TMDL Report for the San Lorenzo River, Soquel Creek, and Aptos Creek Watersheds

October 2018

PURPOSE

This document was prepared by the County of Santa Cruz in collaboration with the Cities of Santa Cruz, Scotts Valley, and Capitola to evaluate the status of Total Maximum Daily Load (TMDL) targets relevant to stormwater management pursuant to Section 303(d) of the Federal Clean Water Act (CWA). The current inventory of stormwater program best management practices (BMPs) is reviewed in the context of wasteload allocations. Trends in monitoring data for sentinel sites within each watershed are evaluated to develop recommendations for the next reporting cycle.

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1 Introduction

Several watersheds within the Santa Cruz County have been identified by the State of California as impaired waterbodies pursuant to Section 303(d) of the Federal Clean Water Act (CWA)[1]. By definition, 303(d) listings and adopted TMDLs are presumed to indicate one or more beneficial use impacts and the need to control the source(s) of these impairments. The Regional Water Board has oversight over these waterbodies and manages water quality through implementing Total Maximum Daily Loads (TMDLs) that are incorporated into Basin[2] Plans, the National Pollutant Discharge Elimination System (NPDES)[3] permit program, and the Stormwater (MS4)[4] program. The overarching goal of each TMDL is to identify sources of contaminants and develop strategies to meet specific targets within a 20-25 year timeframe.

The purpose of this report is to review the status of four individual TMDLs that address contributions from municipal stormwater systems (MS4)to the San Lorenzo River, Soquel Creek, and Aptos Creek watersheds within Santa Cruz County. The TMDL requirements[5] are summarized in Table 1. One TMDL (R3-2002-0063) addresses sediment loading in the San Lorenzo River and tributaries (Carbonera, Lompico, and Shingle Mill Creeks). The other three TMDLs reviewed for this report (R3-2009-0023, R3-2009-0024, and R3-2009-0025) were adopted to mitigate microbiological contamination in the San Lorenzo River, Soquel Creek, and Aptos Creek watersheds. A key concern is to ensure that the water quality in each of these watersheds meets or exceeds requirements for relevant beneficial use designations. The primary focus of the TMDLs is protecting public health, safeguarding the designated beneficial uses of water contact recreation (REC-1) and fisheries support (MIGR and SPWN), and mitigating factors that could impair water quality.

This report reflects extensive stakeholder collaboration to identify MS4 pollution sources and implement best management practices (BMPs), monitoring programs, and modeling tools for meeting the TMDLs. The report includes contributions from the County of Santa Cruz and the Cities of Santa Cruz, Scotts Valley, and Capitola. The current BMP inventory is reviewed in the context of wasteload allocations for MS4s. Trends in monitoring data for sentinel sites within each watershed are evaluated to develop recommendations for the next reporting cycle.

[1] https://www.waterboards.ca.gov/water_issues/programs/tmdl/background.html
[2] https://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/
[3] https://www.waterboards.ca.gov/water_issues/programs/npdes/
[4] https://www.waterboards.ca.gov/water_issues/programs/stormwater/municipal.html
[5] https://www.waterboards.ca.gov/water_issues/programs/stormwater/docs/phsii2012_5th/att_g_tmdl_final.pdf

Table 1. TMDL Reduction Targets for Sediments and Microbial Contamination Related to Urban Stormwater

TMDL Resolution (R3)	Impaired Waterbodies	Date range	MS4 permitees	Reduction Targets
Sediment R3-2002-0063	San Lorenzo River and Carbonera, Lompico, Shingle Mill Creeks	12/18/2003 to 12/18/2028	County of Santa Cruz, City of Santa Cruz, and City of Scotts Valley	Percent reductions of sediment discharges from public roads for each waterbody are: • San Lorenzo River: 27% • Lompico Creek: 24% • Carbonera Creek: 27% • Shingle Mill Creek: 27%.
Pathogens (Indicator Bacteria) R3-2009-0023	San Lorenzo River Estuary San Lorenzo River, Branciforte Creek, Camp Evers Creek, Carbonera Creek, and Lompico Creek	6/8/2011 to 6/8/2024	County of Santa Cruz, City of Santa Cruz, and City of Scotts Valley	Fecal coliform: • log mean below 200 MPN/100 mL and • 90% of samples collected during any 30-day period must be below 400 MPN/100 mL
Pathogens (Indicator Bacteria) R3-2009-0024	Soquel Lagoon, Soquel Creek, and Noble Gulch	9/15/2010 to 9/15/2023	County of Santa Cruz and City of Capitola	
Pathogens (Indicator Bacteria) R3-2009-0025	Aptos Creek, Valencia Creek, and Trout Gulch	10/29/2010 to 10/29/2023	County of Santa Cruz	
Source: Phase II Small MS4 General Permit NPDES General Permit No.S000004; Order No. 2013-0001-DWQ - Attachment G: Region Specific Requirements				

2 Best Management Practices (BMPs)

A multi-faceted multi-jurisdictional approach was developed to establish practicable BMPs for MS4s to mitigate sources of contamination with an emphasis on improving water quality in impaired waterbodies. In many cases, the BMPs address multiple sources of contamination. The primary sources of sediments are related to stormwater runoff from roadways, construction sites, and erosion. Microbial contaminants may originate from wildlife, birds, animal facilities, non-specific urban sources, onsite wastewater systems, encampments, sewer overflows, pet waste, or other sources.

The BMPs developed for the TMDLs in this report span four general categories:

- Illicit Discharge Detection and Elimination
- Construction Site Storm Water Runoff Control Program
- Post-Construction Storm Water Management in New Development and Redevelopment
- Pollution Prevention/Good Housekeeping for Municipal Operations

Priority county-wide BMPs for sediment and microbial contaminants related to MS4s are listed in Table 2 along with tracking information for each of the participating jurisdictions. Each of the listed BMPs is classified as a non-structural BMP that has potential to improve water quality.

The status of each priority BMP is summarized in Table 3. All of the listed BMPs have been successfully implemented, success goals have been defined, and efforts are ongoing to refine strategies and track progress.

Table 2. Status of Priority Best Management Practices (BMPs) to mitigate sediment and microbial contamination from MS4s

County-wide	TMDL Pollutants*		Coordinating Agencies			
BMPs	**Sediment**	**Indicator Bacteria**	**County of Santa Cruz**	**City of Santa Cruz**	**City of Scotts Valley**	**City of Capitola**
Illicit Discharge Detection and Elimination						
Field investigations of storm drain outfalls and creeks		1	E.9.c	* E.9.c	E.9.c.1, E.9.c.2	E.9.5-2.4
Correct sewer leaks and cross-connections, including laterals		1	E.9.d,e	MO-11-E.15 (MO-10-E.15)	E.9.d.1	N/A
Septic Systems Maintenance and Management Program		1	E.9.e	N/A	N/A	N/A
Construction Site Stormwater Runoff Control Program						
Grading, Erosion Control, and Riparian Corridor Ordinances	1		E.10.b	* E.10.b CON-3, CON-5	E.10.b	E.10.6-2.1
Conduct site inspections. Use legal authority to implement procedures for inspecting public and private construction projects and conduct enforcement if necessary	1		E.10.a	CON-1 New BMP-E.10.c	E.10.c E.10.b	E.10.6-2.5
Prompt response to public complaints	1		E.9.d	ID-2-E.9.d (d)(e) CON-3 & CON-5-E.10	E.9.d.3	E.10.6-2.9
Post-Construction Stormwater Management in New Development and Redevelopment						
Review and update post-construction runoff (PCR) (hydromodification) criteria	1	2	E.12.k, E.15	PC-5-E.12.k, E.15	E.12.e.11	E.12.e, f
Provide for ongoing monitoring and maintenance. Implement program to ensure long-term BMP inspection and maintenance	1	3	E.12.g-i	PC-8-E.12.k, E.15	E.12.i E.12.h	E.12.j E.12.h
Pollution Prevention/Good Housekeeping for Municipal Operations						
Street Sweeping	1	2	E.11.h	MO-1-E.11, E.15	E.11.g.4	E.11.8-2.8
Municipal Parking Lot Sweeping	1	2	E.11.h	MO-3-E.11, E.15	E.11.g.4	E.11.8-2.3
* 1-High Effect, 2- Medium Effect, 3-Lower Effect						

Table 3. Metrics and status for BMPs to mitigate sediments and microbial contamination

BMP	Measurable Goal	Implementation status	Effectiveness	CASQA Outcome*	Proposed Modification
Illicit Discharge Detection and Elimination / E.9					
Field investigations of storm drain outfalls and creeks.	Inspection of priority outfalls and issues documented.	Complete/ Ongoing	High	1	None
Correct leaks from sewers, laterals and cross-connections; Implement inspection ordinance	All detected leaks repaired. Number of inspections completed	Complete/ Ongoing	High	4	None
Respond to Reported Spills, Sewer Overflows, and Illegal Discharges	All reported spills and leaks are investigated. investigated.	Complete/ Ongoing	Medium	4	None
Optimize programs for septic system monitoring, management and upgrades.	Identify and replace old or faulty septic systems	Complete/ Ongoing	High	4	None
Construction Site Stormwater Runoff Control Program / E.10					
Grading, Erosion Control, and Riparian Corridor Ordinances	Enact and enforce ordinances	Complete/ Ongoing	High	4	None
Use legal authority to implement procedures for inspecting public and private construction projects and carry out enforcement.	Inspect projects for compliance with Grading and Erosion Control requirements and issue violations.	Complete/ Ongoing	High	3	None
Create a means for the public to report issues and respond	Respond to all public complaints	Complete/ Ongoing	Medium	2	None
Post---Construction Stormwater Management in New Development and Redevelopment / E.12					
Review and modify hydromodification criteria	Provide permittees with low-impact-development (LID) guidelines	Complete	High	4	None
Implement LID O&M Plan for all structural BMPs	Implement and enforce O&M Plan	Complete/ Ongoing	High	1	None
Pollution Prevention/Good Housekeeping for Municipal Operations / E.11					
Conduct regular street sweeping schedule	Track quantities of collected materials	Complete/ Ongoing	High	4	None
Conduct regular sweeping of Municipal parking lots	Track quantities of collected materials	Complete/ Ongoing	High	4	None
California Stormwater Quality Association (CASQA) Outcome Levels 1 = Documenting Activities ; 2 = Raising Awareness; 3 = Changing Behavior; 4 = Reducing Loads from Sources					

3 Evaluation of MS4 BMP Efficacy

Evaluation of the effectiveness of BMPs is challenging. Within a given watershed, the non-structural BMPs function collectively to reduce pollutant loads. However, other variables such as precipitation, changes in land-use patterns, population pressures, and development can exert stressors on watersheds that mask the effectiveness of BMPs. In addition, detecting evidence of water quality improvements can be difficult due to the time-lag between BMP implementation and watershed response. For extreme cases of pollution, direct measures of the contaminant load can be useful for tracking success. For bulk parameters with multiple sources, such as sediments and indicator bacteria, the use of modeling tools coupled with long-term monitoring programs and source tracking may provide some insights into BMP effectiveness.

In 2008, the Central Coast Regional Water Quality Control Board established the Low Impact Development Initiative (LIDI)[6] to develop tools for modeling BMP effectiveness. The tools include mapping of urban catchments, estimation of pollutant loads, simulation of structural BMP efficacy, and Rapid Assessment Methodology (RAM). BMP RAM is intended to provide stormwater managers with the means to evaluate and track the condition of stormwater structural BMPs in any location with minimal subjective decision making or local calibration. An overview of the LIDI components is shown in Table 4. While still under development, it is anticipated that all MS4s in the Central Coast Region will be able to use the modeling tools within the next few years.

The County of Santa Cruz in partnership with the Cities of Santa Cruz, Scotts Valley, and Capitola have conducted initial modeling of the watersheds relevant to the TMDLs. The models are useful for siting potential monitoring sites and evaluating the relative merits of alternative BMPs.

Table 4. Low Impact Development Initiative (LIDI) components and status

LIDI Workplan element	Description	Status
Mapping support	Mapping of urban catchments and associated stormwater routing and outfalls is foundational to understanding the MS4 network and its impact on receiving water(s).	Complete
Pollutant Loading and Reduction estimates	The mapped MS4 provides the basis for hydrologic calculations and pollutant load estimates to identify which catchments represent high risk to the receiving water(s). This information helps identify stormwater program priorities and direct resources. Pollutant reduction estimates can then be estimated based on program actions (structural and non-structural).	Initial inputs completed. Further training for MS4s.
Structural BMP inventory Rapid Assessment (RAM), O&M and performance	Structural BMPs can be tracked by catchment to estimate performance and determine maintenance needs. This information supports sustainable program actions and determination of whether progress toward water quality objectives is being made.	Initial inputs completed. Further training for MS4s.
Calibration of tools	Calibrate tools through implementation with two municipal MS4s	In progress

[6] https://www.centralcoastlidi.org/mspap.php

4 Monitoring Program

The County of Santa Cruz and the Cities of Santa Cruz, Capitola, Scotts Valley, and Watsonville conduct extensive water quality monitoring and there is ongoing collaboration to exchange data among the individual stakeholders. An overview of the routine monitoring sites is shown in Figure 1. The County's monitoring program focuses on routine grab samples from specific sites. The monitoring parameters include fecal indicator bacteria and other geochemical water quality parameters (e.g. conductivity, turbidity, pH, nutrients). The City of Santa Cruz conducts targeted monitoring within the City limits for a wide range of parameters. The monitoring programs serve multiple purposes and the long-term data can provide insight into progress in attaining the TMDL pollutant goals.

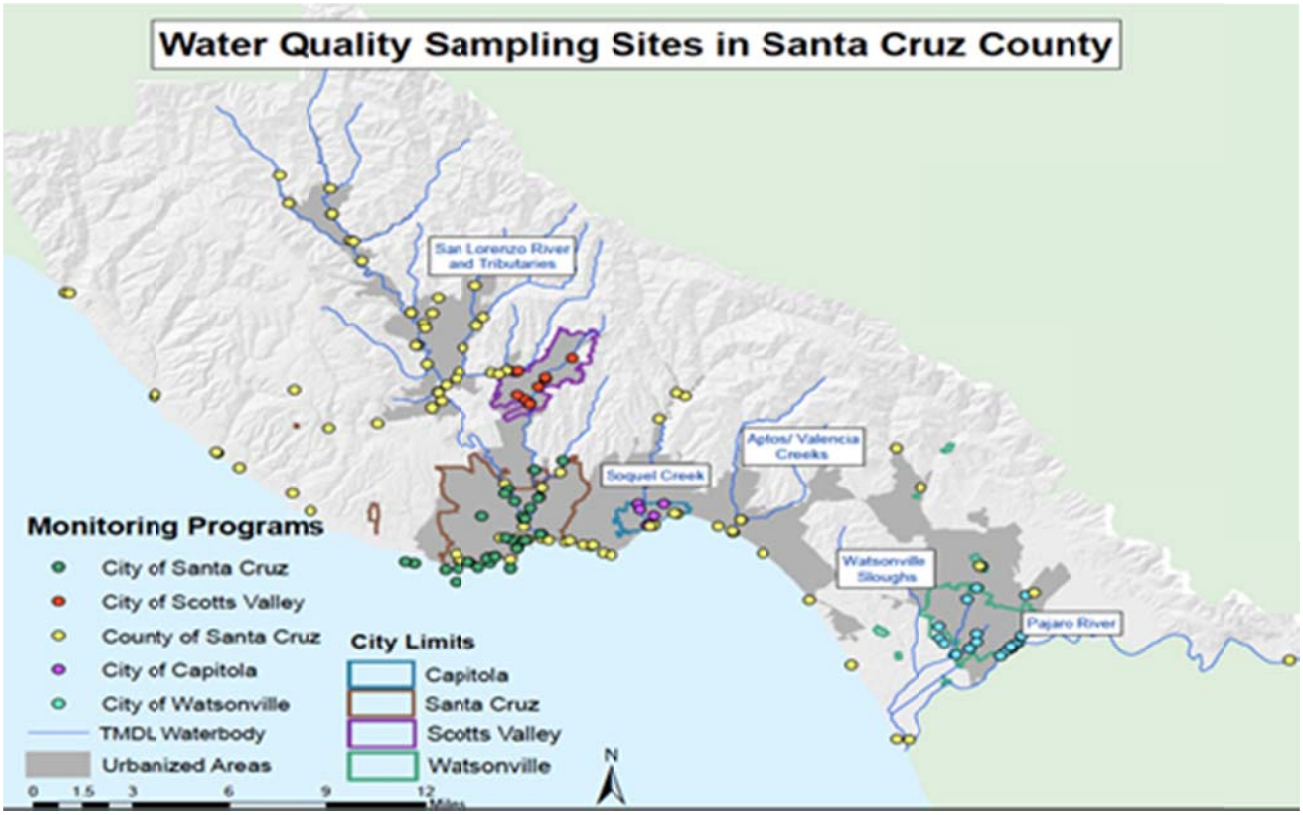


Figure 1. Locations of water quality monitoring sites within the County of Santa Cruz

Sediment TMDL

The sediment TMDL for San Lorenzo River and Carbonera, Lompico, Shingle Mill Creeks (R3-2002-0063) was adopted at the end of 2003. As part of the TMDL, an indicator monitoring program was recommended, as shown in Table 5. The indicator monitoring program is based on the particle size distribution of the sediments and defines specific numeric targets. The Regional Board was designated as the 'Implementing Party'. The TMDL also tasked the City of Santa Cruz to conduct turbidity trend monitoring with a goal of characterizing the turbidity regime of the San Lorenzo River.

Table 5. TMDL Indicator Monitoring Program adapted from San Lorenzo River Total Maximum Daily Load for Sediment (9/20/2002)

Parameter	Numeric Target	Frequency	Implementing Party
Percent fine fines < 0.85 mm in potential spawning gravels.	$\leq$ 21% by wet volume using a McNeil (bulk) sample.	Triennially during low-flow period or, less frequent basis after 3 years if D_{50} correlated with % fines.	Regional Board
Percent coarse fines < 6 mm in potential spawning gravels.	$\leq$ 30% by wet volume using a McNeil (bulk) sample.	Triennially during low-flow period or, less frequent basis after 3 years if D_{50} correlated with % fines.	Regional Board
Residual Pool Volume (V*).	$\leq$ 0.21 (mean) and $\leq$ 0.45 (max).	Triennially during low-flow period.	Regional Board
Median particle size diameter (D_{50}) from riffle crest surfaces.	≥ 37 mm (minimum for a reach) ≥ 69 mm (mean for a reach)	Triennially during low-flow period.	Regional Board
State of California, Central Coast Regional Water Quality Control Board (9/20/02) San Lorenzo River Total Maximum Daily Load for Sediment (including Carbonera Creek, Lompico Creek, and Shingle Mill Creek). Adapted from Table 9-1			

In addition to the indicator monitoring program defined in Table 5, the TMDL tasks the County of Santa Cruz with establishing a bed sedimentation monitoring program to evaluate stream habitat conditions, stream geomorphology, bank erosion, and streamflow in San Lorenzo mainstream and tributaries. The proposed monitoring program focused on the physical factors that influence local sedimentation and salmonid habitat quality. An overview of the proposed monitoring program is shown in Table 6. (Table 9-2). It was suggested that pool embeddedness be monitored biannually during low-flow periods. For the reach-scale parameters, it was recommended that an initial survey of the reach of interest should be used to define the baseline conditions. Five year intervals were recommended to repeat the surveys. Improvements could be measured through time to target problematic areas for restoration. The program for woody debris monitoring should be linked to large-flow events and combined with habitat or bank surveys.

The County of Santa Cruz has worked with other partner agencies since 1988 to conduct annual monitoring of juvenile steelhead populations and various habitat parameters, including large woody material, embeddedness and percent fines. This data is in a database and is currently being analyzed for long term trends and other insights.

Table 6. TMDL Stream Bed Sedimentation Monitoring Program adapted from San Lorenzo River Total Maximum Daily Load for Sediment (9/20/2002)

Monitoring parameter	Description
Pool Embeddedness (Discrete measurement)	Pool Embeddedness relates to available escape cover for juveniles under cobbles and boulders (> 100 mm in diameter). Highly embedded pools support less escape cover due to siltation of interstices. This variable is an estimate averaged over the entire pool with a target of < 25%.
Bankfull width and depth (Reach-scale)	Defined as the flow at which the water begins to access the floodplain. Bankfull is hypothesized to occur during the 1.5 – 2.33 year flood. Often indicated by a break in slope from a streambank to a floodplain depositional surface.
Channel Entrenchment (Reach-scale)	The ratio between the bankfull width and the width at 2 times the bankfull depth. Is an indicator of the confinement of the channel and the width of the floodplain surface. Some channels can become unnaturally entrenched causing excessive bank erosion and reduced sediment deposition on floodplain surfaces.
Rosgen Channel Type (Reach-scale)	Rosgen channel type is based on a combination of gradient, dominant substrate, bankfull width to depth ratio, and channel entrenchment. The Rosgen classification is the most common system used on streams.
Linear distance of eroded banks (Reach-scale)	Measured distance of actively eroding bank length. Height and assumed cause should also be noted for each discrete bank failure
Linear distance of modified banks (Reach-scale)	Measured distance of modified bank length. Type of modification should be noted.
In-channel large woody debris density (Reach-scale)	Large woody debris (>1 ft diameter, > 6 ft length) provides important sediment storage and habitat generating elements. Woody debris should be counted within the active channel bankfull to bankfull and not include recruitment

Trends and Observations

Sediment loading to the watershed is affected by the frequency and intensity of storm events. Drought conditions also affect the accumulation of sediment within a catchment. The USGS operates two gage stations along the San Lorenzo River. One station is at Big Trees (USGS stream gage #11160500[7] (37° 02'40" N, 122° 04'17" W NAD27) County Sampling Site 060) and the other station[8] is within the City of Santa Cruz and near County Sampling Site 022). Due to the terrain in the San Lorenzo Valley, flows can vary over several orders of magnitude. Flows at site 022 can be influenced by the operation of Loch Lomond Reservoir. A summary of the annual average flow at the Big Trees gage from the beginning of the TMDL (2003) through 2017 is shown in Figure 2 along with turbidity data corresponding to the same time frame. As shown, the reported turbidity at this location is generally below 10 NTU (Nephelometric Turbidity Units) with no specific trend that could be linked to any of the BMPs that have been implemented for the TMDL.

[7] https://waterdata.usgs.gov/usa/nwis/uv?site_no=11160500
[8] https://waterdata.usgs.gov/ca/nwis/uv/?site_no=11161000&PARAmeter_cd=00065,00060

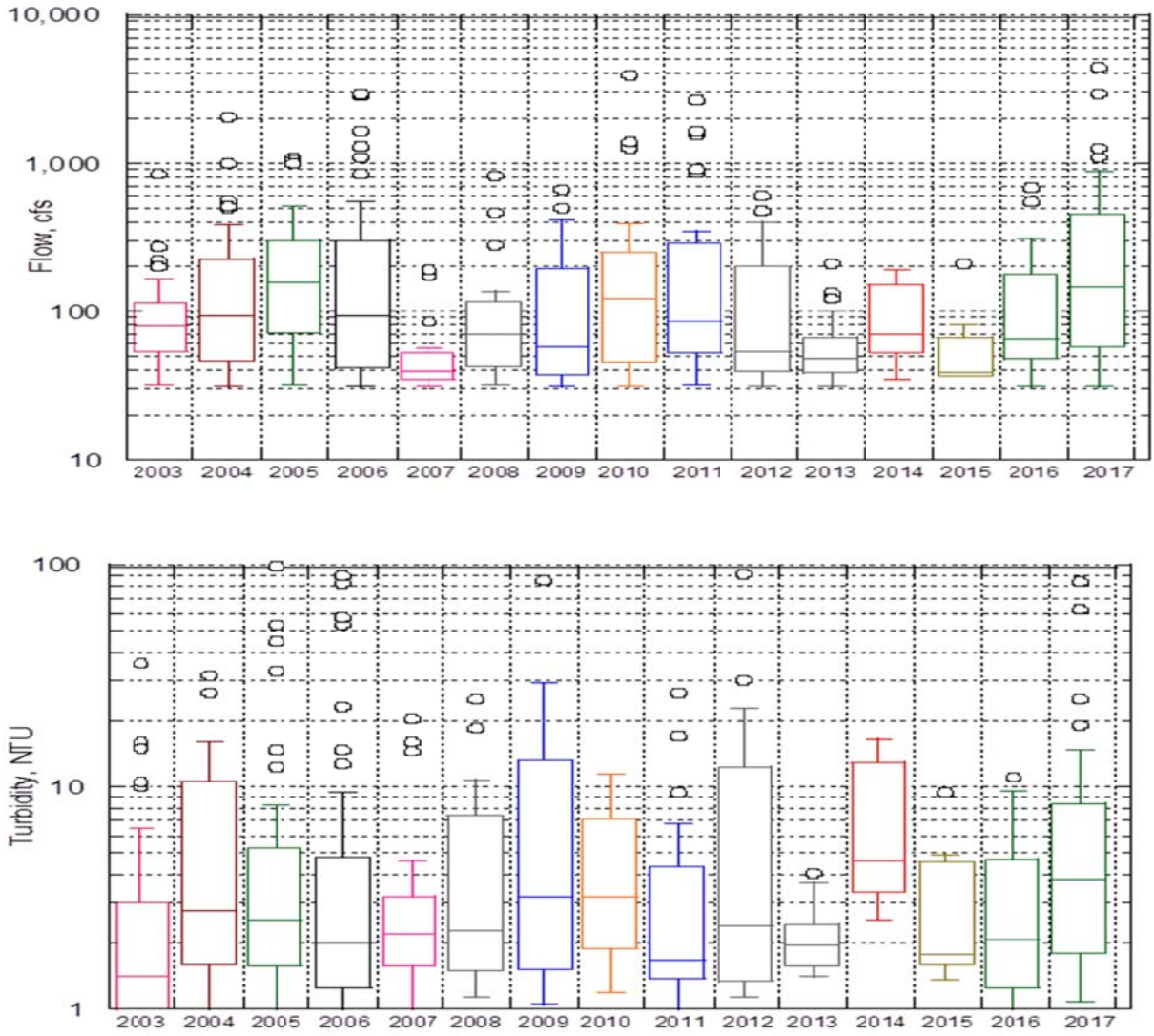


Figure 2. Boxplots of flow and turbidity at Big Trees monitoring station on the San Lorenzo River. Flow data are extrapolated from the daily average data reported by USGS and turbidity data are from grab samples taken by the County of Santa Cruz Environmental Health Program.

A comparison of turbidity and flow at the upstream (060) and downstream (022) gage stations on the San Lorenzo River is shown in Figure 3. In general turbidity is related to runoff and high turbidities can occur even during smaller runoff events. Additional data are available on sediment loading at Zayante Creek and Bean Creeks between 2009 and 2013.

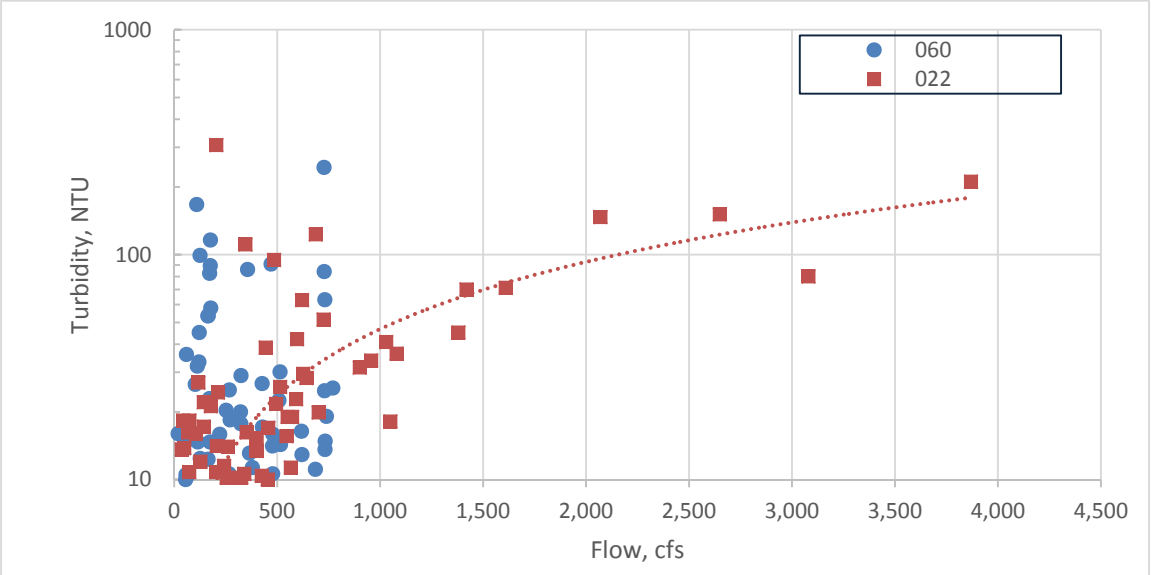


Figure 3. Comparison of turbidity and flowrates at two sampling locations along the San Lorenzo River. Flow data are extrapolated from the daily average data reported by USGS and turbidity data are from grab samples taken by the County of Santa Cruz Environmental Health Program.

Suspended sediment monitoring was conducted in conjunction with streamflow monitoring between 2009 and 2012 (funding from a Proposition 50 IRWM Grant)[9]. Samples were collected using a DH-48 hand-held sampler to directly measure total suspended-sediment concentrations to develop instantaneous sediment-rating curves that relate sediment and streamflow discharges over specific time intervals. Approximately 350 to 450 ml of depth-integrated sample was collected during each sampling event and analyses were conducted of whole-sample total suspended sediment concentration. A comparison of total annual flow (acre-ft) and estimated sediment load (tons) is shown in Figure 4 (data reported by Balance Hydrologics, Inc.). Water Years 2010 and 2011 had similar relationships between flow and sediment (0.5 tons/acre-ft), while the estimated sediment loading for Water Year 2012 was markedly lower (0.2 tons/acre-ft).

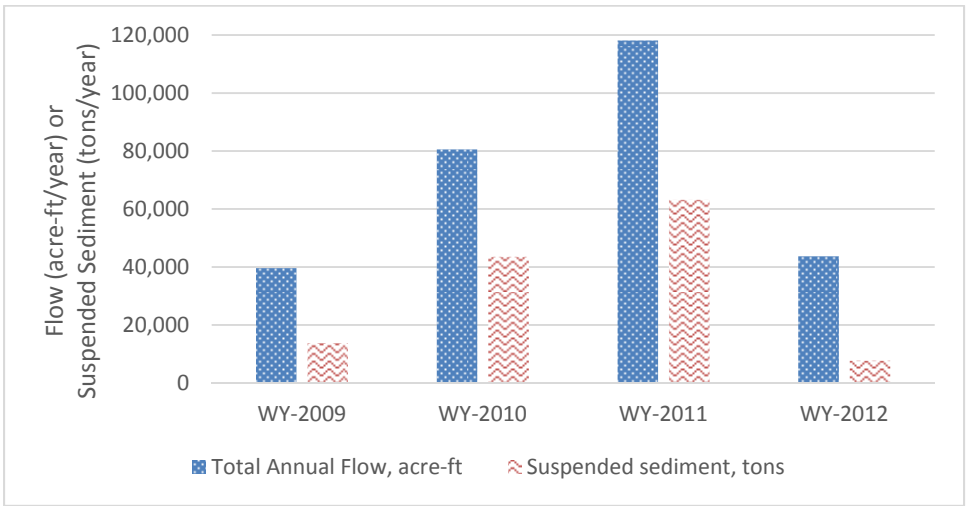


Figure 4. Comparison of annual flow and sediment loading in the San Lorenzo River at the Big Trees monitoring site. Data from Balance Hydrologics, 2013.

[9] Balance Hydrologics, Inc. (2013) Suspended-Sediment Monitoring for Bean and Valencia Creeks, Santa Cruz County, California, Water Year 2012. Project Assignment 212230

Sediment rating curves on Zayante Creek and the San Lorenzo River at Big Trees were developed in the 1970s and 1980s by the USGS. Compared to the more recent data for these sites, sediment loads at comparable flows have declined by about 80% at Zayante Creek and 50% in the San Lorenzo River at Big Trees over the last several decades.[10]

Milestones and Next Steps

The TMDL reduction targets are based on meeting specific sediment discharge reductions from public roads to individual waterbodies:

- San Lorenzo River: 27%
- Lompico Creek: 24%
- Carbonera Creek: 27%
- Shingle Mill Creek: 27%

The current inventory of MS4 BMPs focus on controlling stormwater discharges, mitigating runoff, implementing good-housekeeping practices, infrastructure improvements, and encouraging low-impact development. Milestones for the next reporting period are summarized in Table 7. The milestones focus on continued BMP implementation, modeling, evaluating beneficial uses, and planning additional monitoring campaigns to characterize bedloads.

Table 7. Milestones to meet sediment TMDL

Milestone	Description	Target date
Evaluate use of models to predict sediment loading	Apply, validate, and test the efficacy of using watershed models[11],[12] to simulate sediment loading, optimize monitoring locations, and evaluate the need for additional BMPs	2023
Track BMP effectiveness	Quantify reductions in sediment loading from BMPs in relation to rainfall and in-stream flows	2020
Suspended sediment monitoring	Characterize suspended sediment at specific locations in the watershed	2021 (contingent on funding)
Fisheries and habitat data	Correlate data on fish migration and habitat with flows and water quality data	2021
Evaluate alternative monitoring tools	Explore the use of alternative tools to characterize sediment loading and particle size.	2022

[10] Santa Cruz County Health Services (2013) Final Report, Coordinated Monitoring Program (Component 15)
[11] https://www.epa.gov/ceam/better-assessment-science-integrating-point-and-non-point-sources-basins
[12] https://www.epa.gov/ceam/total-maximum-daily-load-tmdl-models-and-tools-assess-exposures

Microbial indicator TMDL

The County of Santa Cruz has been monitoring the prevalence of microbial indicators in waterbodies throughout the County since the 1970s. The long-term data are valuable for identifying potential trends and assessing whether there are substantive impacts from the BMPs. This report covers the TMDLs for microbial indicators in the San Lorenzo River watershed, Soquel Creek, and Aptos Creek.

The microbial indicator TMDL targets are based on fecal coliform monitoring. The TMDL goal is that the concentrations of fecal coliforms should have a:

- log mean below 200 MPN/100 mL
  and
- 90% of samples collected during any 30-day period must be below 400 MPN/100 mL

The County of Santa Cruz monitoring program is based on testing ambient waters using Defined Substrate Technology (Standard Methods[13] 9223B). The test results are reported as *Escherichia Coliform* (E. Coli), which is widely used as an indicator for fecal contamination. For the purposes of this report, the E. Coli data are used as a proxy for fecal coliform.

Trends and Observations

The data analysis in the report focuses on the San Lorenzo River watershed as an example of the trends that have been observed. General trends related to the TMDLs in the Soquel and Aptos Creek watersheds are also reported.

San Lorenzo River Watershed

The San Lorenzo River drains 138 square miles on the western slopes of the Santa Cruz Mountains at the northern end of Monterey Bay. The San Lorenzo watershed consists of several major sub-watersheds including Boulder, Kings, Bear, Newell, Zayante, and Branciforte Creeks. The San Lorenzo watershed ranges in elevation from near 2,600 feet in its headwaters to sea level at the mouth. An overview of the monitoring stations identified in the TMDL[14] is shown in Figure 5.

[13] American Public Health Association, American Water Works Association, and Water Environment Association (2012) Standard Methods for the Examination of Water and Wastewater.

[14] https://www.waterboards.ca.gov/rwqcb3/board_decisions/adopted_orders/2008/2008_0001_slr_path_tmdl_att_2_proj_rept_21mar08.pdf

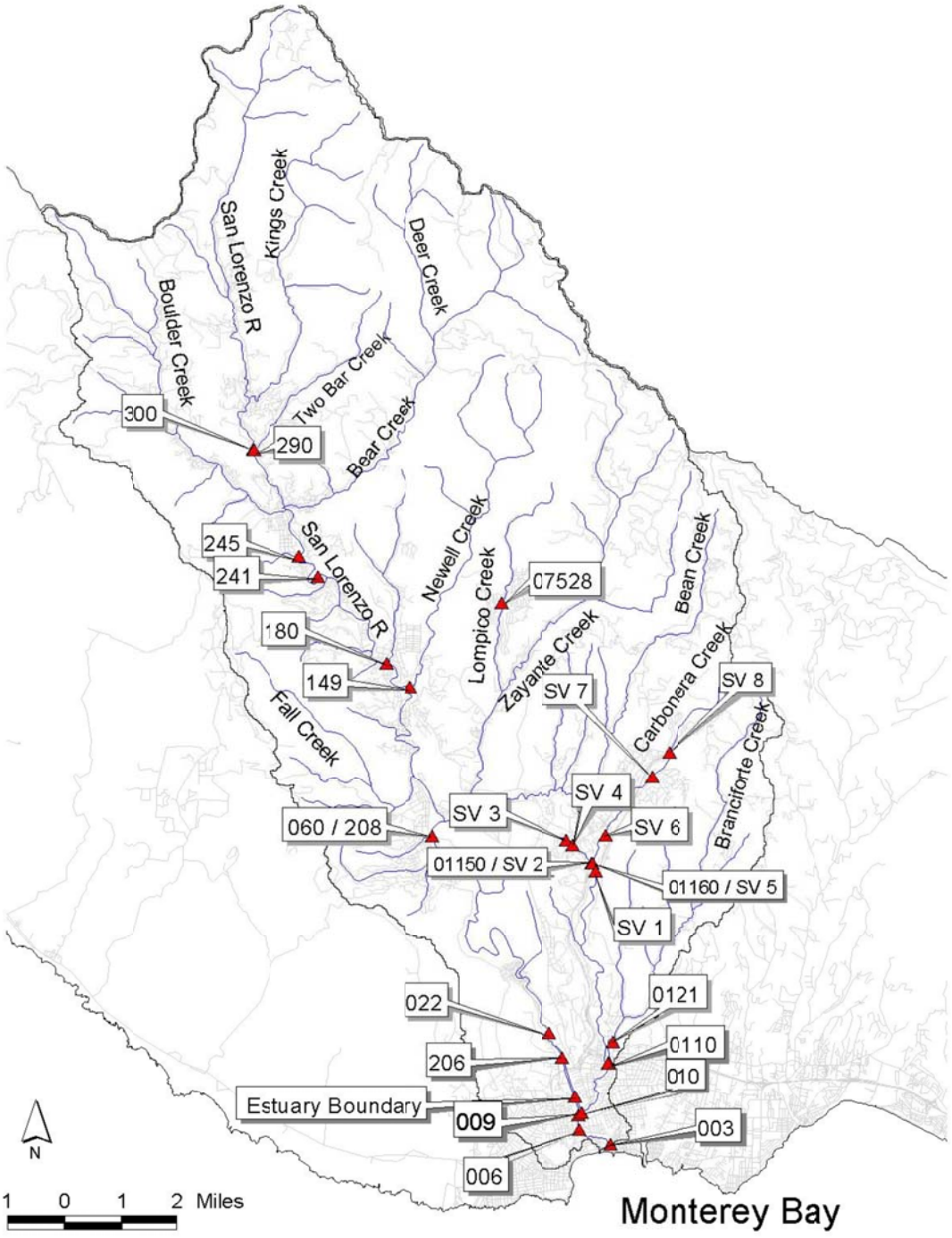


Figure 5. Map of monitoring stations identified in the San Lorenzo River Watershed TMDL (adopted 2011)

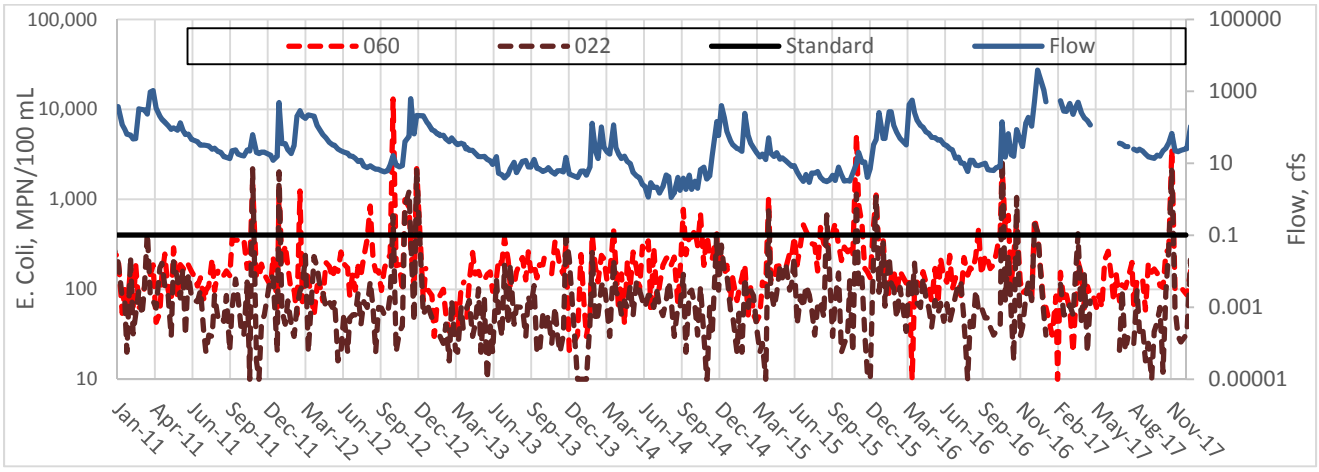
For the purposes of this report, timeseries data (2011-2017) for the six sites listed in Table 8 were selected to conduct a detailed assessment of progress towards meeting the TMDL.

Table 8. Monitoring sites used to evaluate TMDL progress in the San Lorenzo River watershed

River Location	Site Code	Location	Monitoring Frequency
Main stem (listed from upstream to downstream)	180	San Lorenzo River Above Love Creek	Once or twice per month
	060	San Lorenzo River @ Big Trees (near USGS flow gage)	Weekly
	022	San Lorenzo River @ Sycamore Grove (near USGS flow gage)	Weekly
	006	San Lorenzo River @ Broadway/Laurel St Bridge	Weekly
	003	San Lorenzo Rivermouth @ Trestle	Weekly
Tributaries	07528	Lompico Creek at Carbonera	Once or twice per month
	050	Shingle Mill Creek at San Lorenzo	Once or twice per month
	01160	Carbonera Creek above Spring Lakes Creek	Once or twice per month
	0121	Branciforte Creek @ Isbel Drive	Once or twice per month
	0110	Carbonera Creek at Branciforte	Once or twice per month

San Lorenzo River Sampling Sites

Time series of flow and E. Coli data are shown in Figure 6 for upstream locations (060 and 022) and downstream locations (006 and 003). As shown, the coliform concentrations vary from location-to-location. While there is not a strong relationship between average daily flow and microbial loading, peak flows during stormwater runoff events can introduce higher microbial loadings that might not be detected during collection of routine grab samples. The concentrations at the downstream locations tend to exceed the single-sample maximum value of 400 MPN/100 mL more frequently than the upstream locations, reflecting impacts from the more urbanized setting. The lower flows, higher temperatures, and influx of salinity also can affect the microbial loading in the lower reaches of the river.



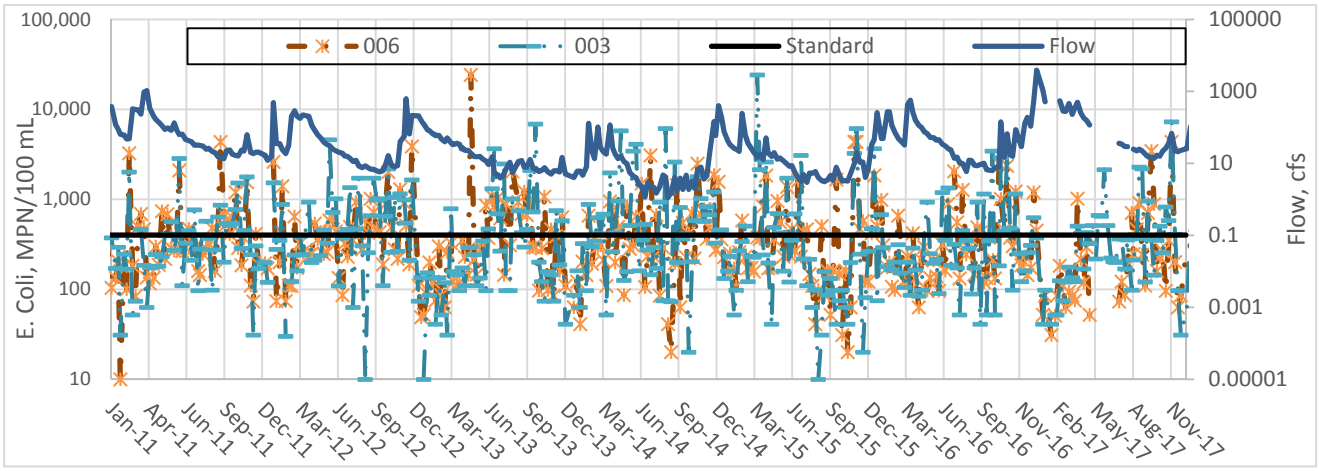


Figure 6. Time series of flow (from USGS gage station at Big Trees) and E. Coli data for sampling stations 060 and 022 (upper graph) and 006 and 003 (lower graph). The single sample maximum target of 400 MPN/100 mL is shown.

The 30-day geometric mean values for the upstream and downstream sites are shown in Figure 7 from 2011 through 2017. For the site at Big Trees (060), the geometric mean tends to exceed the target more frequently than the site at 022. Microbial levels decrease as the River flows through the State Park which is subject to limited disturbance and human inputs. Since 2016, the geometric mean exceeded the target primarily in the fall months (e.g. October and November). This may be related to sampling during early season runoff events. Conversely, geometric mean values for the downstream sites (006 and 003) frequently exceed the TMDL target of 200 MPN/100 mL throughout the year.

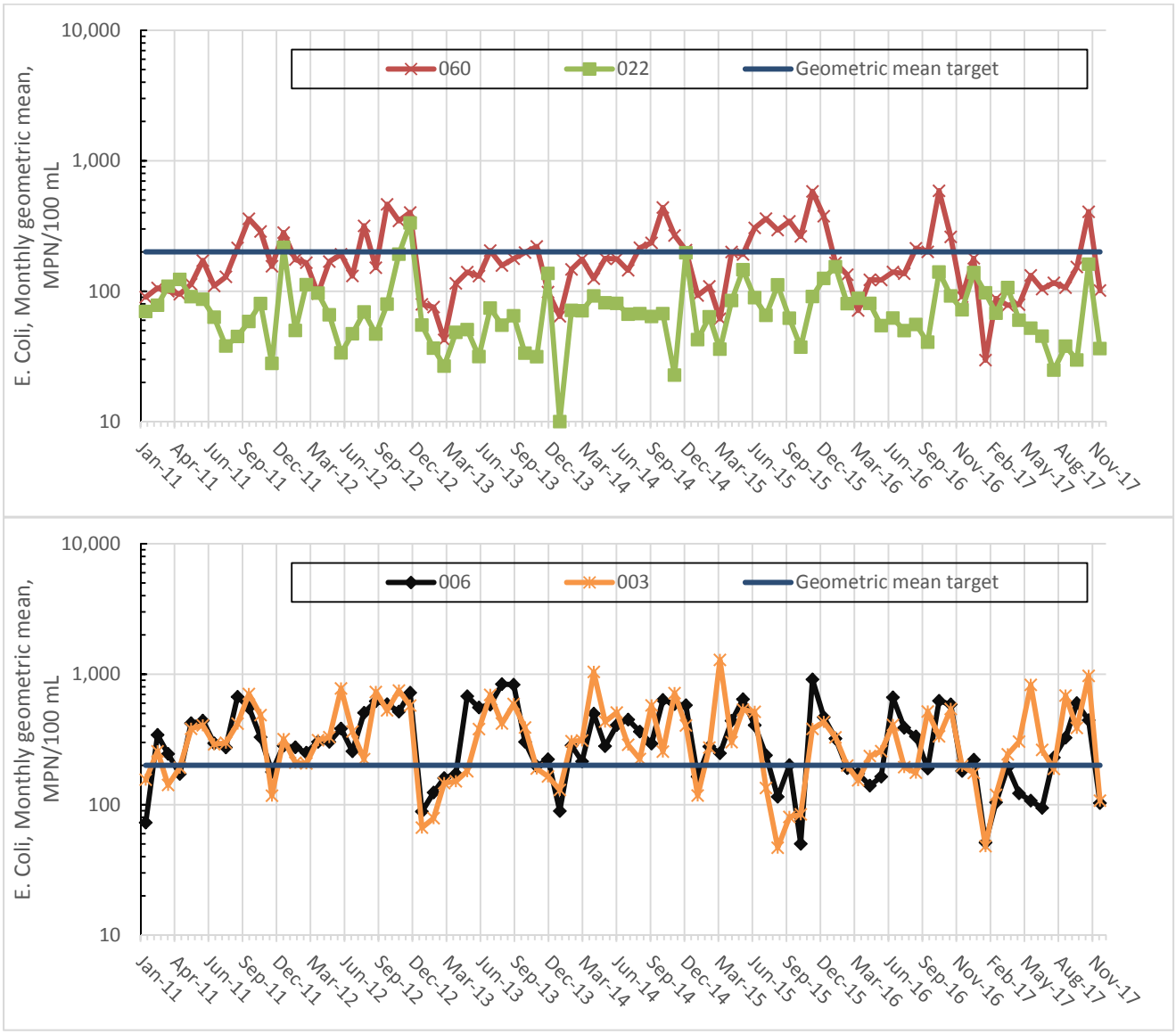


Figure 7. Time series of geometric mean E. Coli data for sampling stations 060 and 022 (upper graph) and 006 and 003 (lower graph). The geometric mean target of 200 MPN/100 mL is shown.

A summary of the percent of samples from five sampling sites in the mainstem of the San Lorenzo River that exceeded the single sample maximum target of 400 MPN/100 mL is shown in Figure 8 (from upstream to downstream). As shown, exceedance of the target tends to be more frequent for the downstream sites (006 and 003). Since 2014, the frequency of exceeding the single-sample maximum target has decreased at all sites. For 2017, only one site exceeded the target more than 10% of the time (site 003). One site (180) did not exceed the target value for indicator bacteria sampling conducted during 2013, 2014, 2016, or 2017.

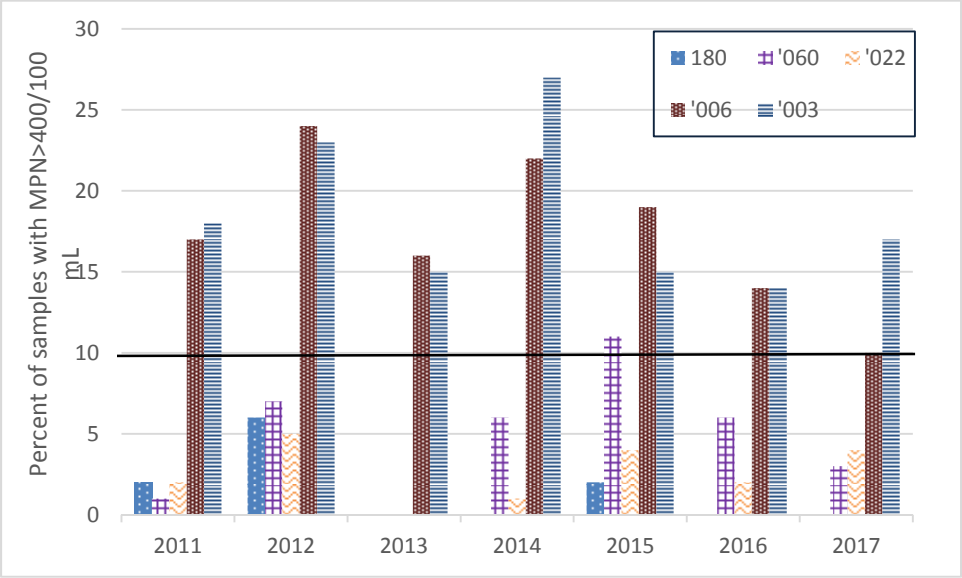


Figure 8. Comparison of the percent of indicator bacteria (E. Coli) samples that exceeded the single sample maximum for five monitoring sites along the San Lorenzo River.

Tributary Sampling Sites

Sampling sites in Lompico and Carbonera Creeks were compared to assess progress towards meeting the TMDL for indicator bacteria. A comparison of the percent of samples from sampling sites in Lompico Creek (07528) and Shingle Mill Creek (050) that exceeded the single-sample maximum target of 400 MPN/100 mL based on monthly sampling of each location is shown in Figure 9. Since 2015, there has been a consistent decrease in the percent of target exceedances. During 2017, all of the samples from both sites had E. Coli values less than 400 MPN/100 mL.

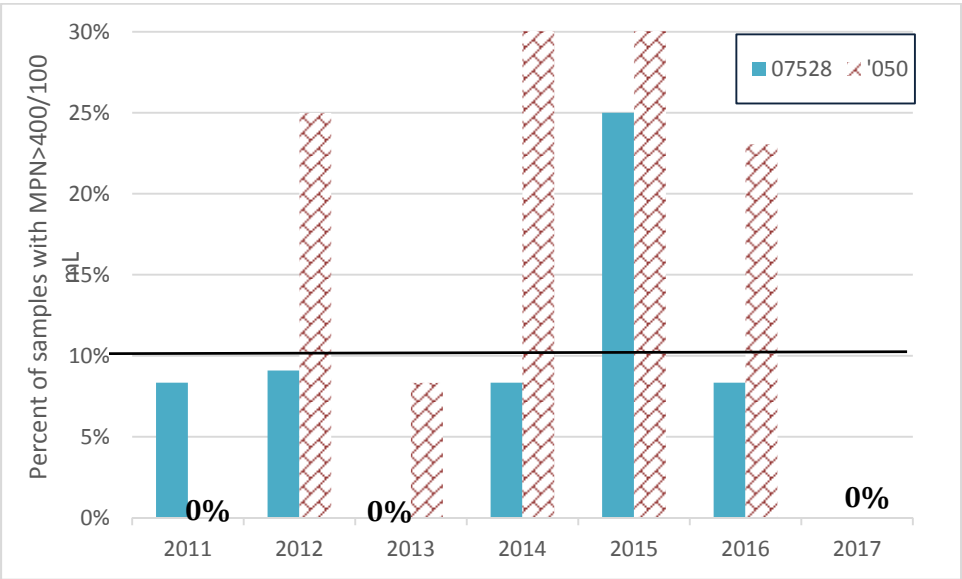


Figure 9. Comparison of the percent of indicator bacteria (E. Coli) samples that exceeded the single sample maximum for Lompico Creek at Carbonera (site 07528) and Shingle Mill Creek at San Lorenzo (site 050).

A comparison of sampling sites in Carbonera Creek upstream and downstream of the confluence with Branciforte Creek is shown in Figure 10. The percent of E. Coli samples that exceeded the target value of 400 MPN/100 mL is shown from 2011 through 2017. As shown, through 2015, the E. Coli concentrations at more than 10% of the samples from all sites were above 400 MPN/100 mL. Since 2015, there is evidence of improvement at the upstream site (01160) and at the Branciforte Creek sampling site. E. Coli concentrations at the downstream site (0110) consistently are over the target value of 400 MPN/100 mL .

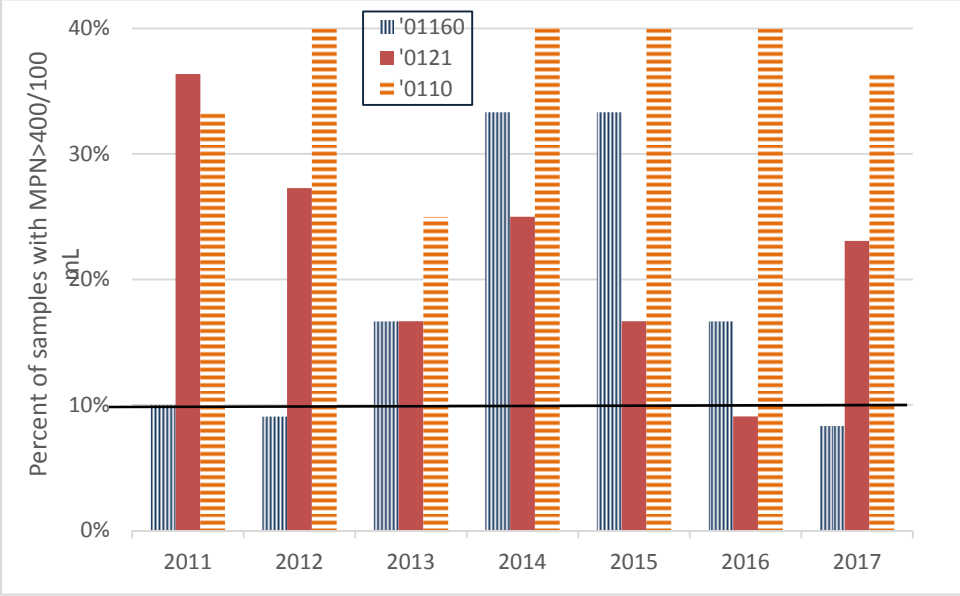


Figure 10. Comparison of the percent of indicator bacteria (E. Coli) samples that exceeded the single sample maximum for two sampling sites upstream and one site downstream of the confluence with Branciforte Creek (site 001160-above Spring Lakes Creek), Site 0121 (Branciforte Creek at Isbel) and Carbonera Creek at Branciforte (site 0110).

Soquel Creek Watershed

Soquel Creek drains a watershed area of 42.5 square miles. Before flowing into Monterey Bay, Soquel Creek forms a lagoon or estuary which provides important habitat for fish and wildlife as well as recreational uses for watershed residents and tourists. Monitoring efforts in the Soquel Creek watershed are shared by the County of Santa Cruz, the City of Capitola, and other stakeholders. The County is currently reviewing the monitoring program and there are plans to add some additional sampling locations. For the purpose of this report, data from the two sites listed in Table 9 are summarized. The upstream site, S9, provides a reference point for progress towards meeting the TMDL . The downstream site, S0, reflects the discharge of Soquel Creek in Capitola.

Table 9. Monitoring sites in the Soquel Creek Watershed used to evaluate TMDL progress

Site Code	Location	Monitoring Frequency
S6	West Branch Soquel C @ San Jose-Olive	Once or twice per month
S0	Soquel Creek @ Flume Outlet	Weekly

Timeseries data of geometric mean E. Coli data from the two sites in Soquel Creek are provided in Figure 11 and the percent of E. Coli that exceeded the single-sample maximum are shown in Figure 12. As shown, the geometric mean coliform concentrations at the upstream site are frequently below the TMDL geometric mean target of 200 MPN/100 mL. Conversely, coliform levels at the flume outlet are frequently above the target. Exceedances of the 400 MPN/100 target averaged about 50% from 2011 through 2016. However, there is evidence of improvement in 2017 with only 19% of the E. Coli samples above the target level (400 MPN/100 mL). These improvements may be reflect reduced loading to the watershed as a result of sewer upgrades that were completed immediately upstream.

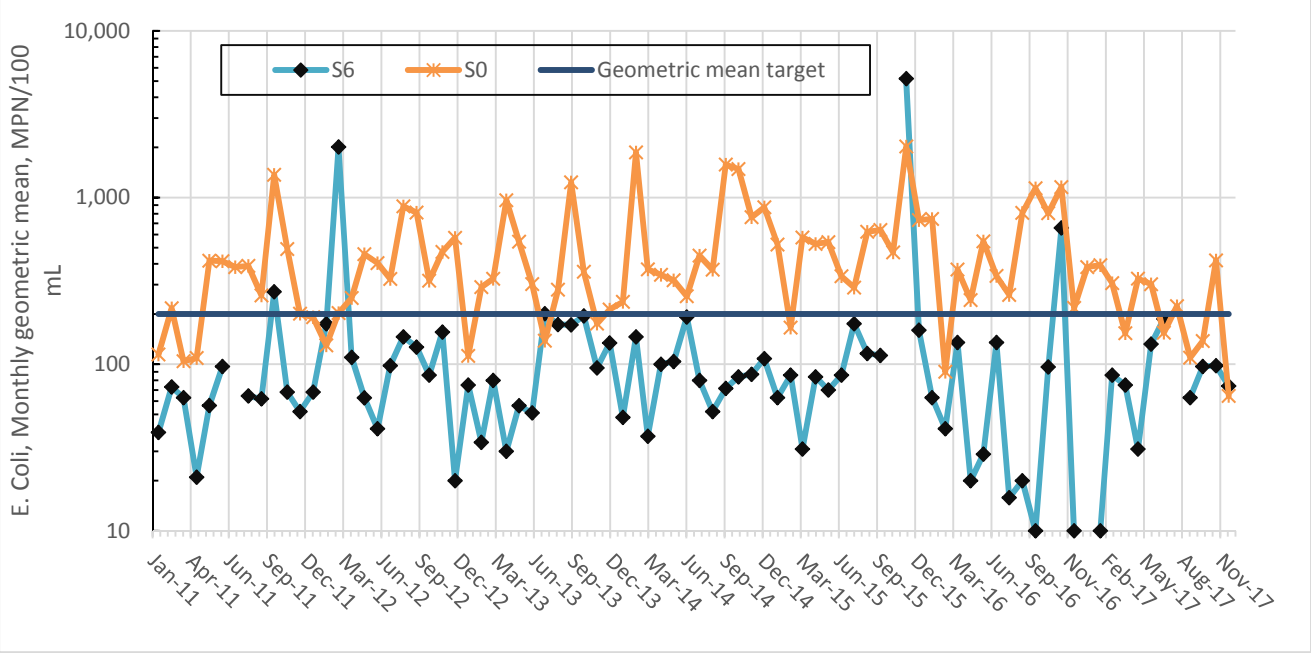


Figure 11. Time series of geometric mean E. Coli data for sampling stations in the Soquel Creek Watershed (S00 and S1). The geometric mean target of 200 MPN/100 mL is shown.

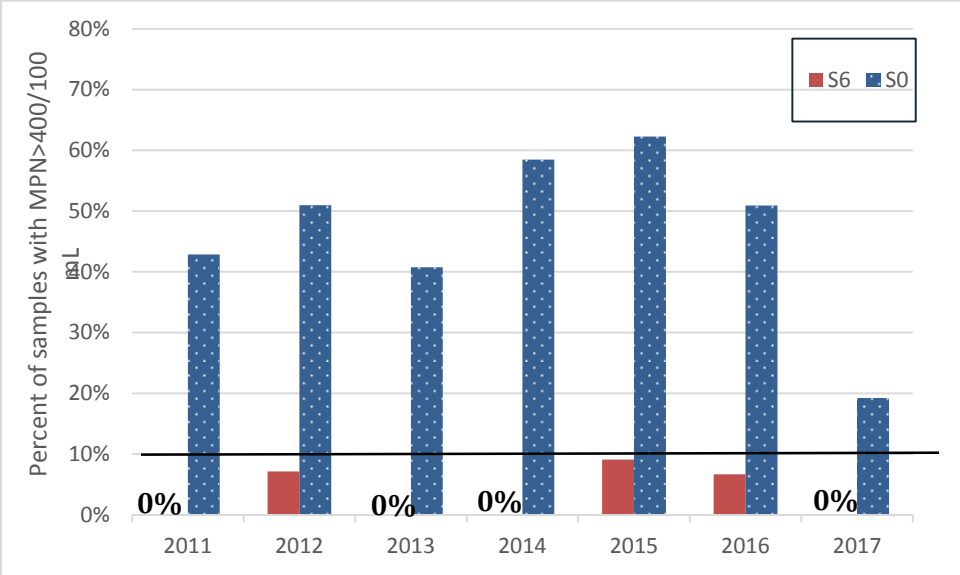


Figure 12. Comparison of the percent of indicator bacteria (E. Coli) samples that exceeded the single sample maximum for two sampling sites in the Soquel Creek Watershed (sites S0 and S6)

Aptos Creek Watershed

The Aptos Creek Watershed encompasses approximately 24.4 square miles of coastal land in southern Santa Cruz County, consisting of several major sub-watersheds including Aptos Creek, Bridge Creek, Trout Gulch, Valencia Creek and Mangels Gulch. Three monitoring sites, listed in Table 10 were used to evaluate TMDL progress.

Table 10. Monitoring sites in the Aptos Creek Watershed used to evaluate TMDL progress

Site Code	Location	Monitoring Frequency
A2	Aptos Creek @ Valencia Creek	Once or twice per month
A1	Valencia Creek @ Aptos Creek	Once or twice per month
A0	Aptos Creek @ Mouth	Weekly

A comparison of monthly geometric mean E. Coli values for three sampling sites in the Aptos Creek Watershed is shown in Figure 13. In general, the geometric mean values for the upstream site are consistently below the target value, except for a few spikes (e.g. December 2015) that might reflect short-term perturbations in the vicinity of the sampling site. However, the E. Coli concentrations at the downstream sites frequently exceed the target value.

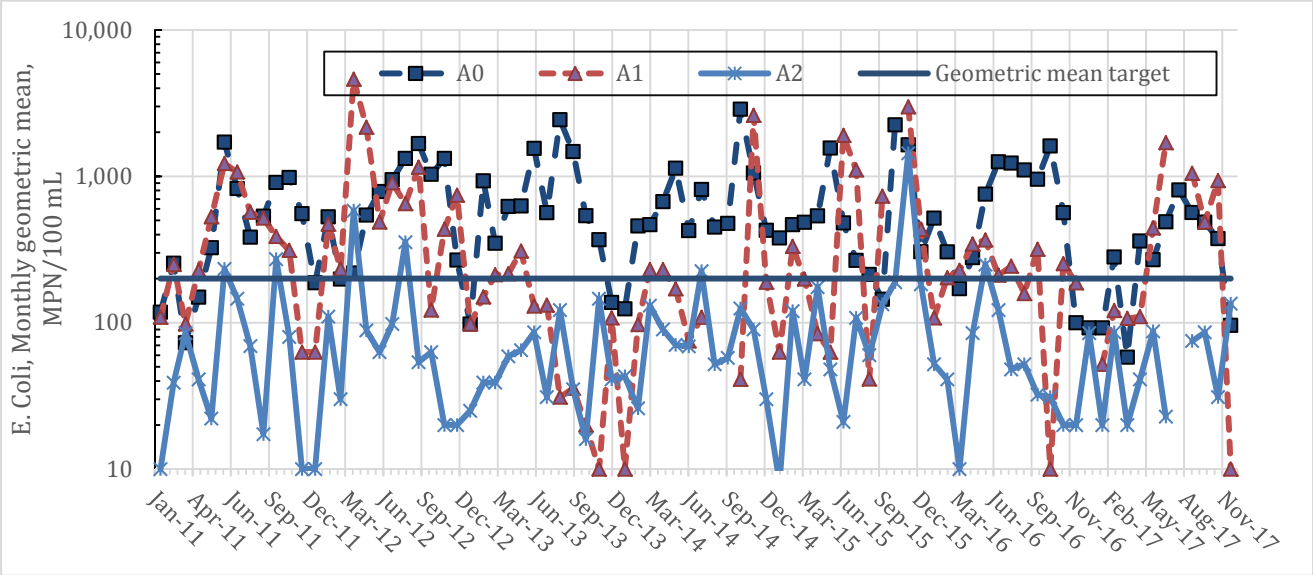


Figure 13. Time series of geometric mean E. Coli data for sampling stations in the Aptos Creek Watershed (A0, A1, and A2). The geometric mean target of 200 MPN/100 mL is shown.

A comparison of the percent of E. Coli samples that exceeded the single-sample maximum value of 400 MPN/100 mL for sampling sites in the Aptos Creek Watershed is shown in Figure 14. The results are similar to the trends displayed in Figure 13 (geometric mean data). In general, the upstream site, Aptos Creek @ Valencia Creek (A2) rarely exceeds the target value. However, the E. Coli concentrations at the downstream sites are chronically above 400 MPN/100 mL, suggesting the need for evaluating options for additional BMPs in the watershed.

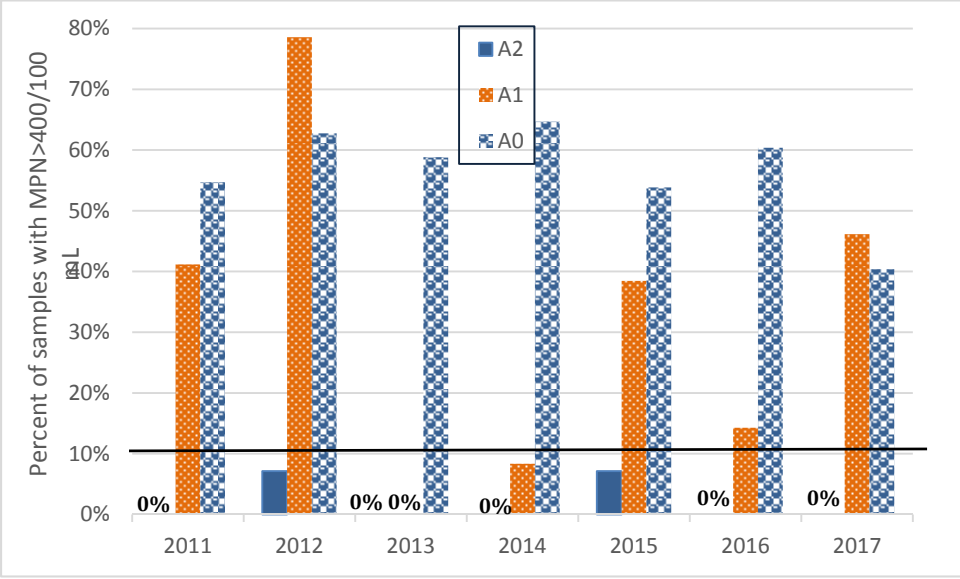


Figure 14. Comparison of the percent of indicator bacteria (E. Coli) samples that exceeded the single sample maximum for three sampling sites in the Aptos Creek Watershed (sites A0, A1, and A2)

Milestones and Next Steps

The long-term monitoring program of sites within the watersheds has provided insights into the prevalence of fecal indicator bacteria in the watersheds. To date there is evidence of improvement in the overall loading of fecal indicator bacteria to the watersheds. Further investigation of potential sources of the bacteria could help the stakeholders determine if additional BMPs are needed. Milestones for the next reporting period are summarized in Table 10. The milestones focus on continued BMP implementation, source tracking, and optimizing monitoring locations and frequency.

Table 11. Milestones to meet indicator bacteria TMDL

Milestone	Description	Target date
Track BMP effectiveness	Quantify reductions in microbial loading from BMPs in relation to rainfall and in-stream flows.	2020
Microbial source tracking	Implement microbial source tracking tools to identify sources of bacterial contamination.	2021
Statistical analyses	Conduct statistical analyses to identify potential factors that influence the prevalence of indicator bacteria and potential sources.	2021

5 Summary

The TMDL program has enabled the stakeholders to collaborate on MS4 BMPs, monitoring, and ongoing water quality protection measures. To-date, there appears to be progress in reducing the loading of sediments and microbial indicators to portions of the watershed. There are several recent initiatives that may also impact water quality. In the lower watershed, there is a recently enacted ordinance to inspect sewer lateral lines and older sewer lines have been upgraded using Clean Beach grant funds. The stakeholders also are conducting various public outreach activities to mitigate sources of contamination from pet-waste, litter, and encampments.

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June 3, 2015