasonal) information about FIB sources from the municipal separate storm sewer system (MS4) through desktop and field investigations. Field investigations included grab samples collected at 14 stations located in five subwatersheds draining to Pillar Point Harbor. In most subwatersheds, the sample design included stations upstream of the MS4, within the MS4, and at the outlet to the Harbor. Sampling was conducted during two storm events and two dry season events in Water Year 2018. All samples were analyzed for FIB (*E. coli*) and human and dog bacteroidales genetic markers. Human and dog markers were selected to represent the most likely controllable anthropogenic sources. Desktop investigations conducted in Water Years 2018 and 2019 included development of a geodatabase to map potential bacteria sources and review of monitoring data collected by San Mateo County Environmental Health Services.

Results showed *E. coli* densities often exceed recommended WQOs for freshwaters designated as having water contact recreation (REC-1) Beneficial Uses (i.e., 320 cfu/100mL). However, FIB densities are highly variable and do not follow predictable seasonal patterns across all subwatersheds investigated. For example, two of the subwatersheds did not have higher wet weather FIB densities compared to dry season densities. A dearth of human and dog markers detected in this SSID study (particularly during the dry season) suggests that FIB conveyed by the MS4 may not be controllable. Instead, the sources of FIB within and conveyed by the MS4 appear to be primarily

uncontrollable wildlife (i.e., raccoons, deer, rodents) that are present in the MS4 and contributing areas. Regrowth of FIB in biofilms within the MS4, and subsequent shearing off of these materials is another likely source of FIB to receiving waters.

Stakeholders in the Pillar Point Harbor watershed, such as the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), the County of San Mateo, the RCD, and the Harbor District are already implementing many management actions along the coast and throughout the County that specifically or opportunistically reduce bacterial sources in stormwater runoff. These actions include stormwater and sewer infrastructure improvements, prohibition of non-stormwater runoff, trash controls, pet waste ordinances, pet waste cleanup stations, stormwater education and outreach, confined animal facility best management practices, and beach clean-ups.

Stakeholders may wish to consider additional bacterial control measures. Potential measures include installation of additional pet waste cleanup stations; continued education and outreach; investigations to identify locations within the MS4 where groundwater infiltration may be occurring (and subsequent repair); outreach to the owner(s)/operator(s) of the sewage collection system to understand and potentially improve operations, monitoring, and maintenance; and continued technical assistance to farms and ranches to promote water quality protection.

It is important to acknowledge that a) WQOs for FIB do not distinguish among sources of FIB and b) FIB detections do not necessarily correlate well with the presence of pathogens. Animal fecal waste is much less likely to contain pathogens of concern to human health than human sources, and FIB associated with biofilms likely does not indicate that pathogens are present. In most cases, human sources of fecal contamination are associated with REC-1 health risks rather than wildlife or domestic animal sources (USEPA 2012). Furthermore, even if controllable bacteria sources (i.e., human and dog sources) are eliminated, FIB densities in receiving waters could still exceed WQOs due to wildlife and natural FIB growth in biofilms, sediment, and organic matter.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

This report presents the results of the Pillar Point Harbor Watershed Pathogen Indicator Stressor/Source Identification Project which was initiated in 2017 to address requirements listed under Provision C.8.e of the San Francisco Bay Region National Pollutant Discharge Elimination System (NPDES) stormwater Municipal Regional Permit (MRP) (Order R2-2015-0049). The San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), a program of the City/County Association of Governments (C/CAG), is working with Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) members to collectively initiate eight Stressor/Source Identification (SSID) projects during the five-year term of the MRP (i.e., 2016 – 2020). The Pillar Point Watershed Pathogen Indicator SSID Project satisfies SMCWPPP's contribution toward the eight SSID projects, as agreed upon by the RMC. Per MRP Provision C.8.e.ii, SSID projects are designed to identify and address potential sources and/or stressors associated with observed or potential impacts to aquatic life or other Beneficial Uses. SSID projects are intended to be oriented toward taking action(s) to alleviate stressors and reduce sources of pollutants.

SMCWPPP initiated the Pathogen Indicator SSID Project in the Pillar Point Harbor watershed in response to historical pathogen indicator bacteria data collected from Pillar Point Harbor and its tributaries indicating potential water quality issues. Implementation of the SSID Project is consistent with the Pillar Point Watershed Pathogen Indicator SSID Project Work Plan (Work Plan; SMCWPPP 2018) which was submitted to the San Francisco Bay Regional Water Quality Control Board (Regional Water Board) with the SMCWPPP Urban Creeks Monitoring Report dated March 31, 2018. SMCWPPP implemented the Work Plan with assistance from and in close coordination with the San Mateo Resource Conservation District (RCD) and the County of San Mateo. RCD work on this project was supported by funding provided by the San Mateo County Harbor District.

This introduction (Section 1.0) provides background on pathogen indicators and water quality objectives (WQOs) developed to protect recreational beneficial uses. Section 2.0 of this report describes methods used in the investigation. Section 3.0 presents results of the SSID project desktop and field investigations. Section 4.0 discusses the results within the context of each of the subwatersheds. Section 5.0 summarizes the results and recommends management actions. References are listed in Section 6.0.

1.1 Work Plan Summary and SSID Study Management Questions

This SSID project was designed to identify whether the areas drained by the municipal separate storm sewer system (MS4) that discharge to Pillar Point Harbor (i.e., Study Area) are an important source of bacteria to Pillar Point Harbor and whether the sources of bacteria in the Study Area are controllable (especially human and dog). These are key steps towards the longer-term goal of reducing fecal indicator bacteria (FIB)[1] densities in Pillar Point Harbor and, more specifically, reducing the risk of illness for recreators at the local beaches. In this effort, it is important to understand the regulatory context of the FIB WQOs, the behavior of these bacteria in the environment, and risks associated with FIB.

[1] Fecal indicator bacteria (FIB) are also referred to as "pathogen indicators".

The core of the SSID Project is identification of FIB sources through information gathering. This includes development of a geodatabase with data layers related to the environmental setting and potential FIB sources and working with the RCD and County to gain a better understanding of the tributaries and catchments draining to Pillar Point Harbor.

Consistent with MRP Provision C.8.e.iii, the Work Plan for the SSID Project (SMCWPPP 2018) contains the following elements:

- **Problem definition.** Historic samples collected in receiving waters and tributaries to Pillar Point Harbor had FIB densities that exceed Water Quality Objectives (WQOs) established by the State and Regional Water Boards to protect water contact recreation (REC-1) and noncontact water recreation (REC-2) Beneficial Uses. A Proposition 50 funded study conducted by the RCD and University of California, Davis (UCD) in 2008 and 2011/2012 suggested that high FIB observed at the beaches was likely influenced by storm drains and creeks more than from sources at the beaches and within the harbor itself (Kim and Wuertz 2014).
- **Study objectives.** The objective of the SSID study is to build on the RCD/UCD Proposition 50 Pillar Point Harbor Source Identification Project by focusing on bacteria sources to specific creeks and storms drains that discharge to Pillar Point Harbor. The SSID study is designed to identify spatial, temporal (seasonal), and species-specific information regarding sources of bacteria to Pillar Point Harbor from the community of El Granada and surrounding areas, which are part of unincorporated San Mateo County, an MRP Permittee.
- **Watershed context.** The watershed draining to Pillar Point Harbor is approximately 3,923 acres and consists of several subwatershed areas (Figure 1.1). The Study Area for the SSID project consists of the Pillar Point Marsh, Denniston Creek, Capistrano Catchment, St. Augustine Creek, and Deer Creek subwatershed areas that are drained by the MS4 and regulated through the MRP.
- **Candidate causes.** Table 1.1 lists potential sources of FIB that may be present in the Study Area. Potential sources are grouped into two categories: controllable and uncontrollable. Controllable sources are those that could be reduced through management actions implemented by municipalities; however, the magnitude of reduction may be constrained. Uncontrollable sources occur naturally and would be difficult or impossible to reduce through the types of management actions available to municipalities.

Table 1.1. Potential sources of pathogen indicators in the Study Area within the Pillar Point Harbor watershed.

Controllable Sources
Pet waste (cats, dogs, chickens)
Wildlife waste (birds, rodents, deer, raccoons), associated with human activities, such as littering and exposed trash receptacles, which can attract wildlife by creating scavenging areas. (Some wildlife waste is controllable; however, most is probably not. Nor would it be desirable to eliminate wildlife from creek corridors.)
Trash receptacle leachate. Trash bins may also contain discarded pet waste or diapers.
Illicit connections.
Power-washing of mats, containers, and impervious surfaces into the MS4.
Human waste discharges (homeless encampments, RV discharges, dumping, leaking sewer lines and septic systems).
Domestic animals and livestock (cattle, horses, chickens, goats). *Likely not present in the area drained by the MS4 (i.e., the Study Area) but may be present within upper watershed.*
Uncontrollable Sources
Wildlife waste (birds, rodents, deer, raccoons, ground squirrels, rabbit, skunk, opossum, coyotes, wild turkey) from wildlife in open space, creek corridors, beaches, stormwater conveyance systems, and forested areas.
Bacteria naturally present in the environment (e.g., biofilms, organic matter, soils, and sediments in the watershed, creek, and conveyance system).

- **Study design and schedule.** The SSID investigation, conducted during Water Years 2018 and 2019, combined desktop approaches and water sample analyses that generally follow the *California Microbial Source Identification Manual: A Tiered Approach for Identifying Fecal Pollution Sources to Beaches* (Griffith et al. 2013). The desktop analysis was based primarily on information gathering and development of a geodatabase. The field investigation consisted of sample collection during two wet weather and two dry season events at fourteen stations. Stations were selected to characterize specific land uses and contributing areas. Samples were analyzed for FIB (*E. coli*) and bacteroidales associated with humans and dogs.

Three Management Questions were identified in the Work Plan:

1. Are there specific areas within the Study Area that are contributing FIB to receiving waters during wet and dry conditions?
2. Are there downstream trends in FIB densities in creeks that flow through urban areas to Pillar Point Harbor during wet and dry conditions?
3. Are controllable sources of bacteria (especially human and dog) present in the urban areas?

The Work Plan also describes the potential need to identify management actions to control bacteria densities in receiving waters depending on results of the SSID investigation.

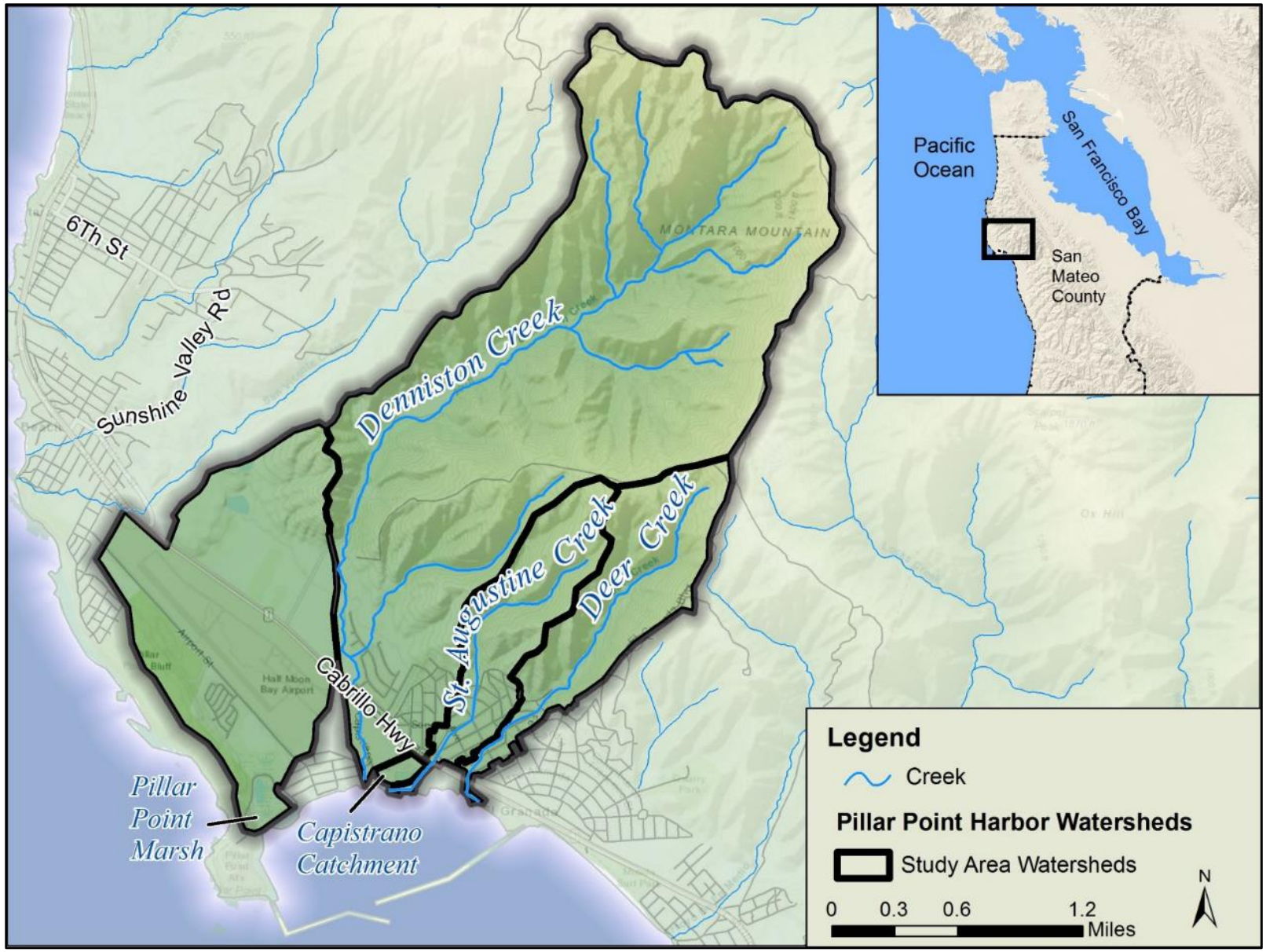


Figure 1.1. Pillar Point Harbor watershed and subwatersheds.

2.0 Methods

In accordance with the Pillar Point Harbor Watershed SSID Work Plan (SMCWPPP 2018), both desktop and field methods based on the tiered approach described in the *California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches* (Griffith et al. 2013) were implemented. Study methods are summarized below; see the SSID Project Work Plan (SMCWPPP 2018) for detailed method descriptions.

2.1 Desktop Analysis

Existing and new data related to potential sources of FIB were collated in a geographic information system (GIS) database using ArcGIS software. The geographic extent of the GIS data layers in the database is generally limited to the portions of the Pillar Point Harbor watershed mapped in Figure 1.1 which includes the following subwatersheds/catchments: Pillar Point Marsh, Denniston Creek, Capistrano Drainage, St. Augustine Creek, and Deer Creek. Data layers were created and digitized by EOA or acquired from public sources such as San Mateo County Information Services Department. The database metadata (Appendix A) contains information on the methodology for creating/compiling individual GIS layers and attribute details for each layer.

The desktop analysis also included review of beach monitoring data collected by County Environmental Health Services and other relevant information gathered by RCD staff. RCD staff conducted targeted reconnaissance surveys of the watershed to understand local hydrology and identify FIB sources such as areas with wildlife, pet waste, and homeless encampments. RCD staff also conducted dye testing within limited portions of the sanitary sewer system to assess whether leaks were reaching the MS4.

2.2 Field Investigation

Fourteen monitoring stations were selected to characterize background water quality upstream of the areas drained by the MS4 and specific catchments within the Study Area. Table 2.1 lists the station locations, goals for each station, and bacteria sampling history. Stations are mapped in Figure 2.1. Samples were collected during four sampling events: two events within 48 hours of rainfall totaling at least 0.20 inches over a 6-hour period (January 9, 2018 and March 2, 2018) and two events during the dry season (June 27, 2018 and July 18, 2018). All stations were sampled during each of the four events unless flowing water was not observed.

All grab samples were analyzed by Cel Analytical in San Francisco, CA for:

- *E. coli* using Standard Method (SM) 9223B
- Universal bacteroidales gene markers (UniB) using quantitative polymerase chain reaction (qPCR)
- Human bacteroidales gene markers (HF183) using qPCR
- Dog bacteroidales gene markers (DogBac) using qPCR

Field measurements of pH, dissolved oxygen, specific conductance, temperature, and ammonia were also collected and recorded with each grab sample.

2.2.1 *E. Coli* Monitoring

E. coli is the FIB recommended by USEPA (2012) for freshwater and was recently adopted by the State Water Resources Control Board as the applicable bacteria indicator, replacing fecal and total coliform. *E. coli* results from this SSID Project are compared to the statistical threshold value (STV) WQO of 320 cfu/100 mL[2] for freshwater (i.e., waters were the salinity is equal to or less than 1 parts per thousand[3] [ppth] 95 percent or more of the time). In this report, the STV is used synonymously with the concept of the single sample maximum (SSM) criteria. The *E. coli* six-week geometric mean (GM) WQO for freshwater is 100 cfu/100 mL.

Water quality objectives for water contact in ocean waters are based on enterococci and fecal coliform. The enterococci SSM WQO in ocean waters is 110 cfu/100 mL. The enterococci six-week GM WQO is 30 cfu/100 mL.

It is important to recognize that pathogen indicator thresholds and WQOs were derived based on human recreation at beaches receiving bacteriological contamination from human wastewater and may not be applicable to conditions in urban creeks which do not receive wastewater treatment plant discharges. Pathogen indicators (i.e., FIB) observed at the Pillar Point Harbor stations may not be associated with human sources and therefore may pose a relatively low threat to human health compared to human sources. As a result, the comparison of FIB results to WQOs may not be appropriate and should be interpreted cautiously.

2.2.2 Microbial Source Tracking

The presence of *E. coli* in Pillar Point Harbor tributaries may indicate fecal contamination; however, *E. coli* results alone do not indicate whether the fecal contamination is associated with a potentially controllable source such as human or pet waste. Therefore, microbial source tracking (MST) techniques were applied to begin characterizing which individual animal species are contributing to fecal contamination in the creeks and MS4. The Pillar Point Harbor SSID Project included sampling for the bacterial group of bacteroidales as an MST approach. Bacteroidales are an abundant bacteria found in human and animal feces that have been found to survive for up to six days in the environment. Similar to pathogens, bacteroidales have little potential for growth outside of the digestive tract of animals. Bacteroidales have a high degree of host specificity and therefore can be used to distinguish between human and other sources of fecal contamination by analyzing gene markers using qPCR.

The microbial source tracking (MST) markers (human and dog) were selected for this SSID Project because they are the most likely “controllable” bacteria sources associated with urban development.

[2] In this document, bacteria colony forming units (cfu) per 100 milliliters (mL) (i.e., cfu/100 mL) are used interchangeably with most probably number (MPN) per 100 mL.
[3] A salinity of 1 ppth is roughly equal to a specific conductance of 1,968 microSiemens (uS) per centimeter (cm).

Table 2.1. Pillar Point Harbor Watershed Pathogen Indicator SSID Project sample stations.

Station ID	Latitude	Longitude	Location	Goal	Bacteria Sampling History
Pillar Point Marsh Subwatershed					
ARPT	37.50638	-122.49473	Swale draining Airport St.	Captures runoff from Airport St. and Pillar Ridge Mobile Home Park	None
Denniston Creek Subwatershed					
DNUS	37.51618	-122.48781	End of Bridgeport Dr./Cabrillo Farms	Background station (upstream of MS4).	Approximate location of Kim and Wuertz (2014) station PPH-DN4. Sampled for FIB and MST in Dec 2012. Limited sampling by RCD.
DNCS	37.50798	-122.48503	Drainage swale below MS4 outfall near Sonora Ave/Coral Reef Ave in upper watershed.	Isolates residential areas in upper watershed. Likely dry during dry weather.	None
DNPC	37.50471	-122.48657	Manhole near Prospect Way/Capistrano Rd.	Includes majority of MS4 discharges in watershed.	Limited sampling by RCD and SMCWPPP
DNDS	37.50522	-122.48700	Creek downstream of Prospect Way.	Downstream station near mouth of creek.	Kim and Wuertz (2014) station PPH-4. Sampled biweekly for FIB in 2011 and 2012. Sampled for MST in 2008, 2011, and 2012 (n=20). Sampling by RCD (2014-2017) and during first flush events.
Capistrano Catchment					
CPNO	37.50447	-122.48576	Manhole on Capistrano Rd in front of HMB Brewing Company	North portion of catchment. GW infiltration causes perennial flow.	Limited sampling by RCD and SMCWPPP
CPSO	37.50367	-122.48520	Inlet on Capistrano Rd in front of Barbara's Fishtrap	South portion of catchment.	Limited sampling by RCD and SMCWPPP
CPDS	37.50381	-122.48590	Outfall to beach	Captures entire Capistrano Catchment.	Kim and Wuertz (2014) station PPH-1. Sampled biweekly for FIB in 2011 and 2012. Sampled for MST in 2008, 2011, and 2012 (n=20). Sampling by RCD (2014-2017) and during first flush events (2008-2017). Some Surfrider data.

Station ID	Latitude	Longitude	Location	Goal	Bacteria Sampling History
St. Augustine Creek Subwatershed					
AGUS	37.50989	-122.47706	Creek at end of Montecito Ave	Background station (upstream of MS4).	Kim and Wuertz (2014) station PPH-2B. Limited sampling by RCD.
AGCH	37.50548	-122.4814	Manhole on north side of Capistrano Rd/Hwy 1	Captures engineered creek and entire residential MS4 (upstream of Harbor District property).	Limited sampling by RCD
AGDS	37.50330	-122.4845	Outfall to beach at "Bathhouse"	Downstream station. Sampling only possible during low tide.	Kim and Wuertz (2014) station PPH-2. Sampled biweekly for FIB in 2008, 2011, and 2012. Sampled for MST in 2008, 2011, and 2012 (n=18). Sampling by RCD (2014-2017) and during first flush events.
Deer Creek Subwatershed					
DRUS	37.50987	-122.47223	Creek near end of San Juan Ave	Background station (upstream of MS4).	Approximate location of Kim and Wuertz (2014) station PPH-DR6. Sampled for FIB and MST in Dec 2012.
DRVL	37.50642	-122.47670	Creek at Valencia Ave crossing	Captures creek and majority of non-engineered MS4 draining residential area.	Approximate location of Kim and Wuertz (2014) station PPH-DR4. Sampled for FIB and MST in Dec 2012.
DRDS	37.50272	-122.47710	Outfall to beach on east side of Launch Ramp	Downstream station. Sampling only possible during low tide.	Kim and Wuertz (2014) station PPH-8. Sampled biweekly for FIB in 2011 and 2012. Sampled for MST in 2008, 2011, and 2012 (n=14). Sampling by RCD (2014-2017) and during first flush events.

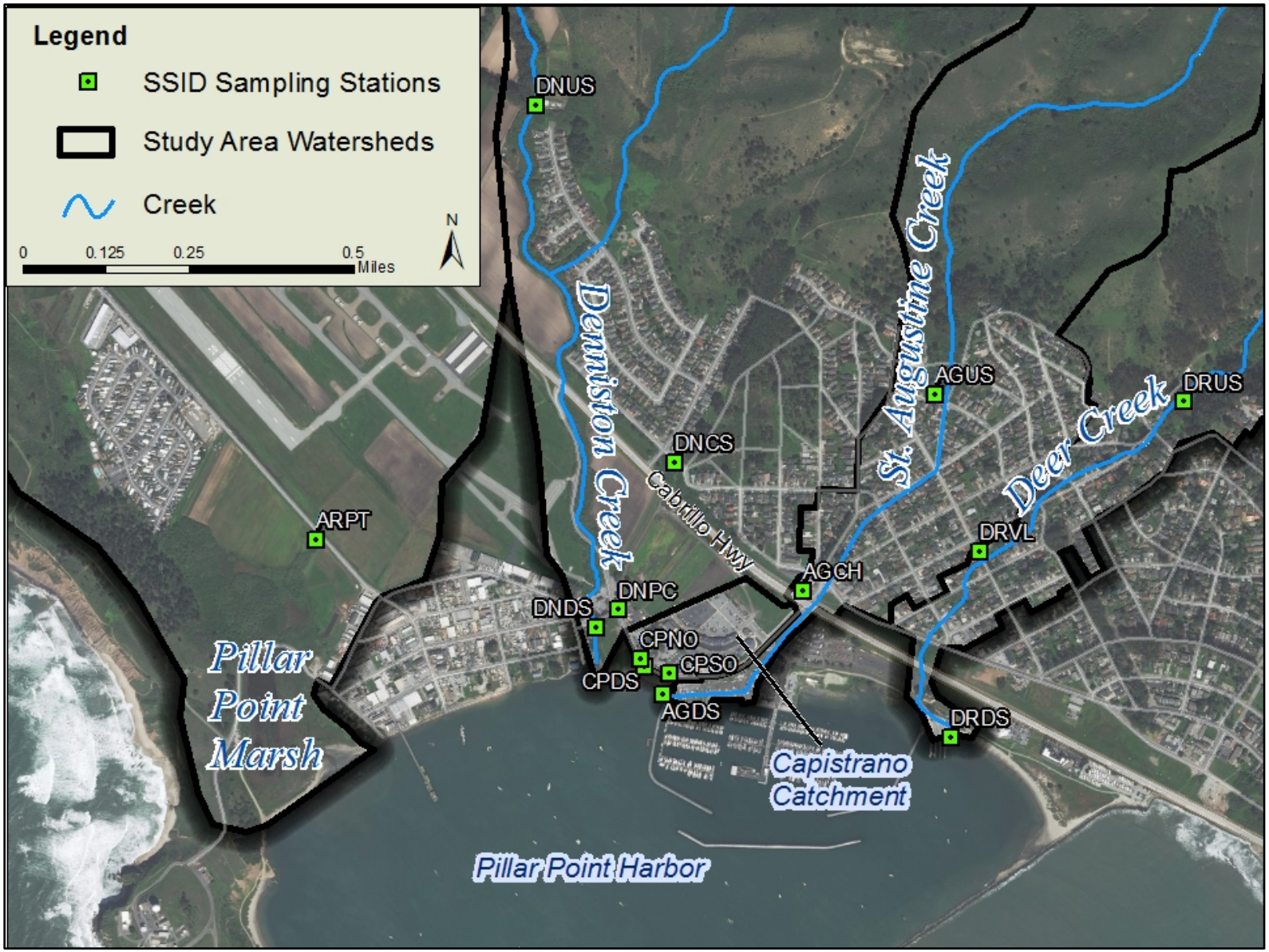


Figure 2.1. Pillar Point Harbor Watershed Pathogen Indicator SSID Project monitoring stations.

2.3 Statement of Data Quality

Data Quality Assurance/Quality Control (QA/QC) for the SSID Project was performed in accordance with procedures established in the BASMAA RMC Quality Assurance Project Plan (QAPP) (BASMAA 2016a) and Standard Operating Procedures (SOPs; BASMAA 2016b), SOP FS-13 (Standard Operating Procedures for QA/QC Data Review). The BASMAA RMC SOPs and QAPP are based on the SOPs and QAPP developed by the Surface Water Ambient Monitoring Program (SWAMP). Data collected during the Pillar Point Harbor SSID Project were compared to seven Data Quality Objectives (DQOs) defined in the BASMAA RMC QAPP that evaluate whether collected data are of adequate quality for their intended use. These DQOs include both quantitative and qualitative assessments of data acceptability. The qualitative goals include representativeness and comparability, and the quantitative goals include completeness, sensitivity, precision, accuracy, and contamination. Overall, the data collected for the SSID Project met the QA/QC objectives.

Representativeness – The representativeness of data is the ability of the sampling locations and sampling procedures to adequately represent the true conditions found at the sample sites. For this project, all samples are assumed to be representative as they were taken according to the protocols specified in the BASMAA RMC SOP and QAPP. All field and laboratory personnel were familiarized with the monitoring methods used in the project and followed prescribed protocols, including laboratory methods to ensure the collection of representative, uncontaminated samples.

Comparability – Comparability is the degree to which data can be compared directly to other studies. The SSID Project data were determined to have sufficient comparability to other similar studies The SSID Project used the same methods for field collection and laboratory analysis of FIB samples as is normally used for FIB sampling carried out as a component of the Creek Status Monitoring projects conducted by the BASMAA RMC. Additionally, the data generated from the SSID Project were entered into Microsoft Excel templates developed by SWAMP and reviewed using SWAMP's online data checker to ensure that the data were formatted correctly. Electronic data deliverables (EDDs) containing the project data were submitted to the San Francisco Bay Regional Water Quality Control Board on March 31, 2019.

Completeness – Completeness is the degree to which all data were generated as planned in terms of both data collection and subsequent analysis. The BASMAA RMC QAPP defines an acceptable completeness threshold for FIB sampling as greater than or equal to 90%, meaning that the SSID Project met the completeness objective.

Sensitivity – Sensitivity is determined by the ability of an analytical method to measure a target parameter at a specified concentration and can be characterized using such metrics as instrument detection limits (IDLs), method detection limits (MDLs), and reporting limits (RLs). For SWAMP-comparable programs, RLs are the measurement of primary interest. The BASMAA RMC QAPP defines the target reporting limit for *E. coli* as 2 MPN/100 mL, meaning that any analytical reporting limit used by the laboratory less than or equal to this endpoint indicates an acceptable sensitivity. The SSID Project *E. coli* samples were analyzed with a reporting limit of 10 MPN/100 mL, meaning the samples did not meet the Sensitivity DQO. However, the exceeded RLs were due to a 10x dilution being necessary for all samples to be quantified, and the RLs would have been less than the target RL if dilution had not been necessary. The

BASMAA RMC QAPP does not specify target reporting limits for bacteroidales analytes, meaning that no sensitivity analysis could be performed for these samples.

Precision – Precision describes the variation in measurement between multiple samples of the same analyte. The BASMAA RMC QAPP requires one laboratory duplicate to be run per 10 samples or per analytical batch, whichever is more frequent. However, determining precision for pathogen indicators requires 15 duplicate sets. Due to the small number of samples collected for this project, there were not enough laboratory duplicates to determine precision.

Accuracy – Accuracy describes the conformity of a measurement to an acceptable reference or true value. The BASMAA RMC QAPP states that positive and negative laboratory controls are to be used to evaluate the accuracy of FIB analysis. Positive laboratory control samples spiked with a known concentration and laboratory blanks were collected and analyzed for all analytes within each lab batch. All positive control samples were found to have detectable concentrations of the target analyte, and all laboratory blanks were measured as non-detect.

Contamination – Contamination determines whether the analyte concentration in a given sample has originated from the target matrix in the sample environment itself or was artificially increased due to factors of the collection or analytical process. Field and laboratory blanks are used to assess potential contamination during sample collection, preparation, and analysis. According to the BASMAA RMC QAPP, laboratory blanks must be collected whenever a sample dilution was necessary, but field blanks are not required. However, both field and laboratory blanks were collected and analyzed during each sample event of the SSID Project, and all were measured as non-detect.

3.0 Results

3.1 Mapping

Geographic information was collected and digitized to identify potential FIB sources and to interpret and visualize relationships between different variables. Most information falls into one of two categories: (1) providing information on the geographic setting of the Study Area and its surroundings, or (2) descriptive of potential bacteria sources. Metadata are included in Appendix A and maps compiling the data layers are included in Appendix B.

3.1.1 Geographic Setting Layers

Geographic setting layers provide the context within which potential bacteria sources and their fate and transport should be evaluated.

- **Creeks** *(Creeks)* – This layer was derived from the National Hydrography Dataset and edited using the Midcoast Storm Drain Inventory Project, prepared by BKF Engineers (2013) (Storm Drain Inventory Project). It shows surface water flows in the region and includes Denniston Creek, St. Augustine Creek, and Deer Creek.

- **Pillar Point Harbor Watersheds** (*Watersheds*) **–** This layer contains the watersheds that drain to Pillar Point Harbor including Pillar Point Marsh, Denniston Creek, St. Augustine Creek, and Deer Creek watersheds, and the Capistrano MS4 catchment. The watersheds were delineated by EOA using the Storm Drain Inventory Project (BKF Engineers 2013) and digital elevation models to improve accuracy. The delineated subwatersheds create a basic hydrologic model of the Study Area.

- **Stormwater System** (*Storm_Drain_Lines*) – This layer, provided by San Mateo County and prepared by FUGRO, shows stormwater conveyance systems such as storm drain lines and ditches which discharge to creeks within the Study Area. For enhanced accuracy, this layer was compared to the Storm Drain Inventory Report (BKF Engineers 2013) and a separate storm drain layer provided by the RCD.

- **Land Use Parcels** *(Parcels)* – This layer is maintained by San Mateo County and includes all parcels within the study. The land use of each parcel provides insight on potential sources draining to Pillar Point Harbor.

- **EOA Land Use Parcels** ***(****EOA_Landuse****)*** – This layer was first created by EOA with the help of San Mateo County for a County trash project. Land use was further collated and truthed for parcels within the Study Area by EOA for this report. This layer has fewer land use designations than the original County layer. The land use of each parcel provides insight on potential sources draining to Pillar Point Harbor.

- **SSID Sites** *(PPHSSIDSites)* – This layer includes the sites where bacteria samples were collected for this SSID study.

- **Other Sampling Locations** *(Bacteria_Sampling Stations)* – This layer contains locations where bacteria samples have been collected on the beaches by the San Mateo County Health Department.

- **SSID Watersheds** (SSID_*Watersheds*) **–** This layer maps the catchments that drain to each of the SSID Sites and helps outline sources for each site. Catchments were delineated using the *Watersheds* layer, digital elevation models, as well as aerial and Google Street View imagery.

3.1.2 Potential Bacteria Source Layers

Potential bacteria sources (listed in Table 1.1) are mapped to gain an understanding of where they occur within the Study Area, how they relate to monitoring results, and where control actions could be targeted.

- **Potential Direct Human Sources** *(Direct_Human_Sources)* – This layer shows current and historic locations of likely direct human sources. The locations were noted by RCD staff. A location is considered a direct source if human waste is observed on the ground and/or there is evidence of people residing there, which could range from obvious garbage and tents to people being there at the time of inspection. One small (i.e., single occupancy) homeless camp has been noted in the woody vegetation on the beach in front of Half Moon Bay Brewing Company at the Capistrano Catchment outfall. Transient homeless have been sighted behind the Mezza Luna restaurant along Denniston Creek. There is evidence of people living in RVs and cars along Airport Street and in Princeton (which borders the Study Area), which suggests that human waste could be present in the vicinity and is why station ARPT was selected (see Table 2.1 and Figure 2.1).

- **Pets** *(Pets)* – Pet waste, when left on the ground, can be a major source of bacteria to MS4s and receiving waters. Residential areas, parks, and favorite dog walking routes are the most likely areas where pet waste is found. The RCD assisted in identifying areas where dog waste was observed. These areas include the open space off Sevilla Avenue, the French and Clipper Ridge trailheads, and the upper watershed of Deer Creek.

- **Dog Waste Stations** *(Dog_Waste_Stations)* – These stations were identified by the RCD as locations where dog waste can be disposed of properly. These points help in considering areas where dogs might frequent, but also where dog waste is managed.

- **Trails** *(Trails)* – This layer was developed by the National Park Service and clipped to include relevant trails in the Pillar Point Harbor watershed. Trails receive frequent use from dog walkers and equestrians and, if waste from these animals is not managed, could act as avenues for contaminated runoff.

- **Sanitary Sewer System** (*Sanitary_Sewer_Lines*) – This layer shows the infrastructure network used to transport wastewater from properties near Pillar Point Harbor to the wastewater treatment facility (Sewer Authority Mid-Coastside) in Half Moon Bay. While this layer was utilized in the source tracking analysis, it is not available to the public and is not included in the geodatabase. Occasional or undiscovered leaks could be a potential source of bacteria to MS4s and receiving waters in the Study Area. The RCD performed three dye tests at targeted locations in the Capistrano Catchment during wet and dry weather with no response observed in the MS4 (i.e., inconclusive results).

- **Sanitary Sewer Overflow Events** *(SSO)* – This point layer maps sanitary sewer overflow (SSO) events that occurred within the Study Area. Category 1 events are discharges of untreated or partially treated wastewater that reach surface water, are not fully captured, and/or are not disposed of properly. Category 2 and Category 3 events do not reach surface waters and therefore are not included. SSOs and leaking conveyance lines can contribute bacteria to MS4s and receiving waters through surface and subsurface pathways. Data were obtained from the State Water Resources Control Board Sanitary Sewer Overflow Reduction Program website. There was one event in the Study Area near the east side of Pillar Point Marsh in 2012; however, no events of any category are listed during the SSID study sampling period (i.e., Water Year 2018).

- **Septic Tanks** *(Septic_Tanks)* – Failing septic systems (i.e., onsite wastewater treatment systems [OWTS]) can allow untreated human waste to flow into drainage ditches and MS4s. The County reports that there is one septic system in the vicinity of the Study Area, on the Half Moon Bay Airport property. While this layer was utilized in the source tracking analysis, it is not available to the public and is not included in the geodatabase.

- **Livestock Areas** *(Livestock)* – Livestock manure, if not properly managed, is potentially a significant source of FIB in the study area. The polygons in this layer show areas that contain or potentially contain livestock such as goats, cattle, or horses. Livestock areas were identified though aerial photo interpretation and local knowledge of the study area. A cattle ranch is located in the Deer Creek watershed. It was also noted that equestrian activity regularly occurs on trails in the upper reaches of Denniston Creek on GGNRA trails.

- **Business sources** *(Business_Sources)* – Disposal of greywater and wastewater from commercial enterprises could introduce bacteria to the MS4. Anecdotal observations and relevant stormwater violations and complaints recorded by the County were compiled to create a GIS layer for these business locations.

- **Storm Drain Issues** *(Storm_Drain_Issues)* –This layer maps probable leaking or damaged infrastructure as noted by RCD staff. Damaged storm lines could be infiltrated by contaminated groundwater. Also, they may not drain properly resulting in pools of stagnant water that attract wildlife and provide habitat for bacteria growth (i.e., biofilms). This layer is a subset of the *Storm_Drain_Lines* layer and was created with direction from RCD staff.

- **Wildlife** *(Wildlife)* – Birds, seagulls, opossums, raccoons, skunks, squirrels, deer, ducks, rodents, pigeons, snakes, woodrats, bobcats, mountain lions, coyotes, and other wildlife are often the primary source of bacteria in creeks. Locations where raccoons were entering the storm drain system and where birds were flocking are included in this layer.

3.2 FIB and MST Monitoring

In accordance with the SSID Work Plan, four sampling events were conducted during Water Year[4] 2018 (WY 2018). Figure 3.1 illustrates the sampling events within the perspective of rainfall recorded at Half Moon Bay, CA approximately 2.5 miles south of the Pillar Point Harbor watershed. The January 9, 2018 sampling event was conducted during a 2-inch storm event resulting in a seasonal total of 9 inches of rainfall. The March 2, 2018 sampling event was conducted during a 0.38-inch storm event. The June 27, 2018 sampling event was conducted during the dry season 18 days after the last recorded rainfall event exceeding 0.08 inch. Rainfall was recorded during two days between the June sampling event and the July 18, 2018 sampling event; however, both of the recorded amounts were less than 0.04 inch. A total of 18.4 inches of rainfall were recorded in WY 2018 which is about 10 inches less than the annual average rainfall of 28.98 inches.

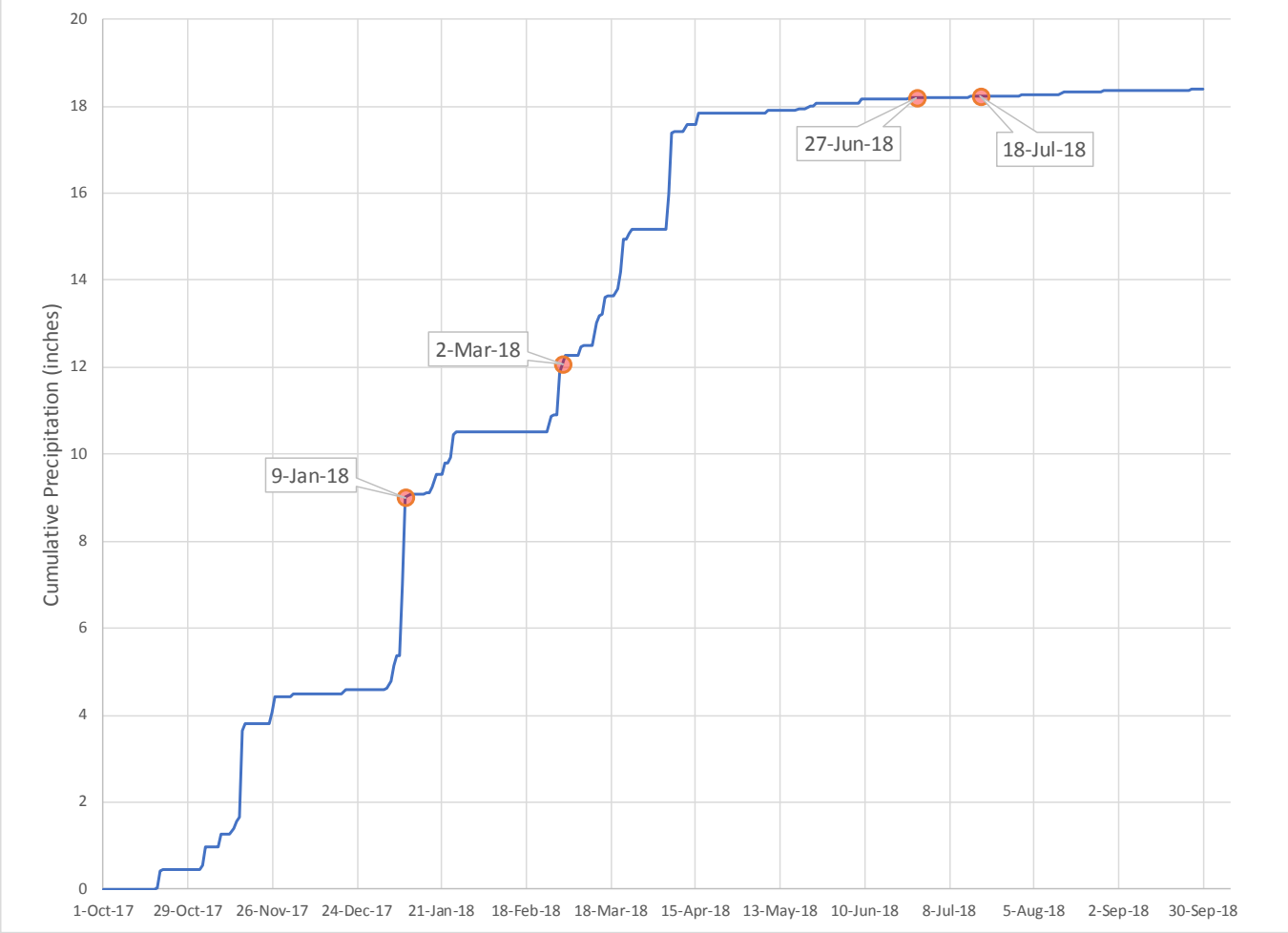


Figure 3.1. Cumulative precipitation at Half Moon Bay, CA (source: U.S. Climate Data) and SSID project sample dates, WY 2018.

[4] Most hydrologic monitoring is conducted on a "water year" basis, which is generally consistent with wet and dry season precipitation patterns. A water year begins on October 1 and ends on September 30 of the named year. For example, WY 2018 began on October 1, 2017 and ended on September 30, 2018.

Table 3.1 lists the analytical results, field measurements, and field observations for the 14 stations targeted in this study. Table 3.1 is organized according to the five subwatersheds where samples were collected. Table 3.2 summarizes human and dog marker results only.

E. coli densities measured during the Pillar Point Harbor Watershed SSID project ranged from 10 MPN/100 mL during the dry season at upstream stations to 24,196 MPN/100 mL during the January 9, 2018 storm event in the Capistrano Catchment. Many of the samples exceeded the newly adopted statewide SSM WQO for *E. coli* in freshwater of 320 MPN/100 mL.

E. coli densities were generally lower at stations upstream of the MS4 compared to downstream stations and were generally higher during storm events compared to the dry season. However, as the sections below detail, these general patterns were not consistent in each of the sampled subwatersheds.

Human and dog markers were present in very few of the samples. Human markers were only detected during the January 9, 2018 storm event in the Capistrano Catchment. Dog markers were more widespread (Denniston Creek, Capistrano Catchment, and St. Augustine Creek) and were detected during both of the storm sampling events, but not during the dry season.

Table 3.1. Bacteria monitoring results and field observations, Pillar Point Harbor Watershed SSID Project. *E. coli* results exceeding the freshwater single sample WQO of 320 cfu/100mL at ambient water station (i.e., not MS4 stations) are shown in **bold.**

Date	Time	*E. Coli*	B. (Human marker)	B. (Dog marker)	Estimated flow	pH	Temp.	Specific Cond.	DO	DO	Ammonium (NH_4^+)	Comments
		(MPN/100mL)	*(gc/mL)*	*(gc/mL)*			*(C°)*	*(µS/cm)*	*(% sat.)*	*(mg/L)*	*(mg/L)*	
Pillar Point Marsh Subwatershed												
ARPT - Swale draining Airport Street												
01/09/18	9:30	**1,014**	0	0	5-20 cfs	6.62	12.9	352	79	7.8	1.2	Lots of trash in drainages and ditches. More drainage from RV (southeast) side of the street, but most from culvert under airport field. Geese and other birds here. Sampled after crew member fell in and disturbed the water.
03/02/18	7:05	96	0	0	1-5 cfs	7.03	9.5	527	87	9.9	0.22	Trash present.
06/27/18	9:42	NS	NS	NS	Isolated Pool	7.41	15.5	645	59	5.8	0.09	Not sampled due to lack of flow.
07/18/18	12:05	NS	NS	NS	Isolated Pool	6.75	16.8	731	62	5.9	0.09	Stagnant. Not sampled due to lack of flow.
Denniston Creek Subwatershed												
DNUS - Background station (upstream of MS4)												
01/09/18	11:20	292	0	0	1-5 cfs	6.72	12.4	261	100	10.7	0.28	Small tributaries to creek discharging downstream of sampling station have higher flow than usual and some foam. Dog waste on trail near the tributary.
03/02/18	7:55	63	0	0	1-5 cfs	7.15	9.4	264	99	11.3	0.11	Active erosion occurring upstream and at sample site.
06/27/18	9:00	36	0	0	0.1-1 cfs	7.54	13.5	343	83	8.5	0.12	NR
07/18/18	11:45	10	0	0	0.1-1 cfs	6.93	15.1	366	36	3.6	0.9	No flow at sample site, sample collected just upstream, on other side of road crossing.
DNCS - Residential catchment (WQOs do not apply to stations within the MS4*)*												
01/09/18	11:00	7,550	0	617	0.1-1 cfs	6.67	11.4	309	95	9.9	0.45	Trash present.
03/02/18	7:45	17,329	0	0	Trickle (<0.1 cfs)	7.03	11.9	327	79	8.5	0.21	Trash and surface scum present. Stagnant, suds on the street.
06/27/18	8:50	NS	NS	NS	Isolated Pool	7.18	16.4	1092	36	3.7	2.62	Trash present.
07/18/18	11:40	NS	NS	NS	Dry	NR	NR	NR	NR	NR	NR	Too dry to sample.
DNPC - Main MS4 in Denniston watershed (WQOs do not apply to stations within the MS4*)*												
01/09/18	10:40	4,160	0	188	1-5 cfs	6.52	13.1	348	93	9.7	0.61	Flow entering from both sides into the manhole (DNPC) but most from the east from residential MS4 that flows to open ditch then back underground behind Seville.
03/02/18	7:30	15,531	0	8	Trickle (<0.1 cfs)	6.93	10.7	427	90	10.0	0.16	Stagnant.
06/27/18	8:15	10	0	0	Isolated Pool	7.17	16.3	937	86	8.3	0.26	Leaf litter present. Grate upstream (behind Seville) has stains, possibly oil or other dumping.
07/18/18	11:30	377	0	0	Trickle (<0.1 cfs)	6.76	18	963	82	7.5	0.16	Water present in grate behind Seville (groundwater infiltration?), oil stains sign of dumping?
DNDS - Downstream station near mouth of creek												
01/09/18	10:20	**771**	0	22	5-20 cfs	6.7	12.5	282	96	10.2	0.35	RV parked directly over storm drain. Approx. 70% of flow at station is from creek; 30% from MS4 outfall at bridge.
03/02/18	7:15	**386**	0	5	1-5 cfs	7.25	9.5	306	102	11.5	0.1	NR
06/27/18	8:05	279	0	0	0.1-1 cfs	7.43	14.5	570	83	8.4	0.16	NR
07/18/18	10:50	**552**	0	0	0.1-1 cfs	6.99	15.2	584	89	8.8	0.24	Downstream water appears very anoxic, blue sheen on water. Dog feces, trash above outfall upstream of DNDS. Creek upstream of road crossing is entirely subsurface.

Date	Time	*E. Coli*	B. (Human marker)	B. (Dog marker)	Estimated flow	pH	Temp.	Specific Cond.	DO	DO	Ammonium (NH_4^+)	Comments
		(MPN/100mL)	*(gc/mL)*	*(gc/mL)*			*(C°)*	*(µS/cm)*	*(% sat.)*	*(mg/L)*	*(mg/L)*	
Capistrano Catchment												
CPNO - North portion of catchment (WQOs do not apply to stations within the MS4***)***												
01/09/18	1:30	231	30	0	0.1-1 cfs	6.78	15.2	968	75	7.5	0.23	Oily sheen upstream. Sulfide odor.
03/02/18	8:25	496	0	0	Trickle (<0.1 cfs)	6.86	12.9	910	65	6.9	0.16	Sulfide odor.
06/27/18	7:30	10	0	0	Trickle (<0.1 cfs)	7.34	18	966	73	6.9	0.36	Debris, dirt and leaf litter in pipe.
07/18/18	10:30	10	0	0	0.1-1 cfs	6.86	20	957	67	6.2	0.39	Feces above water in pipe (raccoon?).
CPSO - South portion of catchment (WQOs do not apply to stations within the MS4***)***												
01/09/18	2:00	24,196	8	597	Trickle (<0.1 cfs)	6.89	13.9	679	89	9.1	0.28	Trash cans nearby. Very little flow, almost stagnant.
03/02/18	8:40	6,867	0	0	Trickle (<0.1 cfs)	7.16	10.4	446	87	9.9	0.14	Unknown odor.
06/27/18	NR	NS	NS	NS	Dry	NR	NR	NR	NR	NR	NR	Trash present. Too little water to sample. Scum on surface, wet on north side wall appears to be groundwater infiltration.
07/18/18	10:45	NS	NS	NS	Isolated Pool	NR	NR	NR	NR	NR	NR	Unable to sample, stagnant and very murky, lots of leaf litter.
CPDS - Entire Capistrano catchment (WQOs do not apply to stations within the MS4***)***												
01/09/18	1:10	1,850	0	0	0.1-1 cfs	6.7	15.4	887	83	8.3	0.33	Sulfide odor. Not much flow. Wood debris right in front of outfall. Sediment in outfall.
03/02/18	8:15	399	0	0	0.1-1 cfs	6.78	14.4	846	80	8.1	0.23	Trash present.
06/27/18	7:20	1,720	0	0	Trickle (<0.1 cfs)	7.42	18	828	63	5.9	0.42	Trash present
07/18/18	10:20	1,291	0	0	Trickle (<0.1 cfs)	6.87	20.2	802	72	6.5	0.35	Wood in pipe. Animal tracks nearby.
St. Augustine Creek Subwatershed												
AGUS - Background station (upstream of MS4)												
01/09/18	12:50	259	0	0	1-5 cfs	6.74	12	467	85	9.1	0.19	Side drainage ditch connects under road downstream of sample site.
03/02/18	6:50	161	0	0	0.1-1 cfs	7.09	8.8	504	93	10.6	0.18	NR
06/27/18	6:20	148	0	0	0.1-1 cfs	7.99	12.6	539	89	9.3	0.47	NR
07/18/18	9:07	10	0	0	0.1-1 cfs	7.47	13.4	580	78	7.9	0.21	Strong odor, possibly decomposing plant materials.
AGCH - Upstream of Harbor District (WQOs do not apply to stations within the MS4***)***												
01/09/18	12:40	557	0	17	1-5 cfs	7.02	12.8	495	98	10.3	0.25	NR
03/02/18	6:35	364	0	0	1-5 cfs	7.55	10	520	100	11.5	0.17	NR
06/27/18	6:10	NS	NS	NS	NR	NR	NR	NR	NR	NR	NR	Too little water to sample. Sand bags placed within MS4 at AGCH. Racoon tracks.
07/18/18	9:04	NS	NS	NS	Dry	NR	NR	NR	NR	NR	NR	Too little water to sample, very strong odor of decomposition.
AGDS - Downstream station (WQOs do not apply to stations within the MS4***)***												
01/09/18	12:25	703	0	0	1-5 cfs	7.03	12.9	526	99	10.4	0.31	Tide up in rocks at the outfall, but not inside. Sample taken from east outfall. There are 2 outfalls. This one had more flow. Could not get sample once they combined; other side had little flow. Would need a negative tide to collect a combined sample; outfalls hit rocks with biofilm.
03/02/18	6:20	459	0	0	0.1-1 cfs	7.19	11.1	1047	102	11.2	0.4	NR
06/27/18	5:55	862	0	0	Trickle (<0.1 cfs)	8.05	15.6	6752	89	8.8	5.73	NR.
07/18/18	8:46	12,033	0	0	Trickle (<0.1 cfs)	6.77	16.3	10653	89	8.3	7.36	Very low flow.

Date	Time	*E. Coli*	B. (Human marker)	B. (Dog marker)	Estimated flow	pH	Temp.	Specific Cond.	DO	DO	Ammonium (NH_4^+)	Comments
		(MPN/100mL)	*(gc/mL)*	*(gc/mL)*			*(C°)*	*(µS/cm)*	*(% sat.)*	*(mg/L)*	*(mg/L)*	
Deer Creek Subwatershed												
DRUS - Background station (upstream of MS4)												
01/09/18	12:15	173	0	0	1-5 cfs	6.97	12.3	360	97	10.4	0.29	Foam in creek.
03/02/18	5:55	122	0	0	0.1-1 cfs	7.31	8	422	105	12.3	0.28	NR
06/27/18	7:05	**473**	0	0	0.1-1 cfs	7.76	13	451	100	10.4	0.31	Dog waste on roadside.
07/18/18	9:50	**471**	0	0	0.1-1 cfs	7.26	14	461	93	9.5	0.16	Many plants at site.
DRVL - Middle station												
01/09/18	12:00	**563**	0	0	1-5 cfs	7.07	12.5	406	101	10.7	0.3	NR
03/02/18	5:35	238	0	0	0.1-1 cfs	7.32	8.4	436	110	12.9	0.34	NR
06/27/18	6:50	**657**	0	0	0.1-1 cfs	8.06	13.3	468	104	10.8	0.31	Racoon prints in stream; algae present.
07/18/18	9:42	**882**	0	0	0.1-1 cfs	7.47	14.6	490	102	10.3	0.15	NR
DRDS - Downstream station (WQOs do not apply to stations within the MS4*)*												
01/09/18	11:45	663	0	0	1-5 cfs	6.9	12.5	413	101	10.6	0.35	Tide close to outfall (a few meters) so Deer creek needs a tide no more than about 1.5 feet. No tidal influence though.
03/02/18	5:15	754	0	0	1-5 cfs	7.41	8.7	471	108	12.5	0.4	NR
06/27/18	6:35	2,224	0	0	0.1-1 cfs	7.85	14.1	727	98	10.1	0.67	Trash present. Lots of gull prints in and out of the water, bird feces on the sand downstream.
07/18/18	9:28	557	0	0	0.1-1 cfs	7.08	15.9	867	84	8.2	0.9	Bird feces near site. Many dead fish on ground near fish cleaning station (drains to beach).

NR = Not Recorded
NS = Not Sampled
cfs = cubic feet per second
gc/mL = gene copies per milliliter

Table 3.2. Human and dog marker results, Pillar Point Harbor Watershed SSID Project.

Human Bacteroidales (gc/mL)														
	Pillar Point Marsh	Denniston Creek				Capistrano Catchment			St. Augustine Creek			Deer Creek		
Date	**ARPT**	**DNUS**	**DNCS**	**DNPC**	**DNDS**	**CPNO**	**CPSO**	**CPDS**	**AGUS**	**AGCH**	**AGDS**	**DRUS**	**DRVL**	**DRDS**
January 2018	0	0	0	0	0	30	8 *	0	0	0	0	0	0	0
March 2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June 2018	NS	0	NS	0	0	0	NS	0	0	NS	0	0	0	0
July 2018	NS	0	NS	0	0	0	NS	0	0	NS	0	0	0	0

Dog Bacteroidales (gc/mL)														
	Pillar Point Marsh	Denniston Creek				Capistrano Catchment			St. Augustine Creek			Deer Creek		
Date	**ARPT**	**DNUS**	**DNCS**	**DNPC**	**DNDS**	**CPNO**	**CPSO**	**CPDS**	**AGUS**	**AGCH**	**AGDS**	**DRUS**	**DRVL**	**DRDS**
January 2018	0	0	617	188	22	0	597	0	0	17	0	0	0	0
March 2018	0	0	0	8	5	0	0	0	0	0	0	0	0	0
June 2018	NS	0	NS	0	0	0	NS	0	0	NS	0	0	0	0
July 2018	NS	0	NS	0	0	0	NS	0	0	NS	0	0	0	0

NS = not sampled
* Sample results below reporting limit but above method detection limit

3.3 Beach Data Review

Water samples from recreational waters in San Mateo County are sampled each week for FIB by County staff and volunteers from the Surfrider Foundation. The data are compared by County Environmental Health Services staff to WQOs and advisory or warning signs are posted (online and at the beach) if the samples exceed WQOs. Samples are typically collected every Monday morning in the surf zone at the beach. A total of 43 beaches are sampled countywide, including four stations in Pillar Point Harbor (Figure 4.1).

Figure 3.2 shows enterococci values and the running geometric means for samples collected during WY 2018 from Capistrano Beach (station Pillar Point #5) and Beach House Beach (Pillar Point #9). Although these two beaches are on opposite sides of the Inner Harbor, enterococci densities follow roughly the same pattern, suggesting that circulation and mixing within Pillar Point Harbor may be more influential on beach FIB than local freshwater sources. Occasional high single samples elevate the calculated 6-week geometric mean for several weeks. The highest densities at the beaches in WY 2018 were measured on January 8, 2018 just prior to the January 9 sampling event. Water quality objectives for enterococci and sampling event dates are shown in Figure 3.2 for reference.

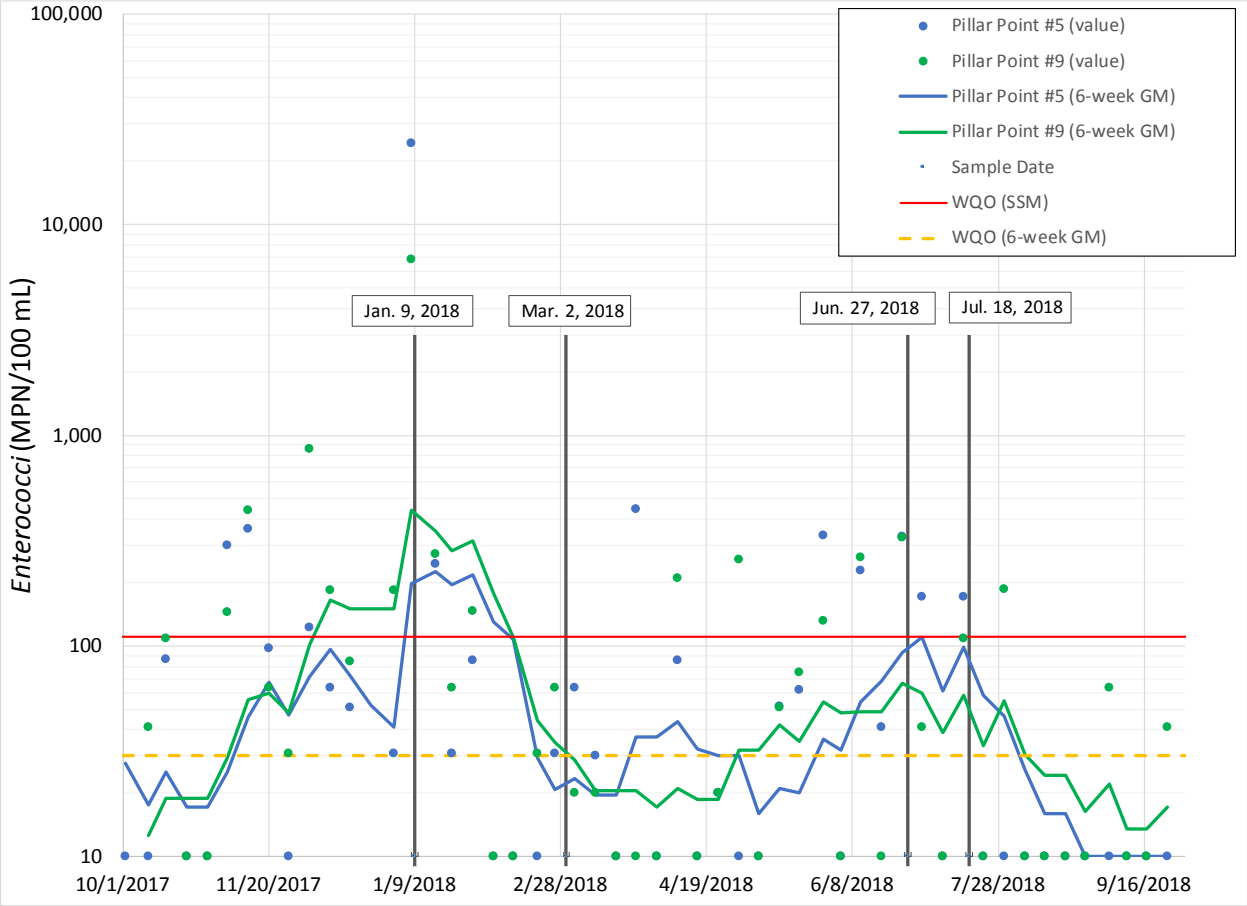


Figure 3.2. Enterococci densities measured in the surf zone at Capistrano Beach (Pillar Point #5) and Beach House Beach (Pillar Point #9) by County Environmental Health Services, WY 2018.

Figure 3.2 shows that there were seasonal differences in enterococci densities at the two beach stations during WY 2018. Densities are lowest during the very dry months of September and October at the start and end of the water year. The highest densities are measured during the wet season followed by a drop in densities in the spring as rainfall becomes less frequent. There was also a mid-summer "peak" in June and July. This bimodal pattern is observed in some, but not all, years in the long-term record. Figure 3.3 plots enterococci densities at Capistrano Beach and Beach House Beach for WY 2013 through WY 2018.

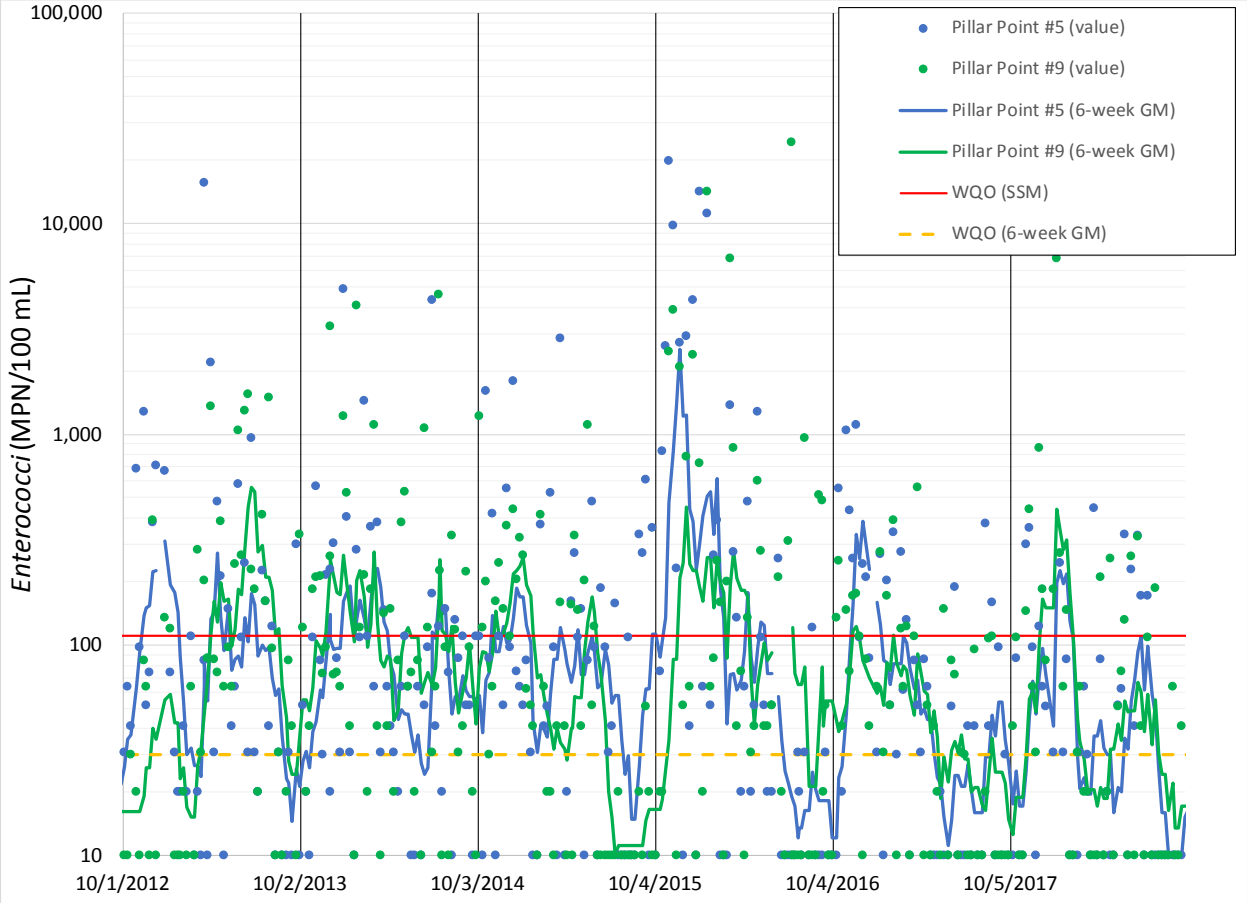


Figure 3.3. Enterococci densities measured in the surf zone at Capistrano Beach (Pillar Point #5) and Beach House Beach (Pillar Point #9) by County Environmental Health Services, WYs 2013 – 2018.

4.0 Discussion

Pillar Point Harbor (Figure 4.1) is an embayment located along the San Mateo County coastline that is enclosed by two sets of breakwaters (Wuertz et al. 2011). The inner breakwaters, constructed in 1982, protect the 45-acre inner boat harbor which contains an active marina with approximately 400 slips and an adjacent beach (Inner Harbor Beach). The outer breakwaters, constructed in 1961, protect an additional 280 acres of ocean waters with five beaches (Mavericks Beach, Pillar Point Marsh Beach, Yacht Club Beach, Capistrano Beach, and Beach House Beach).

The breakwaters mitigate the exchange of harbor water with the open ocean. Results of a circulation study using fluorescent dyes and drogues (i.e., floating citrus fruit) conducted in September 2008 (dry conditions with low stormwater inflow) suggest that Pillar Point Harbor is somewhat isolated from surrounding beaches and coastal features (Wuertz et al. 2011). Circulation within the harbor is in a clockwise pattern driven primarily by the tidal prism with wind as a secondary mechanism. The breakwaters are relatively impermeable and flushing of the outer harbor occurs within 2.5 days (for the northern zone) to over 3 days (for the shallow waters of the northwestern side of the harbor).

Figure 4.1. Pillar Point Harbor beaches and County Environmental Health Services sample stations.

The watershed draining to Pillar Point Harbor is approximately 3,923 acres and consists of several subwatershed areas (Figure 1.1), which are described below. The Study Area for this SSID project is limited to the Pillar Point Marsh, Denniston Creek, Capistrano Catchment, St. Augustine Creek, and Deer Creek subwatershed areas that are drained by the MS4 and regulated through the MRP. The small community of Princeton-by-the-Sea is not included in the Study Area; it drains directly to Yacht Club Beach and does not contain natural waterbodies.

4.1 Pillar Point Marsh

This 850-acre subwatershed includes a protected 66-acre brackish marsh that conveys runoff from the Half Moon Bay Airport, the Pillar Ridge Mobile Home Park, and several agricultural fields to Pillar Point Harbor (Flint 1977). Although the mouth of Pillar Point Marsh at the beach is sampled weekly for FIB (station Pillar Point 8), upstream locations (such as station ARPT from this study) have not been previously targeted. Station ARPT was included in the PPH SSID study because it is located within a swale downstream of MS4 discharges from the Pillar Ridge Mobile Home Park and a section of Airport Street where recreational vehicles (RVs) are often parked (Figure 4.2). There have been anecdotal reports of dumping from the RVs and trailers into roadside ditches and observations of trash at the monitoring station. Furthermore, large numbers of birds have been observed in the fields south of the airport runway. Flow was only present at the station during the two wet season sampling events. During the dry season events, only stagnant, isolated pools were observed.

Figure 4.2. Photo showing RVs parked along Airport Road and trash in nearby ditch.

The swale at the ARPT station had high *E. coli* densities during the January storm event (1,014 MPN/100 mL) but relatively low densities during the March storm event (96 MPN/ 100mL) (Table 3.1) suggesting that, even during runoff events, bacteria loading from this swale is variable. Human and dog markers were not observed in either of the storm event samples (Table 3.2) suggesting that RVs may not be contributing these sources, at least not during events of this magnitude. A lack of flow at ARPT during the June and July monitoring events suggests that this swale is not contributing to dry season observations of elevated FIB at Pillar Point March Beach.

4.2 Princeton-by-the-Sea

Princeton-by-the-Sea is a small community located between the Pillar Point Marsh and Denniston Creek subwatersheds. It is densely developed with residential, commercial, and industrial uses. Runoff from this area drains down roadside ditches that drain directly to Yacht Club Beach. The ditches are generally dry, except during storm events. There is little to no upstream contributing watershed area and no creeks or other natural waterbodies. No samples were collected in Princeton-by-the-Sea as part of this SSID study; however, the County conducts weekly FIB sampling in the surf zone on the western end of Yacht Club Beach (station Pillar Point 7, Figure 4.1). The RCD also collects samples during the first flush from several outfalls in this area.

4.3 Denniston Creek

At approximately 2,500 acres, the Denniston Creek watershed is the largest watershed draining to Pillar Point Harbor (Figure 1.1). The upper watershed is undeveloped and much of it lies within the protected Golden Gate National Recreation Area (GGNRA). This part of the GGNRA is known as the Rancho Corral de Tierra and was acquired in 2011. Multi-use trails (hiking, horses, bikes) run along the ridgetops on both sides of Denniston Creek with some trailheads near residential areas in the watershed. Other land uses in the upper watershed include approximately 38 acres (2% of watershed) of agricultural fields and Coastside County Water District (CCWD) properties. CCWD owns and operates the Denniston Reservoir (an onstream, regulating reservoir), a point of diversion for municipal water supply (located approximately 4,300-feet upstream of the reservoir), the Denniston Water Treatment Plant, and nearby storage tanks. Although operated for water storage, the reservoir also functions to capture sediment from Denniston Creek and must be periodically dredged to maintain capacity. Flow in Denniston Creek below the reservoir consists of spillage over and seepage through the dam. Downstream of the CCWD properties, on the coastal plain, land uses in the watershed consist of agricultural fields and residential subdivisions in El Granada which are drained by an engineered MS4. Several commercial properties (primarily restaurants), also drained by the MS4, are located near the mouth of the creek.

Denniston Creek is a relatively natural channel with a thickly wooded riparian corridor through the coastal plain. Culverted sections are limited to major road crossings (e.g., Highway 1, Prospect Way). There are four MS4 outfalls to the creek with small catchment areas upstream of Highway 1. The majority of the MS4 within the Denniston Creek watershed enters the creek at Prospect Way, just upstream of the bottom-of-the-watershed station (DNDS).

The monitoring network in Denniston Creek watershed includes a station in the creek upstream of the MS4 (DNUS); a downstream, bottom-of-the-watershed station (DNDS); and two stations that characterize the MS4:

- Station DNCS is located in a swale that is part of the MS4 and receives runoff via a culvert from approximately 32-acres of residential land use. An open space area above station DNCS appears to be privately owned but contains what appear to be dirt bike trails. RCD staff observed several piles of dog waste in the vicinity. Flow was only observed at this station during the storm events.

- Station DNPC, accessed via a manhole, is located within the main MS4 pipe draining the watershed. Samples are collected downstream of "confluence" of the two pipes that meet at this point. One of the pipes drains a small amount of roadway and enters from the north; the other consists of the main MS4 and enters from the east. The catchment area for DNPC is approximately 130 acres and consists of residential and park areas east of Highway 1 (including the DNCS catchment area), Highway 1, agricultural fields west of Highway 1, and commercial properties with parking areas along Capistrano Road. During the dry season, the ditch upstream of DNPC that conveys the majority of the MS4 runoff through an agricultural field is consistently dry. Flows observed at DNPC during the dry season appear to be the result of underground infiltration into the MS4 pipe in the immediate vicinity of DNPC. This hypothesis is consistent with findings from a closed-circuit television (CCTV) investigation conducted by the RCD which found multiple cracks and fractures in the MS4. Relatively high dry season specific conductance levels (937 and 963 µS/cm) suggest that sea water intrusion may be part of the dry season groundwater signature. Racoons have been observed in the MS4 at DNPC.

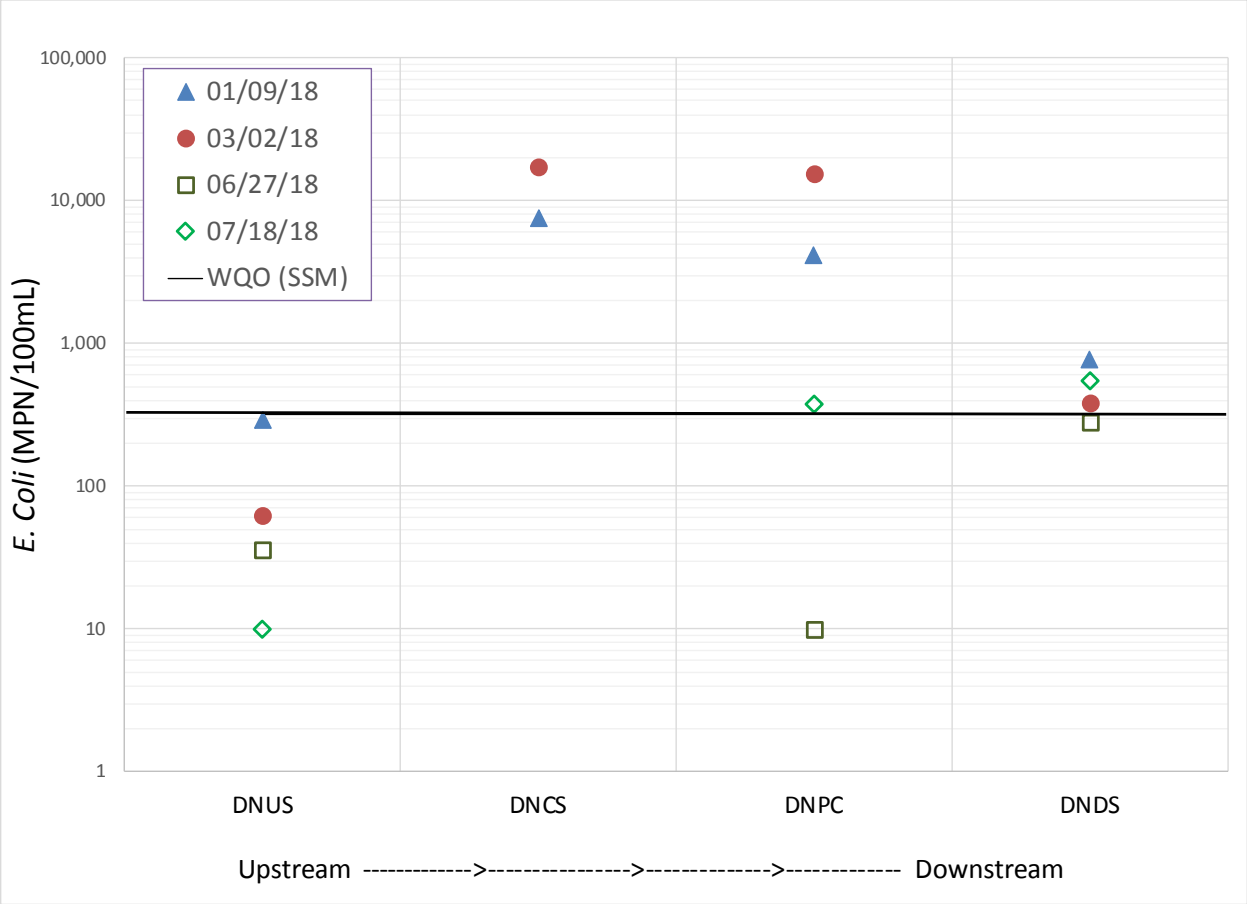


Figure 4.3. *E. coli* densities measured at Denniston Creek watershed stations.

Figure 4.3 shows that *E. coli* densities measured at the upstream station on Denniston Creek (DNUS) were consistently lower than other stations in the Denniston Creek watershed. Although densities at DNUS were higher during the two storm events compared to the two dry season events, they never exceeded the single sample maximum WQO of 320 cfu/100mL.

E. coli densities measured at the downstream station on Denniston Creek (DNDS) were consistently higher than those measured at DNUS and exceeded the SSM WQO during three of the four sampling events (both of the storm events and the July dry season event). During storm events high *E. coli* densities discharged from the MS4 appear to be diluted by flows in the creek. For example, on March 2, 2018, *E. coli* was 386 MPN/100mL at DNDS and over 15,000 MPN/100mL at the MS4 stations (DNCS and DNPC). During the dry season, *E. coli* densities at DNDS were higher than those measured at DNPC (DNCS was too dry to sample in June and July), suggesting that bacteria sources outside of the MS4 are also important.

Evidence of a transient use is occasionally observed in the creek upstream of station DNDS; however, human markers were not detected at this station or any other station in the Denniston Creek watershed. Dog markers were detected at the two MS4 stations (DNCS and DNPC) and the bottom-of-the-watershed station (DNDS) during storm events (Tables 3.1 and 3.2). The higher quantity of dog marker detected at the upper MS4 station (DNCS; 617 gc/mL) compared to the lower MS4 station (DNPC; 188 gc/mL) and bottom-of-the-watershed stations (DNDS; 22 gc/mL) on January 9, 2018 suggests that the primary source of dog-specific bacteria is in the residential part of the watershed. A small park (Princeton by the Sea Park) that drains directly to the creek contains a designated “Dog Area” that has a dog bag dispenser and a waste receptible; however, some users may neglect to use the supplies, as RCD staff observed a pile of waste in the park. There was no overall correlation between dog marker concentrations and *E. coli* densities at the Denniston Creek stations.

4.4 Capistrano Catchment

The 15-acre Capistrano catchment is a piped system that does not contain any natural waterbodies. It is almost entirely impervious and contains hotels, shops, restaurants, brew pubs, and large parking lots (Figure 4.5). Many of the businesses have private storm drains that connect directly to the underground MS4. The Capistrano catchment MS4 network discharges directly to Capistrano Beach via a 24-inch reinforced concrete pipe (RCP) (Figures 4.4 and 4.5). This outfall flows year-round and can be inundated by water and sediment during high tides. There are anecdotal reports that a homeless individual is regularly observed resting in the vegetation above the outfall. Through its Business and Commercial Inspection Program, the County has had to repeatedly instruct restaurants in this catchment that wash water from cleaning floor mats, garbage cans, and sidewalks/patios should not be allowed to flow into storm drains. Wash water can convey fats, oils, and grease (FOG) and other pollutants into the storm drain.[5] FOG in storm drains and sanitary sewer lines can build up causing blockages that constrict flow and may eventually result in breaks. FOG may also attract wildlife, such as rats and raccoons, to storm drains. It is unknown what role if any FOG plays in biofilms.

The SSID sampling design for this catchment includes the outfall at the beach (CPDS) and two sub-catchments: the north area (CPNO) and the south area (CPSO) (Figure 4.5). RCD investigations suggest that a portion of the south sub-catchment shown in Figure 4.5 drains to the St. Augustine system. Storm drains at the south sub-catchment station (CPSO) were not flowing

[5] County Ordinance (4.28.110) prohibits discharge of wastewater containing more than 300 mg/L of FOG into the collection system. Grease traps and interceptors are required at new restaurants to prevent FOG discharges.

during the dry season; whereas, storm drains in the north sub-catchment (CPNO) have a small amount of year-round flow. The year-round flow at CPNO and CPDS appear to be largely the result of groundwater seepage into the pipes, via cracks and breaks observed by the RCD using CCTV. Consistently high (relative to fresh water) specific conductance levels suggest that, similar to the lower Denniston Creek watershed, sea water may be part of the groundwater signature in the Capistrano catchment. Low dry season flows at private MS4 connections in both the CPNO and CPSO sub-catchments have also been observed.

Figure 4.4. Capistrano catchment outfall at Capistrano Beach (station CPDS), August 2017.

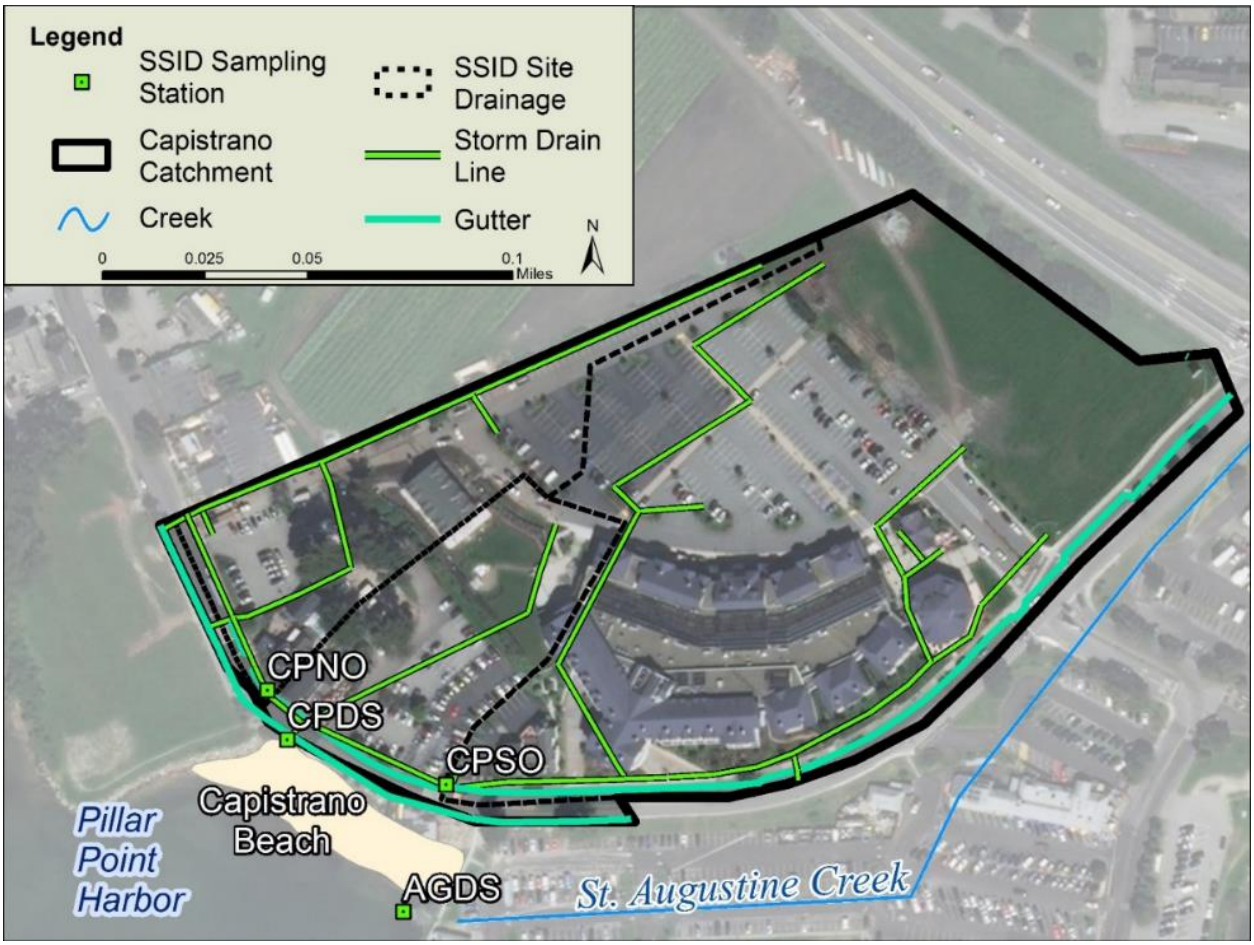


Figure 4.5. Capistrano catchment MS4 and SSID sample stations with drainage areas (MS4 based on BKF 2013 and differs from County storm drain GIS layer in geodatabase and RCD investigations).

The highest *E. coli* densities from this SSID study were measured in the south sub-catchment (station CPSO) on January 9, 2018 (24,196 MPN/100mL) (Table 3.1 and Figure 4.6). Both human and dog markers were detected in this sample (Table 3.2). Although, the south sub-catchment is a source of high *E. coli*, as well as potential human and dog bacteria sources during storm events, there is little to no flow during the dry season (Table 2.1). The catch basin at CPSO was dry during the June event and contained a stagnant puddle in July. The small amount of dry season water appears to originate from groundwater infiltration into the MS4 and from private storm drain connections to the MS4. The source of the human marker is unknown. As follow-up to the human marker detection, the RCD conducted limited dye tests during wet and dry weather to investigate whether sanitary sewer lines in the south sub-catchment leak into the MS4; however, results were inconclusive. Although the dye added to the sanitary system was not observed in the MS4, the test did not rule out the possibility of a connection.

E. coli densities measured at the Capistrano catchment outfall (CPDS) were consistently above the SSM WQO (320 cfu/100mL) (Figure 4.6). During storm events, it is likely that primary sources of FIB are conveyed through the MS4 (especially from the south sub-catchment [CPSO]), with contributions from pet waste and an unknown human source. During the dry

season, no flow was observed in the south sub-catchment and *E. coli* densities measured in the north sub-catchment (CPNO) were very low (10 MPN/100mL). It is possible that wildlife (rodents and raccoons) waste and growth of FIB in biofilms (supported by groundwater infiltration) in the lower end of the pipe system are the primary source of dry season FIB at CPDS. This suggestion is supported by the presence of animal tracks that have been observed nearby (Table 3.1).

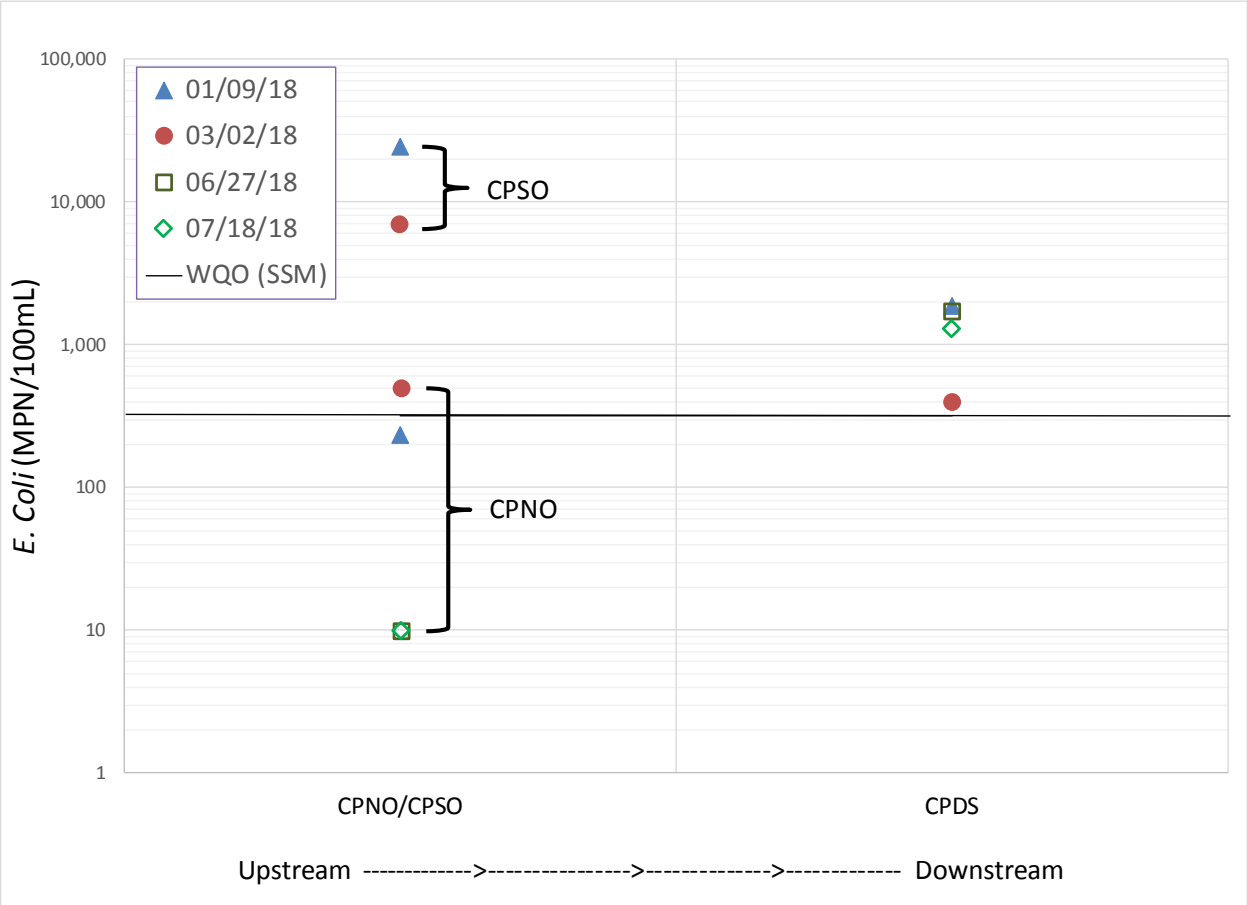


Figure 4.6. *E. coli* densities measured in Capistrano Catchment stations.

4.5 St. Augustine Creek

The St. Augustine Creek watershed is approximately 310 acres. Land uses consist of open space (including GGNRA) in the upper watershed, residential uses east of Highway 1, and Pillar Point Harbor District property in the lower watershed. St. Augustine Creek is contained within the engineered storm drain system through the entire developed portion of the watershed. Pillar Point Harbor District includes parking areas, Harbor Master offices, maintenance buildings, public restrooms, and several small business leases (e.g., surf shop, restaurants, bait and tackle). The Harbor District is drained by a private storm drain system, parts of which discharge directly to the inner harbor and parts of which connect underground to St. Augustine Creek.

The RCD is assisting the Harbor District in investigating their private storm drain system using techniques such as CCTV, flow observations, and dye testing. FOG and sediment were found to be partially blocking the lower 500 feet of the storm drain through which St. Augustine Creek flows on Harbor District property. The primary source of FOG to the system has been addressed by sealing off a misplaced wash water connection to the storm drain. Management practices have also been discussed with Harbor District tenants and staff, and all storm drains have been marked with "Flows to Ocean" stickers. In the summer of 2020, the FOG and sediment will be cleaned out of the storm drain line and the remainder of the line will be inspected using CCTV. In addition to the work on the St. Augustine line, the Harbor District replaced or repaired compromised storm drain pipes flowing to the inner harbor on the north end of the property in September 2018. Potential improvements on the south end of Harbor District property, near the Deer Creek outfall, are still being considered.

The SSID sampling design for the St. Augustine Creek watershed includes three stations:

- An upstream station (AGUS) flows year-round and is located near the point where the creek enters the engineered storm drain system that conveys it all the way to the beach.
- Station AGCH is located within the underground portion of the creek, downstream of the residential area and upstream of the Harbor District area. Station AGCH is accessed via a vault and, although dry season flow was observed, it was very low and unsafe to sample. There is a linear park located upstream of station AGCH along Ave Granada; it contains a pet waste cleanup station (bag dispenser and waste bin) and was observed to be free of pet waste by RCD staff during one watershed survey.
- The downstream station (AGDS) is located at the double 48-inch RCP outfall to the beach (Figure 4.7). The outfall is inundated with sea water during high tides and, although sampling events were timed to coincide with low tide when inundation was less likely, specific conductance levels suggest that most samples collected at AGDS were influenced by sea water (Table 3.1). The sea water may have entered the system via the outfalls due to tidal action and/or via sea water influenced groundwater seepage into the pipes.

E. coli densities measured at the St. Augustine stations increase in the downstream direction, especially during the dry season (Figure 4.8). At the upstream background station (AGUS), *E. coli* densities were higher during storm events compared to the dry season but remained below the SSM WQO. Although flow at station AGCH (downstream of the residential area) was observed during all four sampling events, the field crew was unable to safely collect samples from the vault during the June and July events. During storm events, *E. coli* densities measured at station AGCH were higher than densities measured upstream at AGUS and exceeded the SSM WQO. Dog-specific bacteroidales markers were also present at AGCH during the January storm event. The dog marker was not detected during any other sampling event or at any other St. Augustine station, and human markers were not detected at any of the St. Augustine stations.

E. coli densities at the downstream station (AGDS) were higher than the two upstream stations, and the *E. coli* pattern differed from the upstream station (AGUS). At the downstream station, *E. coli* densities were higher during the dry season; whereas, they were lower during the dry season

at the upstream station. The source of the dry season FIB is difficult to assess with the limited sampling data. Harbor District sewer lines are ruled out as a likely source based on dye testing that did not show a connection to the creek. Therefore, dry season bacteria sources at AGDS are likely due to wildlife within the system (confirmed by observations of raccoon feces) and/or biofilm growth within the MS4 supported by groundwater infiltration. Residential areas draining to the MS4 are a likely contributor of FIB from pet waste at AGDS during storm events.

Figure 4.7. St. Augustine Creek outfall at Capistrano Beach (station AGDS).

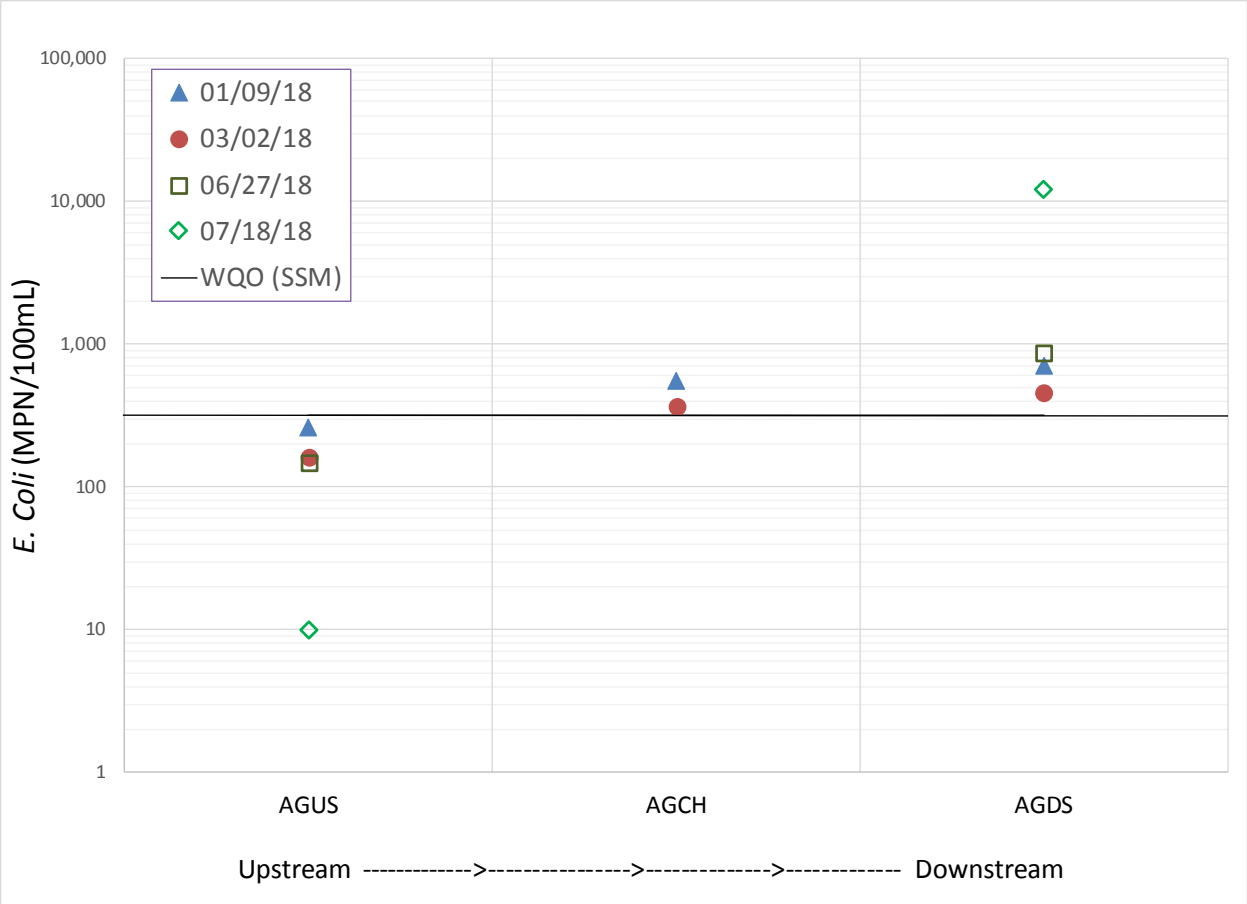


Figure 4.8. *E. coli* densities measured in St. Augustine Creek watershed stations.

4.6 Deer Creek

The Deer Creek watershed is approximately 309 acres. Land uses consist of open space (including GGNRA) and a cattle ranch in the upper watershed, and residential uses east of Highway 1. West of Highway 1, there is a parking area, launch ramp, and adjacent fish cleaning station, restrooms, and a portable waste dump station on Harbor District property. Deer Creek flows in a natural but highly constrained channel through the residential area (Figure 4.9). The MS4 in the residential area consists primarily of roadside ditches; an engineered pipe system is absent. Deer Creek enters a culvert just east of Highway 1 and remains in the engineered storm drain system until its discharge point at the beach. Historical imagery and pipeline investigations suggest that Deer Creek formerly discharged to the Inner Harbor but is now diverted to the Outer Harbor just south of the boat launch (Figure 2.1). The outfall, a 36-inch RCP, is inundated with sea water at high tide. The RCD conducted CCTV scoping in parts of the Deer Creek pipe on Harbor District property as part of their larger investigation. A considerable amount of sediment was observed relatively high up in the system, presumably pushed in by the tides. The presence of an old buoy and lifejackets in abandoned pipelines seems to confirm the tidal influence. Above ground, in the Harbor District parking lot near the outfall, newly installed educational signage is present with messaging about pollution, conservation, fishing, and cleaning up

cigarette butts and after pets. There is also a pet waste cleanup station and a sewage discharge station for small boats and RVs (plumbed directly into the sanitary sewer line) in this location.

The SSID sampling design for the Deer Creek watershed includes a station upstream of the MS4 (DRUS) which flows year-round, a station within the residential area (DRVL; Figure 4.9), and a downstream station at the outfall to the beach (DRDS) (Figures 2.1 and 4.10).

During storm events, *E. coli* densities increased in the downstream direction, with upstream densities below the SSM WQO and densities measured at downstream stations generally above the SSM WQO (Figure 4.11). However, this pattern was observed in only one of the two dry season events (June). In July, *E. coli* densities measured at the downstream station (DRDR) (557 MPN/100mL) were lower than those measured at the residential station (DRVL; 882 MPN/100mL). *E. coli* densities at all stations in Deer Creek were generally higher during the dry season compared to the wet season (Table 3.1, Figure 4.12). This pattern differs from other watersheds sampled in this SSID study, which generally had lower dry season *E. coli* densities compared to those measured during storm events, particularly at upstream stations. Dry season *E. coli* densities at upstream stations in Denniston Creek and St. Augustine Creek were relatively low, ranging from 10 MPN/100 mL to 148 MPN/100 mL; whereas, dry season *E. coli* densities at the upstream station on Deer Creek ranged from 471 MPN/100 mL to 473 MPN/100 mL, which is above the WQO. There appears to be a dry season FIB source in the upper watershed of Deer Creek, perhaps associated with the cattle ranch and/or wildlife. This is supported by findings from Kim and Wuertz (2014) which found that bovine waste (including cattle and/or deer) was the main source of bacteria at the Deer Creek outlet.

No human or dog markers were detected in any of the Deer Creek samples (Table 3.2).

Figure 4.9. Deer Creek at Valencia Ave (Station DRVL) showing constrained channel, January 2018.

Figure 4.10. Deer Creek outfall (station DRDS) with boat launch in background, January 9, 2018.

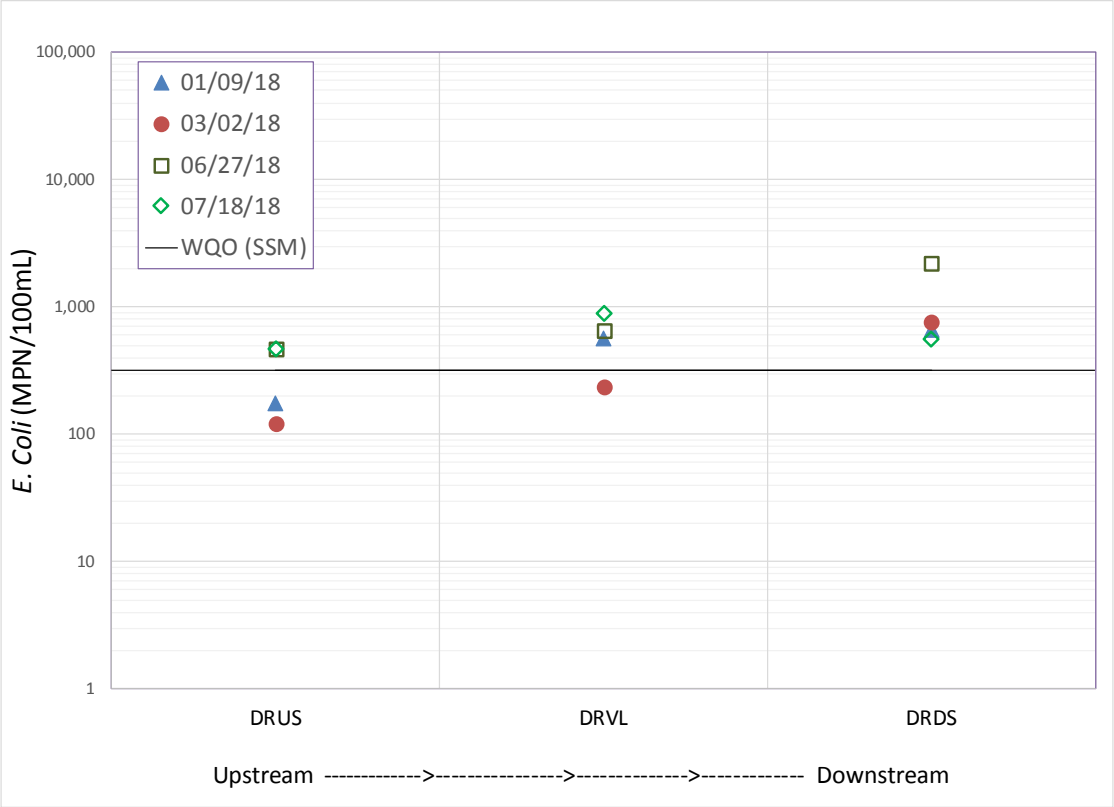


Figure 4.11. *E. coli* densities measured in Deer Creek watershed stations, by site, upstream to downstream.

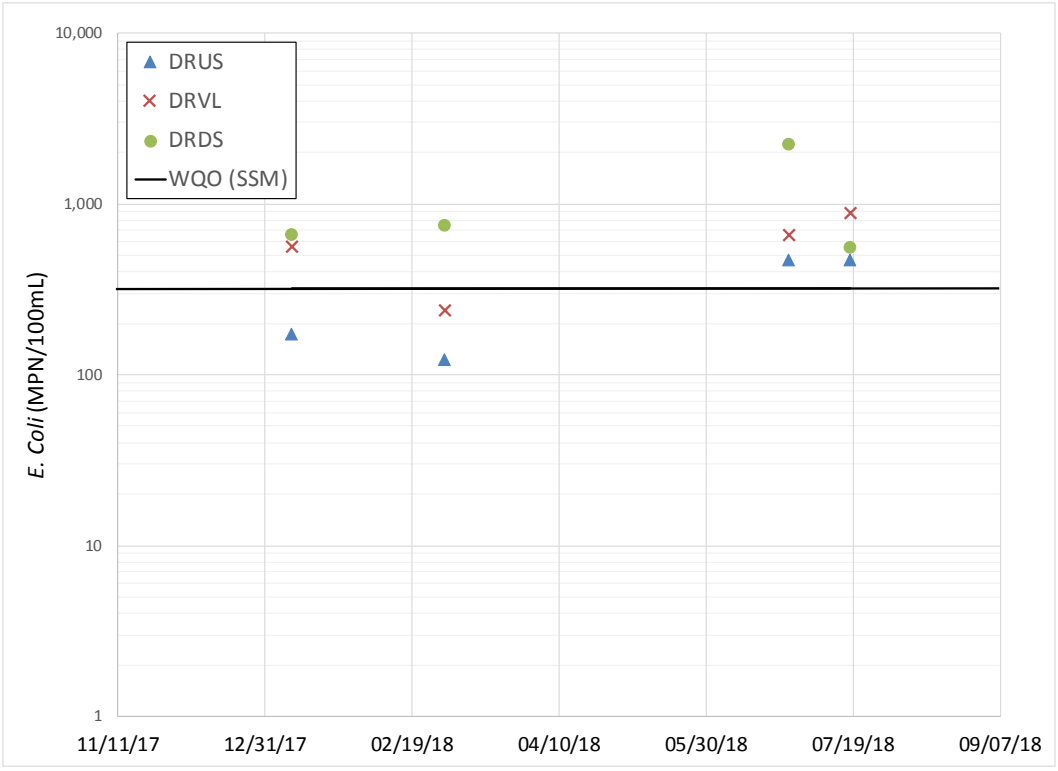


Figure 4.12. *E. coli* densities measured in Deer Creek watershed stations, by date.

5.0 Conclusions and Recommendations

5.1 Overall Findings

The Pillar Point Harbor Watershed Pathogen Indicator SSID Project implemented desktop and field investigations to answer the three Management Questions identified in the Work Plan (SMCWPPP 2018). Desktop analysis included development of a geodatabase with layers showing potential bacteria sources as well as the geographic setting and review of recent and historical monitoring data collected at local beaches by County Environmental Health Services. Field investigations included grab samples collected at 14 freshwater stations for analysis of FIB (*E. coli*) and human and dog genetic markers. Sampling was conducted during two wet weather events and two dry season events. These investigations were supplemented by field reconnaissance and limited dye testing of the sanitary sewer system conducted by the RCD.

1. **Are there specific areas within the Study Area (i.e., the area drained by the MS4 that discharges to Pillar Point Harbor) that are contributing FIB to receiving waters during wet and dry conditions?**

   As described in the preceding sections of this report, FIB densities in the Study Area are highly variable and do not follow predictable patterns across all subwatersheds investigated.

   - **Wet vs. Dry Tributary Source Areas.** *E. coli* densities measured at bottom-of-the-watershed stations in Denniston Creek (DNDS) and the Capistrano Catchment (CPDS) were roughly in the same range during wet conditions compared to dry conditions. In contrast, *E. coli* densities measured at bottom-of-the-watershed stations in St. Augustine Creek (AGDS) and Deer Creek (DRDS) were lower during wet conditions compared to dry conditions (Table 3.1).
   - **Wet vs. Dry MS4 Source Areas**. MS4 (or mid-channel) stations in the Pillar Point Marsh subwatershed (station ARPT), Denniston Creek, the Capistrano Catchment, and St. Augustine Creek had higher *E. coli* densities in wet conditions compared to dry conditions. Some of the MS4 stations were dry or not flowing during dry weather, suggesting that the MS4 draining residential areas in these subwatersheds is not the primary contributor of FIB during the dry season. In contrast, the mid-channel station in Deer Creek (DRVL) had lower *E. coli* densities during wet conditions compared to dry conditions (Figure 4.11 and Table 3.1).
   - **Wet vs. Dry Conditions in the Harbor**. FIB (i.e., enterococci) densities measured in the surf zone at beaches on opposite sides of the Inner Harbor (Capistrano Beach and Beach House Beach) by County Environmental Health Services were very similar in magnitude and pattern. This suggests good mixing of all FIB sources within the Harbor, including those originating on land (e.g., urban runoff, riparian wildlife, biofilm growth within MS4) and those originating on the beach and in the Harbor (e.g., boats, biofilm growth on beach sediments, wildlife). Although wet season FIB densities were higher than dry season FIB densities at both beaches, a dry season peak was also observed some years (Figures 3.2 and 3.3).

2. **Are there downstream trends in FIB densities in creeks that flow through urban areas to Pillar Point Harbor during wet and dry conditions?**

   All tributaries had lower *E. coli* densities at stations upstream of the MS4 compared to bottom-of-the-watershed stations (see Table 3.1 and Figures 4.3, 4.6, 4.7, and 4.10), suggesting that FIB sources are present in the urban areas draining to the MS4. However, as discussed above and in Section 4, because MS4 discharges are limited during the dry season (i.e., some of the MS4 stations were dry or not flowing), some of the FIB increases at downstream stations appear to be caused by sources other than the urban areas (e.g., biofilm growth in the MS4 due to groundwater infiltration, wildlife).

3. **Are controllable sources of bacteria (especially human and dog) present in the urban areas?**

   The geodatabase GIS layers show potential controllable and uncontrollable bacteria sources such as direct human sources (e.g., homeless encampments and RVs), areas where pet waste is observed, areas where pet waste and horse droppings are likely (e.g., trails), livestock areas, public and private sanitary systems, and wildlife (see Section 3.1). Many of these potential sources are present throughout the Study Area (Appendix B). However, the overall dearth of human and dog markers present in the MST samples suggest that controllable sources, and especially human sources, may be limited. Human markers were only detected during the January 9, 2018 storm event in the Capistrano Catchment. Dog markers were more widespread (Denniston Creek, Capistrano Catchment, and St. Augustine Creek) and were detected during both of the storm sampling events.

Overall, FIB (*E. coli*) in freshwater tributaries to Pillar Point Harbor exhibit complex patterns that differ depending on the subwatershed. The MS4 appears to be a source of FIB to local creeks and Pillar Point Harbor during storm events; however, the relatively limited flow from the MS4 during the dry season limits its year-round importance. Furthermore, the overall lack of human and dog markers detected in this SSID study (particularly during the dry season) suggests that FIB conveyed by the MS4 may not be controllable. Instead, the sources of FIB within and conveyed by the MS4 appear to be primarily the result of wildlife (i.e., raccoons, deer, rodents) that are present in the MS4 and contributing areas. FIB growth within biofilms in the MS4 may be another likely source of FIB, particularly during the dry season.

Two of the creeks that discharge to Pillar Point Harbor (St. Augustine Creek and Deer Creek) are diverted to underground culverts east of Highway 1 and remain underground until they discharge at the beach. Both of these creeks have higher FIB levels at their beach outfalls compared to upstream stations and both have relatively high dry season FIB levels. These findings further support biofilm growth within the MS4 as a potential source.

Results showed *E. coli* densities often exceed recommended WQOs for freshwaters designated as having water contact recreation (REC-1) Beneficial Uses (i.e., 320 cfu/100mL). It is important to acknowledge that a) WQOs for FIB do not distinguish among sources of FIB and b) FIB detections do not necessarily correlate well with the presence of pathogens. Animal fecal waste is much less likely to contain pathogens of concern to human health than human sources, and FIB associated with biofilms likely does not indicate that pathogens are present. In most cases, human sources of fecal contamination are associated with REC-1 health risks rather than wildlife

or domestic animal sources (USEPA 2012). Furthermore, even if controllable bacteria sources (i.e., human and dog sources) are eliminated, FIB densities in receiving waters could still exceed WQOs due to wildlife and natural FIB growth in biofilms.

5.1.1 Bacteria Fate and Transport

The fate and transport of bacteria in the system is an important factor that affects the concentration of FIB measured at any one location. Removal mechanisms include inactivation (i.e., loss in viability of the microorganism) and physical transport (either downstream or into bed sediments). Inactivation or die-off is dependent on several factors, including temperature, pH, salinity, nutrient concentrations, predation, and ultraviolet (UV) irradiance. Bacteria can attach to sediment particles even under flowing or turbulent conditions resulting in removal from the water column and the formation of biofilms. However, bacteria colonies can grow in the sediment and biofilms and later become resuspended in the water column. Bed sediments thereby can transition from a sink to a source. Modeling of these mechanisms is difficult because the conditions (physical and chemical variables) under which bacteria attach or detach from particles are not fully understood (Walters et al. 2013).

5.2 Current and Recommended Management Actions

Stakeholders in the Pillar Point Harbor watershed such as SMCWPPP, the County, the RCD, Surfrider, the Harbor District, and the Granada Community Services District[6] implement many management actions along the coast and throughout the County to address the water quality impacts of stormwater runoff. Some of these actions are required or recommended by permits, plans, and ordinances such as the MRP, Local Coastal Program (LCP), and the County Stormwater Management and Discharge Control Ordinance (Chapter 4.100) and Prohibition on Use of Vehicle for Human Habitation (Chapter 7.96). Other actions are volunteer efforts often coordinated by the RCD. Management actions designed specifically or opportunistically to control bacterial sources are discussed in the sections below according to the primary bacteria source that they address.

The stakeholders may wish to consider additional management actions to further control bacterial discharges from the MS4 to receiving waters. However, it should be noted that, even if controllable bacteria sources (i.e., primarily human and dog sources) are eliminated, FIB densities in receiving waters could still exceed WQOs due to wildlife and natural FIB growth in biofilms.

5.2.1 Biofilms

Biofilms in storm drains and creeks were identified as a potential source of FIB in the Pillar Point Harbor watershed. Biofilms are communities of microorganisms surrounded by extracellular polymeric substances (i.e., sticky substances, slime). Biofilms can form on any solid surface that has contact with water and nutrients, including storm drain pipes and sediment particles. The public and privately-owned storm drain pipes in the lower watershed provide a particularly good environment for biofilm growth. Water is present year-round, often as a result

[6] The Granada Community Services District oversees parks in the unincorporated areas of El Granada and Princeton-by-the-Sea.

of perennial creeks flowing through the system, seawater entering the pipes during high tides, and groundwater infiltration into the pipes where cracks and leaks are present. Furthermore, the underground systems protect the bacterial colonies from temperature fluctuations and UV irradiance that might otherwise cause die-off. Detached FIB from biofilms likely contribute to concentrations measured at sampling stations, even though these FIB would not be associated with recent fecal contamination. Recent studies conducted in Newport Beach concluded that biofilm regrowth of FIB in street gutters and storm drains may explain high levels of FIB in runoff from residential areas where extensive measures have been conducted to eliminate sewage contributions from the sanitary sewer system (Skinner et al. 2010).

Biofilms as a source of FIB could be reduced by controlling nuisance runoff (and other dry weather water sources), nutrient loading, and the debris/trash that provide additional surfaces for biofilm growth.

- Nuisance runoff (i.e., non-stormwater discharges) is prohibited under Provision A.1 of the MRP. The County's Illicit Discharge Detection and Elimination (IDDE) Program and Enforcement Response Plan (ERP) provide a system for active surveillance (i.e., business inspections) and complaint response. County staff regularly inspect businesses in the Pillar Point Harbor watershed and frequently inform business owners and operators that equipment wash water should not be allowed to drain into the MS4.
- The RCD and the Harbor District will be cleaning FOG from one of the Harbor District stormwater lines that could be harboring biofilms. They will also continue to make improvements to stormwater infrastructure as needed and implement measures to control and discourage nuisance runoff.
- Other dry weather water sources are more difficult to control. For example, it is unlikely that seawater inundation during high tide could be eliminated. However, cracks in the MS4 and private storm drains that allow groundwater infiltration could be repaired. Several such cracks have been identified by the RCD using CCTV and communicated to the County.

Potential Additional Management Actions

- The County and Harbor District could work with the RCD to understand where storm drain repairs are warranted. Work to conduct the repairs should be considered through the capital improvement process.
- Cracks and leaks already identified in the MS4 in the Capistrano Catchment should be repaired.

5.2.2 Trash

Unmanaged trash can be a source of bacteria to creeks, both directly and by attracting birds, rodents, and other wildlife. It may also play a role in the formation of biofilms by providing surfaces on which biofilms can adhere. In compliance with Provision C.10 of the MRP, the County is implementing a Long-Term Trash Load Reduction Plan and Assessment Strategy (County of San Mateo 2014). The Long-Term Plan identifies and maps trash generating areas

and trash sources, delineates and prioritizes Trash Management Areas (TMAs), and describes current and future control measures. Although the Long-Term Plan is focused on reducing the impacts of discharges from the MS4, it also addresses direct dumping and wind dispersion of trash where possible.

Areas of Moderate trash generation were mapped in the Pillar Ridge Mobile Home Park (Pillar Point Marsh watershed), Princeton-by-the-Sea, and some commercial areas in El Granada. The remainder of the watershed is mapped as Low trash generation. Management actions being implemented in these areas include installation and maintenance of several full trash capture devices, enhanced street sweeping, beach and roadway cleanup events, outreach to businesses and residents, improved bins/container management, and bag and polystyrene bans. The goal is achieve full trash capture equivalency by 2022.

5.2.3 Pet Waste

Pet waste left on sidewalks, streets, yards, trails, and open space areas can enter the creek during runoff events (e.g., storms, sidewalk washing, irrigation). Even in the absence of other fecal sources, pet waste from dogs, cats, and other domestic animals contains FIB in quantities that can cause exceedances of WQOs in receiving water.

Control measures for pet waste currently include enforcement of County ordinances that limit the number of allowable pets, complaint response, pet waste cleanup signage and dog bag dispensers, and public outreach and education.

- The RCD identified seven pet waste cleanup stations in the watershed:
    - Tide pools parking lot near Pillar Point Marsh,
    - Park off Bridgeport Ave in the Denniston Creek watershed,
    - Park on El Granada Ave in the St., Augustine Creek watershed,
    - North Harbor District parking lot,
    - Harbor District Johnston Pier,
    - Harbor District Residential Pier
    - South Harbor District parking lot near the Deer Creek outfall.
- Public outreach and education is conducted by the County, SMCWPPP, the RCD, the Harbor District, Surfrider, and the Sewer Authority Mid-Coastside. These agencies have also come together in a group called Coastside One Water to discuss local water issues and pool resources for education and outreach initiatives that include pet waste pollution messaging. Proximity of Pillar Point Harbor to the Fitzgerald Area of Special Biological Significance (ASBS) provides local residents and visitors exposure to the stormwater and pet waste education and outreach programs that are part of the Fitzgerald Pollution Reduction Program and the San Vicente Creek Bacteria Water Quality Improvement Plan (WQIP). Efforts include websites hosted by the County, Harbor District, and RCD, special edition newsletters, community and school presentations, tabling events, flyers, mailers, factsheets, and a pet waste pledge.

However, detection of dog markers in storm samples collected in Denniston Creek, Capistrano Catchment, and St. Augustine Creek suggests that further efforts to control dog waste could potentially help reduce concentrations of FIB. Furthermore, feeding of feral cats is known to occur in some creekside locations.

Potential Additional Management Actions

- Install pet waste cleanup stations and/or signage at GGNRA trailheads. Dog waste has been observed at these locations.
- The Granada Community Service District could consider installing a pet waste cleanup station complete with signage, bag dispenser, and waste bin at or near Capistrano Beach.
- Several hotels in the watershed allow pets. The County, RCD, and/or other stakeholders could reach out to these hotels to identify ways of educating out-of-town guests who may not be as informed or conscientious as local residents.
- The County or other stakeholders could consider developing outreach materials that target individuals who encourage the presence of feral cats. If warranted, feral cat populations could be controlled through sterilization programs.

5.2.4 Wastewater

Leaks and overflows from the public sanitary sewer conveyance system and private laterals can convey human waste directly or indirectly to the MS4 and receiving waters. Although SSOs in the Study Area are rare, human markers have rarely been found in the Study Area, and targeted dye testing conducted in the Capistrano Catchment by the RCD did not identify any sanitary system leaks, this potential bacteria source is still considered a priority due to potential risks to human health in recreational waters contaminated with human fecal material. Furthermore, human markers were detected in two samples collected during the January storm event in the Capistrano Catchment.

There is one septic tank (OWTS) in the Pillar Point Harbor watershed, at the Half Moon Bay Airport. Per the County's Individual Sewage Disposal Systems Ordinance (Chapter 4.84), this OWTS is subject to a triennial inspection by the County Health Officer to ensure its continued proper functioning.

Potential Additional Management Actions

- A deeper understanding of the operations, monitoring, and maintenance schedule and procedures for the collection system in the Study Area could be developed.
- Sewer districts and other stakeholders could explore opportunities to conduct outreach to owners/operators of private laterals.

5.2.5 Direct Sources of Wastes

Although homelessness in the Pillar Point Harbor watershed is not as extensive as it is in other parts of the County, homeless encampments are considered a priority bacteria source because

they can result in the direct discharge of human fecal material and trash to receiving waters. Transient individuals have been observed in Denniston Creek, at the Capistrano Catchment outlet, and along Airport Road (i.e., RVs). The issue of homelessness is complex and politically sensitive. Potential solutions to address discharge from encampments to the watershed are generally resource intensive and beyond the scope of stormwater programs. This is complicated by the fact that ordinances relied upon to enforce cleanup activities were developed for businesses and landowners, not individuals trying to reside in public areas and along creeks. Therefore, municipalities may not have legal standing to remove encampments. Furthermore, cleanup activities can be dangerous to personnel due to encounters with individuals/dogs and the presence of hazardous materials. Nonetheless, the County Department of Human Services, Center on Homelessness is actively involved in efforts to prevent encampments by helping to move homeless people into housing. The Strategic Plan: Ending Homelessness in San Mateo County (2016) articulates a path to achieve that goal by 2020. Interventions include outreach and engagement, emergency shelters, transitional housing, and prevention programs. The County also has an ordinance prohibiting overnight parking of RVs and the use of vehicles for human habitation (Chapter 7.96).

5.2.6 Livestock

There is only one known location with livestock in the Pillar Point Harbor watershed, a cattle ranch located upstream of the MS4 in the Deer Creek watershed. Monitoring results suggest that this ranch may be contributing wet and dry season FIB to Deer Creek.

Trails in the GGNRA receive frequent use from equestrians (and dog walkers). If waste from these animals is not managed, it could contribute FIB to the Pillar Point Harbor watershed.

Potential Additional Management Actions

- The RCD could continue to reach out to the cattle ranch owner and offer technical assistance as well as highlight funding sources to install fencing to prevent cattle from entering the creek.

- The County and/or RCD could consider working with GGNRA to add educational signage to GGNRA trails about the Pillar Point Harbor watershed and the need to control waste from horses and pets.

5.2.6 Wildlife Waste

Wildlife sources of bacteria are generally considered uncontrollable. The riparian corridors along the Study Area creek, parks (including the GGNRA), beaches, and large residential lots provide desirable habitat for attracting and sustaining many wildlife and avian populations. These include raccoons, skunks, squirrels, deer, ducks, rodents, pigeons, snakes, woodrats, bobcats, mountain lions and coyotes. Raccoons and skunks were observed in the storm drain system during the SSID Project site visits. Furthermore, rodents and pigeons are common nuisance wildlife in commercial areas.

Control measures for wildlife waste are generally limited to trash reduction efforts and trash receptable management to prevent scavenging. Reducing non-stormwater flows in the MS4 may also make pipes less attractive to wildlife if they are using those flows as a water source.

6.0 References

Bay Area Stormwater Management Agencies Association (BASMAA). 2016a. Regional Monitoring Coalition Creek Status Monitoring Program Quality Assurance Project Plan.

Bay Area Stormwater Management Agencies Association (BASMAA). 2016b. Regional Monitoring Coalition Creek Status Monitoring Program Standard Operating Procedures.

BKF Engineers. 2013. Drainage Report. Midcoast Storm Drain Inventory and Assessment Project. Prepared for the County of San Mateo. February 8, 2013.

County of San Mateo. 2014. Long-Term Trash Load Reduction Plan and Assessment Strategy. In compliance with Provision C.10.c of Order R2-2009-0074. February 1, 2014.

Flint, P.S. 1977. Environmental Study of the Pillar Pt. Marsh, San Mateo County, California. Part I. Baseline Data. Consulting report prepared for Coastside County Water District.

Griffith, J.F., Blythe, A.L., Boehm, A.B., Holden, P.A., Jay, J.A., Hagedorn, C., McGee, C.D., and Weisberg, S.B. 2013. The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches. Southern California coastal Water Research Project Technical Report 804.

Kim, M. and Wuertz, S. 2014. Identification of Sources of Fecal Pollution Impacting Pillar Point Harbor. A Final Report Submitted to San Mateo Resource Conservation District. January 2014.

San Mateo County Resource Conservation District (RCD). 2014. Final Project Report. Pillar Point Harbor Source Identification Project. Clean Beaches Grant Program, Proposition 50. Agreement 07-574-550-2. January 2014.

San Mateo Countywide Water Pollution Prevention Program (SMCWPPP). 2018. Pillar Point Watershed Pathogen Indicator Stressor/Source Identification Project Work Plan. Prepared for SMCWPPP by EOA, Inc., Oakland, California. March 31.

Skinner, J.f., Kappeler, J., and Guzman, J. 2010. Regrowth of enterococci and fecal coliform in biofilm. Stormwater Magazine, June 30, 2010.

United States Environmental Protection Agency (USEPA). 2012. Recreational Water Quality Criteria. Office of Water 820-F-12-058.

Urban Water Resources Research Council (UWRRC). 2014. Pathogens in Urban Stormwater Systems. Prepared by UWRRC Pathogens in Wet Weather Flows Technical Committee, Environmental and Water Resources Institute, American Society of Civil Engineers with support from Urban Drainage and Flood Control District, Denver, CO and Urban Watersheds Research Institute. August 2014. Accessible at: http://www.asce-pgh.org/Resources/EWRI/Pathogens%20Paper%20August%202014.pdf

Walters, E., Schwarzwalder, K., Rutschmann, P., Muller, E., and Horn, H. 2013. Influence of resuspension on the fate of fecal indicator bacteria in large-scale flumes mimicking an oligotrophic river. Water Research, http://dx.doi.org/10.1016/j.watres.2013.10.002.

Wuertz, S., Wang, D., Zamani, K., and Bombardelli, F. 2011. An Analysis of Water Circulation in Pillar Point Harbor, Half Moon Bay, California, based on the Dye Distribution Study of September 27, 2008. Report prepared for San Mateo County Resource Conservation District.

Appendix A

Geodatabase Metadata

Pillar Point Harbor Bacteria Geodatabase

Metadata

Geodatabase: PillarPointBacteria.gdb

Publication Date: October 15, 2019

Datum: D_North_American_1983
Projected Coordinate System: NAD_1983_StatePlane_California_III_FIPS_0403_Feet
Attribute: the title of the field/column
Attribute Type: The data type stored in the geodatabase. ""Double" and "Float" refer to a numeric attribute, while "String" is a text attribute.
Description: Brief explanation of the attribute as well as a note if it was created by an organization other than EOA.

*All original attributes have been left in each geodatabase layer, however not all are listed in this appendix. All fields created by EOA have been included.

Primary Contact:

Alec Arditti
EOA, Inc.
1410 Jackson St.
Oakland, CA
aarditti@eoainc.com
(510)832-2852 ext. 114

Disclaimer:

The GIS data layers described below should be considered in draft form and are subject to change. These data are a work in progress and will be updated as more information is gathered. EOA and SMCWPPP staff do not take responsibility for any errors in the data, or any analysis that may result.

Geodatabase Layers:

Point Layers

Business_Sources -
Businesses cited as having potential illicit discharges to creeks. Businesses were also included that had relevant stormwater violations or complaints per the San Mateo County Stormwater Program. Layer digitized by EOA (2019).

Attribute	Attribute Type	Description
Comments	String	Description of potential runoff issue
Business	String	Name of business associated with the violation or complaint
Lat	Double	Latitude (Decimal Degrees)
Long	Double	Longitude (Decimal Degrees)
Watershed	String	Watershed business falls within

Direct_Human_Sources –
Locations identified by the San Mateo County Resource Conservation District as suspected or confirmed human source sites. Sites digitized by EOA (2019).

Attribute	Attribute Type	Description
Permanency	String	If the source is continuous and if not the frequency at which it occurs
Scale	String	The extent of the potential human source (single vs. multiple)
Comments	String	Description of the location
Year	String	The year or time descriptor the human source has been observed
Lat	Double	Latitude (Decimal Degrees)
Long	Double	Longitude (Decimal Degrees)
Watershed	String	Watershed the human source falls within

Dog_Waste_Stations –
Locations within the study area that have stations for proper disposal of dog waste. The stations were identified by the RCD.

Attribute	Attribute Type	Description
Name	String	Location of the station
Lat	Double	Latitude (Decimal Degrees)
Long	Double	Longitude (Decimal Degrees)
Watershed	String	Watershed the station falls within

Other_Bacteria_Monitoring_Sites –
Locations of bacteria sampling stations maintained by the County health department and Snapshot Day. Locations and information pertaining to the sites is taken from the County Health website and the state Waterboard's safe to swim website:
http://maps.smcgov.org/beachmonitoring/
https://mywaterquality.ca.gov/safe_to_swim/interactive_map/
Layer created by EOA (2019)

Attribute	Attribute Type	Description
Name	String	ID used by the agency who maintains the station
Lat	Double	Latitude (Decimal Degrees)
Long	Double	Longitude (Decimal Degrees)
Watershed	String	Watershed the site falls within

PPHSSIDSites –
Locations of bacteria sampling stations. The locations were selected as representative of important subwatersheds of the study area. Layer created by EOA (2019).

Attribute	Attribute Type	Description
Name	String	Abbreviation that serves as an identifier for the point
Lat	Double	Latitude (Decimal Degrees)
Long	Double	Longitude (Decimal Degrees)
Watershed	String	Watershed the site falls within

SSO –
Category 1 Sanitary Sewer Overflow (SSO) events that have occurred within the MS4 permit area. Category 1 events are discharges of untreated or partially treated wastewater that reach surface water, are not fully captured, or are not disposed of properly. Locations and information pertaining to the events is taken from the State Water Resources Control Board Sanitary Sewer Overflow Reduction Program website:
https://www.waterboards.ca.gov/water_issues/programs/sso/sso_map/sso_pub.shtml
Layer created by EOA (2019).

Attribute	Attribute Type	Description
Date	String	Month, Day, Year and Time of overage
SSO_Event_ID	String	SSO event identification number, linked to report on SWRCB website
Site_Name	String	Specifies location of spill
Volume	String	Total spill volume
Recovered	String	Spill volume recovered
Type	String	Category 1, 2 or 3
Reason	String	The cause of the spill
Lat	Double	Latitude (Decimal Degrees)
Long	Double	Longitude (Decimal Degrees)
Watershed	String	Watershed the SSO occurred within

Wildlife –
Locations identified by the RCD as suspected or confirmed wildlife source sites. Digitized by EOA (2019).

Attribute	Attribute Type	Description
Comments	String	Summary of applicable wildlife locations and activities
Latitude	Double	Latitude (approximate)
Longitude	Double	Longitude (approximate)
Watershed	String	Watershed the wildlife were noted within

Polyline Layers:

Creeks –
Creeks that drain into Pillar Point Harbor, including tributaries. Taken from the National Hydrography Dataset, which is maintained by USGS. Then modified using the Storm Drain Inventory Project to improve accuracy. Layer created by EOA (2019).

Attribute	Attribute Type	Description
Creek_name	String	Name of the creek that the line segment is a part of
FEET	Double	Length of segment in feet

Storm_Drain_Lines –
Locations of the storm drain network, including storm drain lines, ditches, swales and gutters that fall within the study area. Data was gathered by FUGRO. (2013).

Attribute	Attribute Type	Description
PIPEDIAM	Double	Diameter of the pipe (attribute created by FUGRO)
UNITTYPE	String	Specifies pipe, gutter, ditch, swale etc. (attribute created by FUGRO)
Display	String	Categorization of storm lines for map displaying purposes
Feet	Float	Length of segment in feet

Storm_Drain_Issues –
Locations of potential issues with the storm drain system, identified by the RCD. Line segments were extracted by EOA from the existing *Storm_Drain_Lines* (2019).

Attribute	Attribute Type	Description
Comments	String	Description of issue
Watershed	String	Watershed the issue falls within
FEET	Double	Length of segment in feet

Trails –
Extent of trails that pass through the study area. The source data were provided by the National Park Service and relevant trails were extracted by EOA (2019).

Attribute	Attribute Type	Description
TRLNAME	String	Name of the trail
TRLUSE	String	Specifies whether the trail allows hiking, biking or horses
FEET	Double	Length of segment in feet

Polygon Layers

Livestock –
Locations of livestock within the study. Data collected by EOA via aerial imagery Digitized by EOA (2019).

Attribute	Attribute Type	Description
Comments	String	Description of livestock
Watershed	String	Watershed livestock are located within
ACRES	Double	Size of livestock area in acres

Parcels –
The parcel boundaries of the parcels that intersect the study area, available publicly online from San Mateo County and downloaded by EOA in 2014. Also included in this GIS layer is the owner information and land use code of every parcel. Data was obtained from the San Mateo County Recorder's office in 2014. All attributes are original to the layer.

Attribute	Attribute Type	Description
APN	String	Assessor's parcel number
Acres	Float	Acreage
OWNER	String	Property owner
Mailing_Address	String	Owner mailing address
Site_Address	String	Site address
PUC_CODE	Double	Parcel Land Use Code, as provided the County Recorder's office
Landuse	String	Land Use

EOA_Landuse –
The parcel boundaries of the parcels that intersect the study area, taken from ABAG (Association of Bay Area Governments) and modified by EOA. Landuse was modified by EOA for a trash project and approved by the county. Landuse was further modified within the study area by EOA staff to reduce the number of categories and improve accuracy.

Attribute	Attribute Type	Description
Landuse	String	EOA landuse designation with County approval for county trash project
acres	Float	Acreage
Reclassified	String	EOA landuse designation specifically for Pillar Point Harbor

Pets –
Locations within the study area that have potential sources of bacteria from pet waste. Locations were identified with the help of the RCD. Digitized by EOA (2019).

Attribute	Attribute Type	Description
Comments	String	Description of pet and location
ACRES	Double	Size of area in acres

Watersheds –
Watershed boundaries for surface waters, creek and storm drain networks that drain to Pillar Point Harbor. Watersheds were created and verified through a combination of Storm Drain Inventory Project, digital elevation models, and aerial and Google Street View imagery. Layer created by EOA (2018).

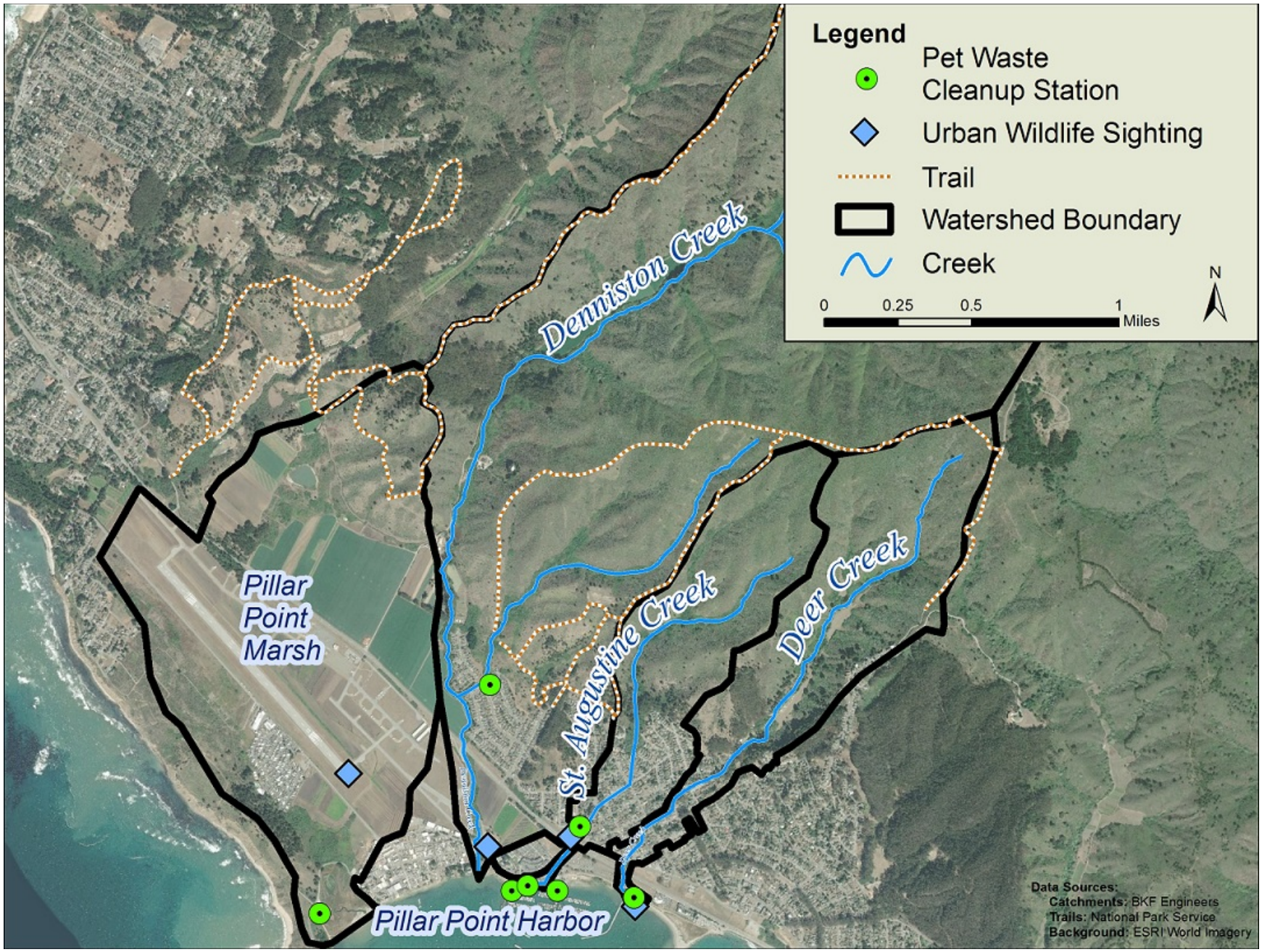
Attribute	Attribute Type	Description
NAME	String	Name of creek or surface water associated with watershed
ACRES	Double	Watershed acreage
WATERSHED	String	Name of watershed

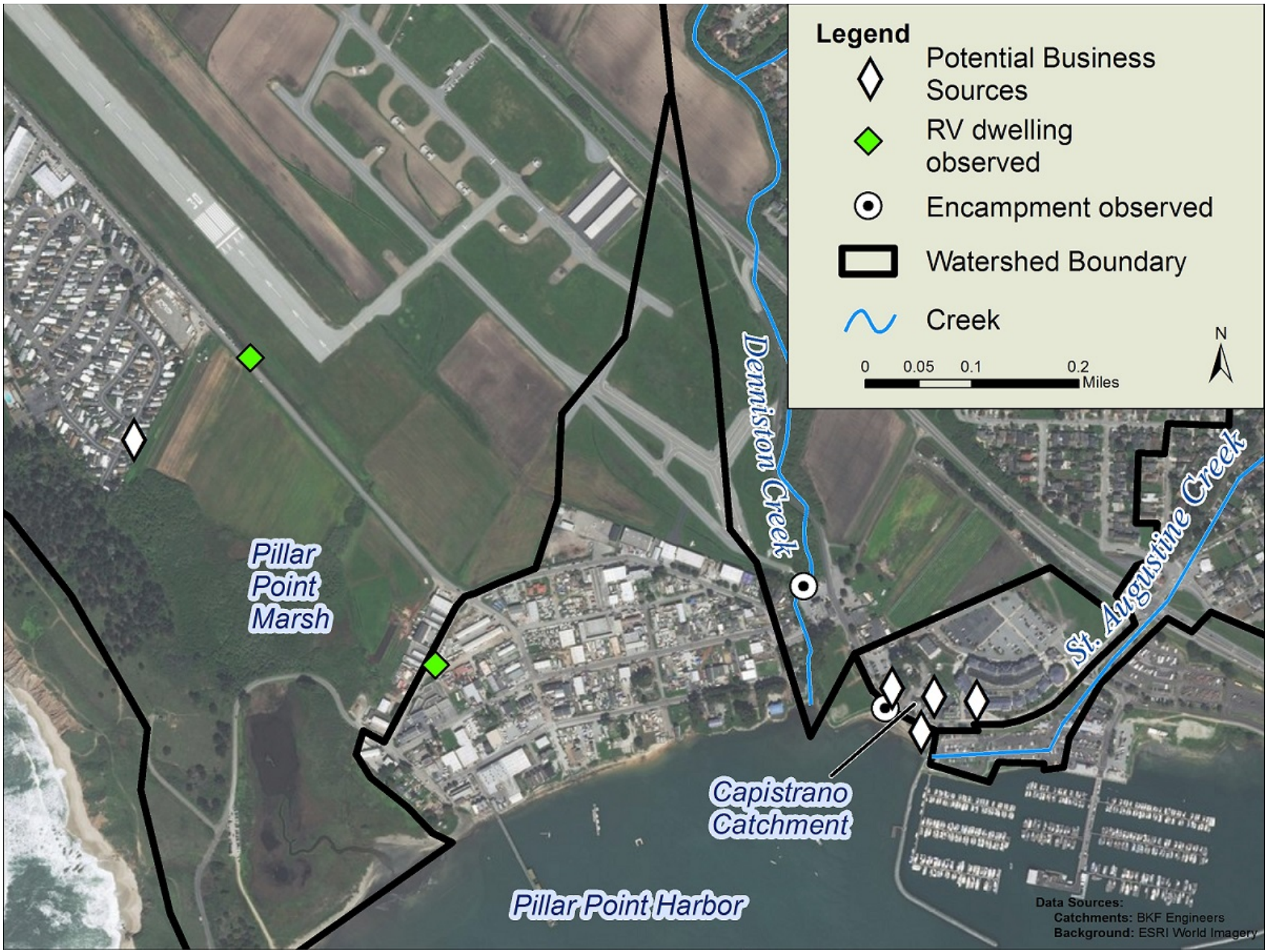
SSID_Watersheds–
Catchment boundaries for surface waters, creek and storm drain networks that drain to the SSID Sites. Catchments were delineated through a combination of the Storm Drain Inventory Project, digital elevation models and aerial and streetview imagery. Layer created by EOA (2019).

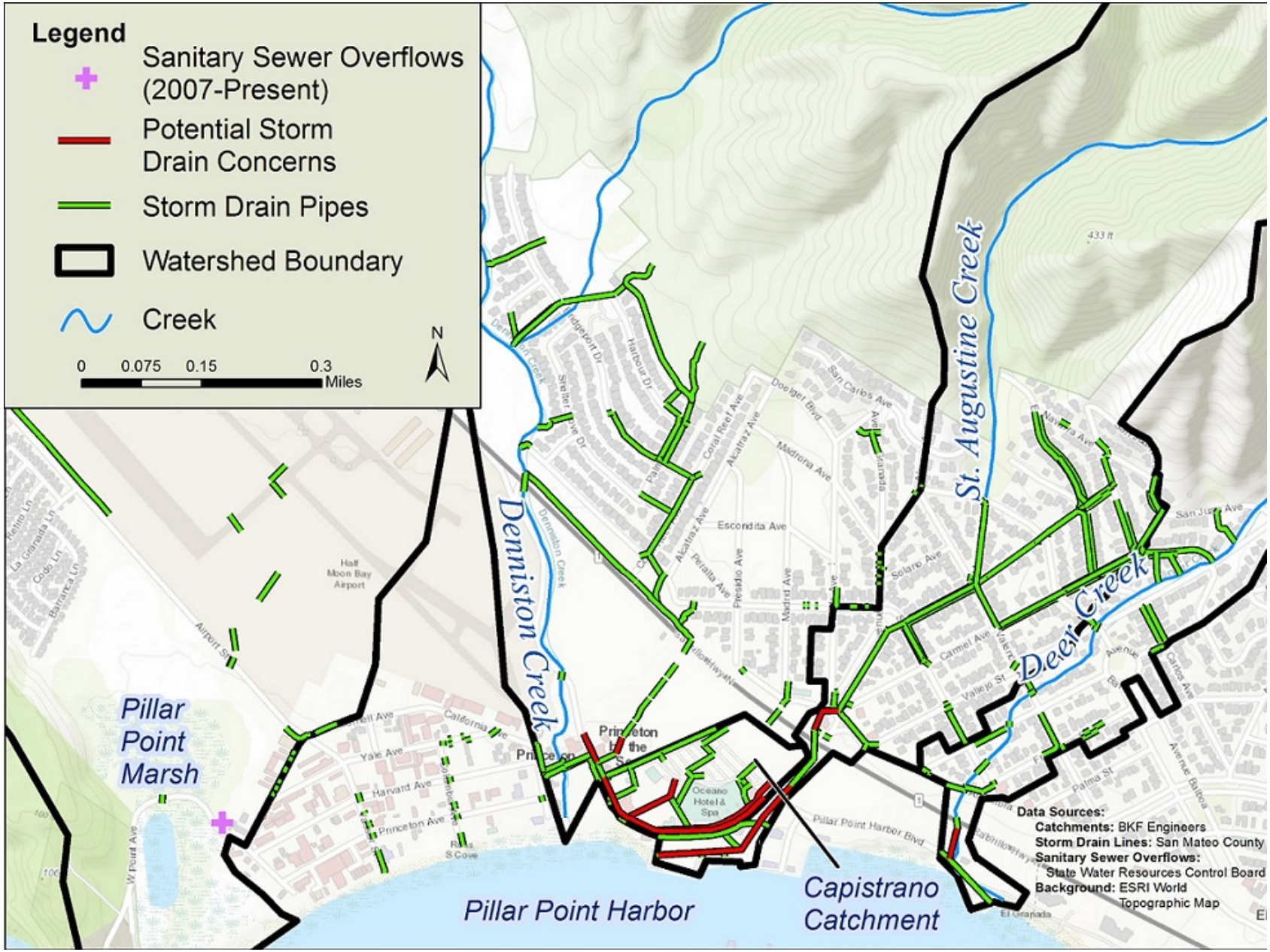
Attribute	Attribute Type	Description
NAME	String	Name of creek or surface water associated with watershed
ACRES	Double	Watershed acreage
Catchment	String	Name of SSID site that catchment drains to

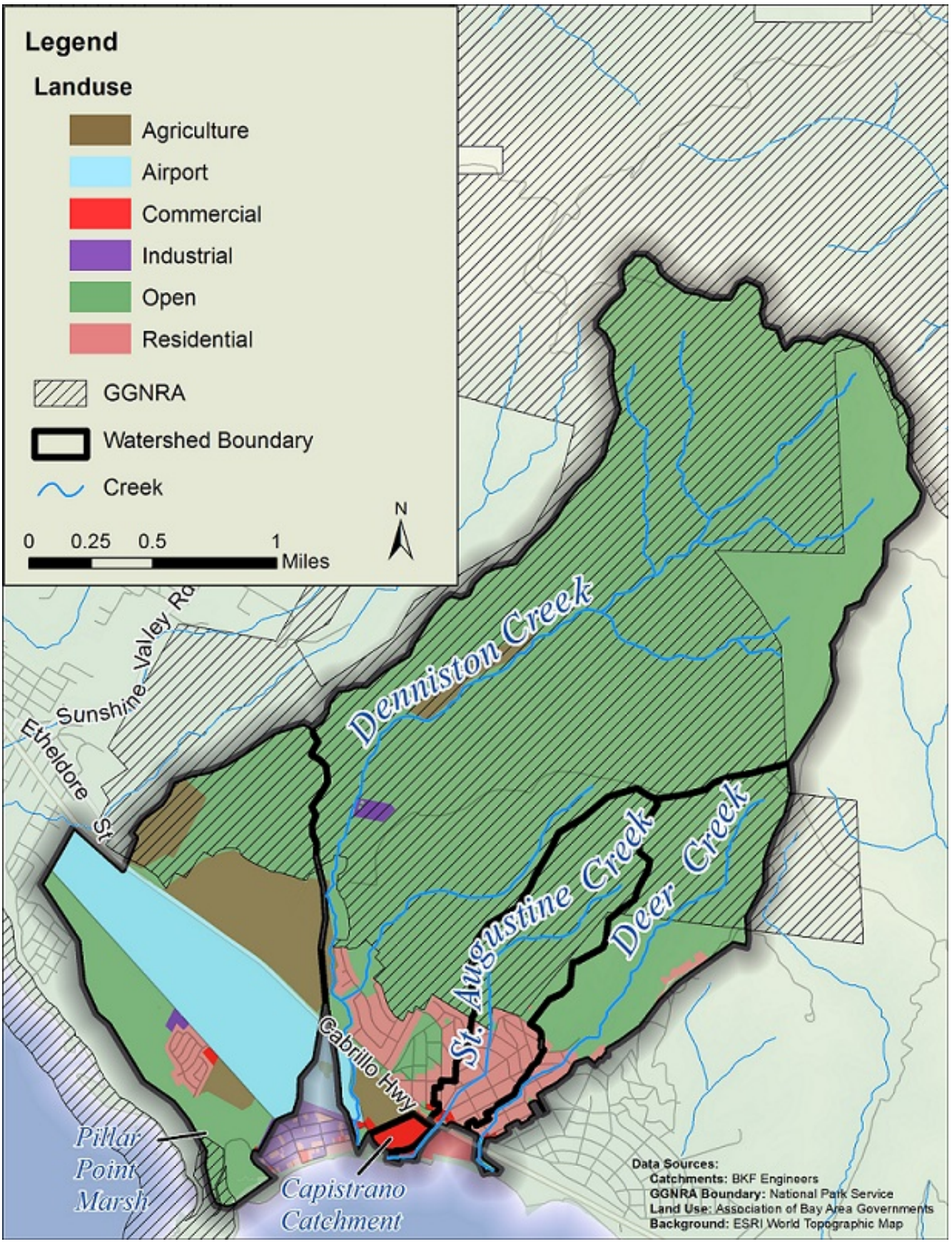
Appendix B

Geodatabase Figures


Legend
Pet Waste Cleanup Station
Urban Wildlife Sighting
Trail
Watershed Boundary
Creek
0
0.25
0.5
1
Miles
N
Denniston Creek
St. Augustine Creek
Deer Creek
Pillar Point Marsh
Pillar Point Harbor
Data Sources:
Catchments: BKF Engineers
Trails: National Park Service
Background: ESRI World Imagery


Legend
Potential Business Sources
RV dwelling observed
Encampment observed
Watershed Boundary
Creek
0 0.05 0.1 0.2 Miles
N
Pillar Point Marsh
Denniston Creek
St. Augustine Creek
Capistrano Catchment
Pillar Point Harbor
Data Sources:
Catchments: BKF Engineers
Background: ESRI World Imagery


Legend
Sanitary Sewer Overflows (2007-Present)
Potential Storm Drain Concerns
Storm Drain Pipes
Watershed Boundary
Creek
0 0.075 0.15 0.3 Miles
N
Pillar Point Marsh
Pillar Point Harbor
Capistrano Catchment
Denniston Creek
St. Augustine Creek
Deer Creek
Half Moon Bay Airport
Princeton by the Sea
Oceano Hotel & Spa
Pillar Point Harbor Blvd
Data Sources:
Catchments: BKF Engineers
Storm Drain Lines: San Mateo County
Sanitary Sewer Overflows: State Water Resources Control Board
Background: ESRI World Topographic Map


Legend
Landuse
Agriculture
Airport
Commercial
Industrial
Open
Residential
GGNRA
Watershed Boundary
Creek
0 0.25 0.5 1
Miles
N
Sunshine Valley Rd
Etheldore St
Denniston Creek
St. Augustine Creek
Deer Creek
Cabrillo Hwy
Pillar Point Marsh
Capistrano Catchment
Data Sources:
Catchments: BKF Engineers
GGNRA Boundary: National Park Service
Land Use: Association of Bay Area Governments
Background: ESRI World Topographic Map