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CITY OF SANTA CRUZ

Program Effectiveness Assessment and Improvement Plan

Prepared by

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1 PURPOSE OF THE PROGRAM EFFECTIVENESS ASSESSMENT AND IMPROVEMENT PLAN

- To improve the implementation and effectiveness of elements of the storm water program
- To improve management of limited resources and support decisions associated with allocation of funds
- To demonstrate local program efforts and effectiveness to regulators, City Council and the general public
- To identify implementation gaps

2 PROGRAM OVERVIEW

2.1 PROGRAM SUMMARY

In compliance with the Phase II regulations, the City has developed a comprehensive SWMP that is designed to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) and to protect water quality. The SWMP is tailored to meet the City's needs and requirements. The SWMP includes the following elements:

- **Municipal Operations/Pollution Prevention and Good Housekeeping:**
  Municipal operations include a wide variety of activities conducted to maintain City owned property and facilities, such as public streets and the storm drain system. Significant amounts of urban pollutants are found on street and road surfaces due to pavement abrasion and littering. The objective of the City's Municipal Operations Program is to prevent pollutants generated by municipal operations and activities from entering the storm drain system by implementing Best Management Practices (BMPs) to prevent or reduce pollutant runoff from municipal operations.

- **Illicit Discharge Detection and Elimination:**
  The goal of the Illicit Discharge Detection and Elimination Program is to detect and eliminate illicit connections and illegal discharges to the storm drain system from a variety of sources including industrial facilities, commercial establishments, residential areas, and construction sites.

- **Public Education and Participation:**
  The Public Education Program objectives are to increase public awareness on urban runoff pollution issues, to educate the community about specific sources of pollutants and what people can do to reduce them, to foster participation through community-based projects or volunteer activities focused on pollution prevention, and to decrease the amount of illegal dumping and polluted urban runoff that is discharged into the storm drain system.

- **Construction Site Storm Water Runoff Control:**
  The Construction Site Storm Water Runoff Control Program was developed to protect the City's storm drain system and receiving waters from pollutants that may be discharged as a result of construction activities, including clearing, grading, excavation, landscaping, building, and remodeling of existing buildings. Objectives include minimizing land disturbance at all permitted construction sites, protecting water quality from pollutants generated by construction activities, and requiring Best Management Practices (BMPs) to be implemented at all permitted construction sites.

- **Post Construction Storm Water Management:**
  Objectives of Post-Construction storm water management include ensuring that new developments and remodeled sites are designed and constructed in a manner that minimizes the alteration of natural

watercourses and drainage patterns, as well as alleviating the impact of new developments or remodeling projects on a site's and surrounding natural hydrology.

- **Industrial and Commercial Facilities:**
  The objectives of the City's Industrial Facilities Program are to reduce urban runoff pollution generated by industrial facility operations and activities and to ensure that industrial facilities comply with the City's Storm Water Ordinance, mandatory BMPs, and Industrial Waste Discharge Permit requirements (as applicable). The City's Commercial Facilities Program is designed to have a positive approach combining outreach, education, and incentives with the more traditional methods of regulation, including mandatory BMPs.

These programs work together in a multi-faceted approach to reducing urban runoff pollution within the City.

2.2 Storm Drainage System

The City's storm drain system is comprised of a wide variety of conveyance systems such as underground pipes, small open drainage channels, creeks, and the San Lorenzo River. There are also numerous storm drain inlets and catch basins (approximately 1,450) throughout the City, and five pump stations that discharge storm water directly into the San Lorenzo River. In addition, along both the east and west sides of the City, there are storm water outfalls that discharge onto the beaches or cliffs, and into Monterey Bay.

There is approximately 50 miles of underground storm drain system pipeline in the City. The majority of pipes are comprised of concrete. Old pipelines still remain that are comprised of clay, while new pipelines installed by the City are either made of PVC or high-density polyethylene (HDPE). The typical pipeline diameter is 12-15 inches although both smaller and larger pipelines, up to 72 inches, exist. Maintenance and repair of the City's storm drain system is conducted by the Public Works Department and is described in greater detail in the Municipal Operations Program-Pollution Prevention and Good Housekeeping.

In general, the City's downtown area drains to the San Lorenzo River. Although some storm water reaches the river by absorption and gravity, the five pump stations along the river were installed in order to transfer the majority of the storm water through the river levees. There are three pump stations located on the west side of the river and two on the east side. The west side pump stations are located at Broadway (1) and in Beach Flats (2). The east side locations pump stations are located at lower Ocean Street and at Water Street. In addition to the San Lorenzo River, there are numerous creeks traversing the City. Major creeks and their watersheds are discussed in Section 2.3.

In certain areas of the City, natural spring water and storm water flows through a network of conveyance systems, such as small creeks and underground piping. This is especially the case in the west side of Santa Cruz, particularly the upper west side. The upper west side is dotted by natural springs, which feed the small creeks that run through residential yards and cross streets via underground piping. These creeks drain either into Neary Lagoon or run through the storm drains system discharge from West Cliff Drive into Monterey Bay. As expected, the flow from some of these smaller creeks is seasonal or intermittent with the greatest flows occurring during the rainy season.

2.3 Watersheds and Land Use

Within each major creek watershed, land use was characterized into one of the following categories: State Highway (Caltrans), State Parks, the University of California at Santa Cruz, agriculture, commercial and mixed use, high density commercial, industrial, multi-family residential, single-family residential, open space, and park. The land use and primary resources within each of the seven watersheds are detailed below. See Figure 1 below for a map of major City creeks, their watersheds, and associated land uses.

2.3.1 Moore Creek Watershed

The Moore Creek watershed is located on the western side of Santa Cruz and drains into the Pacific Ocean at Natural Bridges State Park. Within City limits, the watershed is comprised primarily of open space (68%) and single-family residential areas (17%). Also within the middle and lower parts of the watershed are multi-family residential, industrial, agriculture, UCSC property and a State Park. At the mouth of the watershed, Natural Bridges State Park is a popular beach park that serves approximately 800,000 visitors annually.

2.3.2 Arroyo Seco Watershed

The Arroyo Seco watershed is also located on the western side of the city, between the Moore Creek watershed and the Neary Lagoon watershed, and drains into the Pacific Ocean via a 60-inch outfall. Not including the UCSC campus, this watershed is comprised mostly of residential areas (78%), primarily in the upper part of the watershed, and industrial areas (17%) in the lower part of the watershed. Multi-family residential areas also account for approximately 5% of the land use in the watershed.

2.3.3 Bethany Curve Watershed

The Bethany Curve watershed is located on the western side of the city, just south of the Neary Lagoon watershed, and drains into the Pacific Ocean via Bethany Curve Creek, which outlets at a 36-inch outfall. The watershed is comprised mostly of single-family residential areas (96%), and a small amount of commercial areas (4%) nearest Mission Street.

2.3.4 Neary Lagoon Watershed

The Neary Lagoon Watershed is located in between Arroyo Seco and San Lorenzo River watersheds. The Near Lagoon watershed drains into Monterey Bay and the Pacific Ocean at Cowell Beach. Within City limits and not including the UCSC campus, this watershed is comprised primarily of single-family residential areas (86%). Other land uses include open space (6%), commercial (4%), multi-family residential (2%), and industrial (2%). Neary Lagoon is centrally located in the city’s urban core and is comprised of approximately 44 acres of wetland, riparian and woodland habitats. A weir controls the lagoon water level. The lagoon outlets to Monterey Bay at Cowell Beach during the wet weather season via a gravity storm drain and one forced main storm drain. During the dry weather season, the lagoon’s discharge is diverted to the Wastewater Treatment Facility.

2.3.5 San Lorenzo River Watershed

The San Lorenzo River Watershed is the largest watershed in the City, with the San Lorenzo River flowing adjacent to the center of the city’s shopping district. The San Lorenzo River flows into Monterey Bay, creating San Lorenzo Lagoon where the river water meets the tidal waters of the bay. Within City limits, this watershed is comprised predominantly of single-family residential areas (32%), parks (30%), and commercial areas (13%). Other land uses include industrial areas (6%), open space (6%), high-density commercial (6%), multi-family residential (3%) and Caltrans property (3%). The San Lorenzo River is listed as steelhead trout critical habitat.

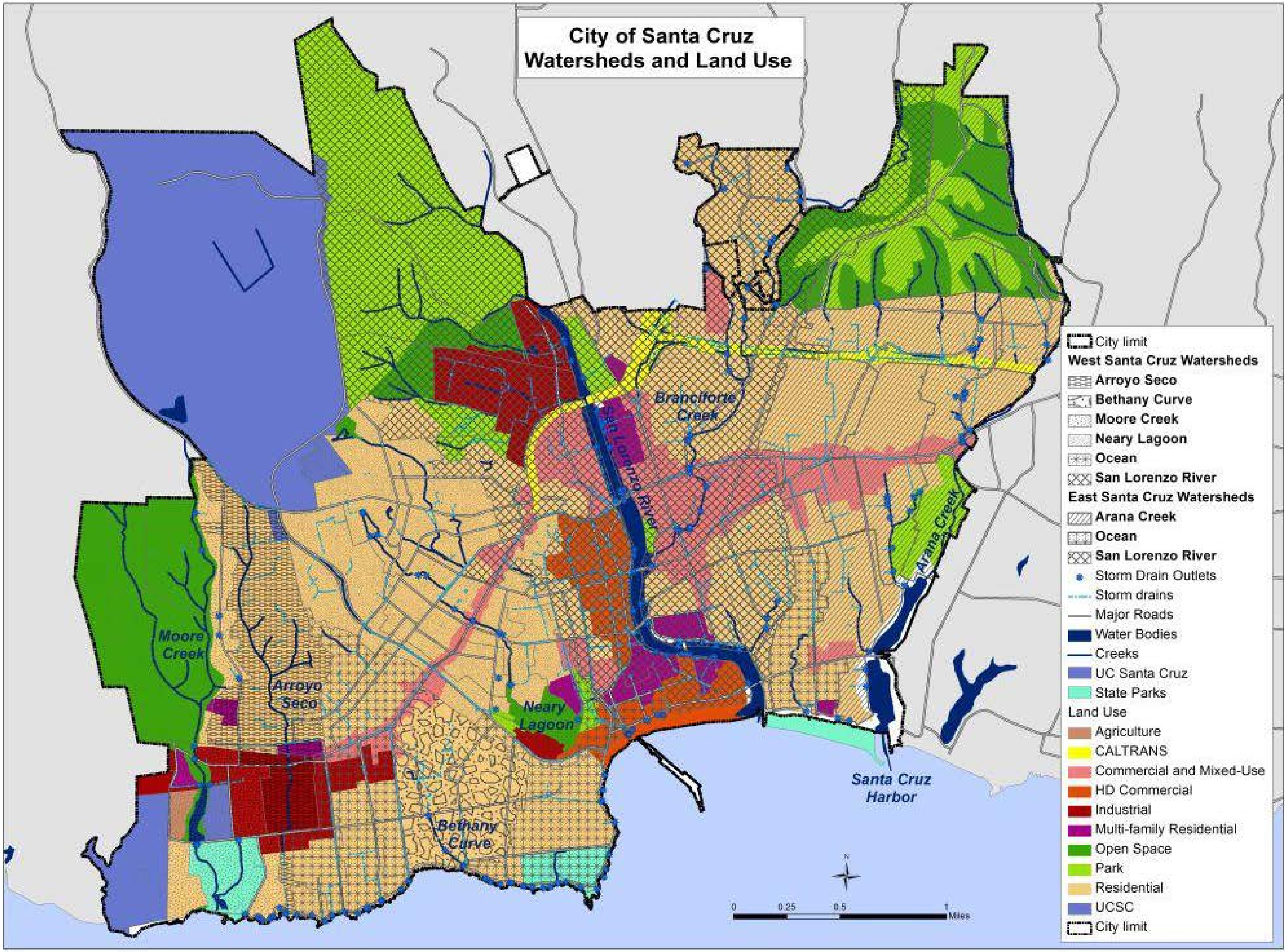
2.3.6 Arana Gulch Watershed

The Arana Gulch Watershed is located on the City’s eastern border. The watershed drains into Monterey Bay at the Santa Cruz Yacht Harbor. The watershed, within City limits, is comprised predominantly of residential neighborhoods (52%), parks (19%), and open space (17%). Other land uses include commercial areas (10%) and Caltrans property (2.5%). Arana Creek is listed as steelhead trout critical habitat.

2.3.7 Ocean Watersheds

In addition to the watersheds outlined above, several areas of the East and West side of the City drain directly to the ocean via the City’s storm drain system and ocean outfalls. These areas comprise a total of approximately 720 acres of land and are primarily single-family residential areas (72%). Other land uses in these watersheds include industrial (7%), open space (6%), commercial (5%), high-density commercial (5%), parks (3%) and multi-family residential (3%).

Figure 1: City Watersheds and Associated Land Use



2.4 Receiving Water and Urban Runoff Water Quality

2.4.1 Primary Pollutants of Concern

In the City, there are a number of different sources of urban runoff pollution. Potential sources and examples of activities that may generate pollutants are listed below:

- Industrial facilities: industrial chemical processes; chemical and waste storage; fleet maintenance and vehicle washing; and landscaping.
- Commercial businesses including food and vehicle service facilities: vehicle and equipment maintenance; food processing; vehicle washing; landscaping; and chemical and waste storage.
- Residential dwellings: vehicle washing; home vehicle repair; home painting and construction projects; chemical and waste storage; pet waste; and landscaping.
- Construction and remodeling projects: grading; vegetation removal; concrete washout; vehicle and equipment fluids; landscaping; and material and waste storage.
- Municipal sewer system and private sewer laterals: exfiltration from leaking, cracked, and debilitated pipelines; and overflows from blocked pipelines.
- Open space and parks: soil erosion from high-use areas, pesticide and fertilizer application in parks

Storm water pollutants generated by the sources described above are numerous and quite varied. These pollutants include: metals, solvents, paint, concrete, masonry products, detergents, vehicle fuels and fluids, oil and grease, pesticides and fertilizers (organic compounds and nutrients), debris and litter, bacteria, pathogens and oxygen demanding compounds, and sediment and silt.

In general, all of the City's watersheds contain most or all of these pollutants. This is because the various types of land uses are distributed throughout the City rather than certain types being concentrated in specific watersheds. The San Lorenzo River watershed does have a higher level of commercial activity, which will require more focus than the other watersheds.

Of the pollutants mentioned above, as indicated by the State and Regional Boards, the primary pollutants of concern in the City watersheds are the following:

- Sediment and silt
- Pathogens (Fecal Indicator Bacteria)
- Trash

The City is targeting these primary pollutants of concern because certain water bodies within the City are listed on the Section 303(d) list as impaired for sediment and fecal indicator bacteria and Total Maximum Daily Loads (TMDLs) have been adopted for these pollutants. On May 16, 2003, the RWQCB adopted a sediment TMDL for the San Lorenzo River and Carbonera Creek. In March 2008, a TMDL for Pathogens (Fecal Indicator Bacteria) was adopted for the San Lorenzo River, San Lorenzo River Estuary (Lagoon), Branciforte Creek, and Carbonera Creek. Trash is also a focus of the City Storm Water Management Program due to the significant recreational and wildlife benefits of the City's coastal waters.

2.4.2 Receiving Water Monitoring Efforts and Results

The City has been implementing its monitoring program in the San Lorenzo River since the promulgation of TMDL for pathogens in 2010, both to (a) develop information on the trends of bacteria levels in order to assess the effectiveness of the interventions and management practices implemented; and (b) also to develop information for controlling anthropogenic sources of the bacteria so as to subsequently implement measures to affect those and other identifiable controllable sources of bacteria in the river.

Consequently the City samples and analyzes for indicator bacteria along San Lorenzo River from Tate Street and from the Branciforte Creek junction through the estuary into the Ocean. The City also initiated testing for domestic sources of bacteria by directly monitoring for caffeine associated with high FIB in the river, and by working within a regional framework to identify fecal sterols associated with high FIB in the river. Finally in 2015 the City added the analyses of sediments and nutrients to aid in the unravelling of the emerging bacteria profile in the lower San Lorenzo River. The results suggest the following trends:

- Bacteria levels generally increase as the river courses through the City to and through the estuary;
- Bacteria input from Branciforte Creek is elevated post significant rainfall events, which are also likely associated with higher levels of sediment input from the creek into the river;
- Initial 6-month studies of the fecal tracer chemicals in the river indicate the preponderance of non-human sources for the bacteria, and implicate avian sources.
- Bacteria levels appear to be correlated with sediment loads

Perhaps the most impactful sources of bacteria into SLR are avian and sediment inputs. These conclusions are derived from the data gathering and collaborative work by the City and other stakeholders at the San Lorenzo River Alliance in 2014. During that period, tests for controllable sources of bacteria were performed alongside of the bacteria monitoring. While bacteria levels remained high and were occasionally below the Recreational limits levels, none of the bacteria levels were associated with detectable caffeine at any time. In addition, the ratios of Fecal Sterols and Stanols detected in SLR were predominantly avian. Additional analyses were performed on samples at storm drains feeding into SLR at the City. These analyses were able to determine by using detectable caffeine associated with high level of FIB when there was stormwater pollution arising from domestic sewage. The analyses of such events also provided the City the appropriate technical tools to track the source of such discharge. All such discharges ended within the pump stations, which were either subsequently pumped through Vac-tor trucks and had their content diverted to the POTW for treatment; and when this was not feasible and the contents of the pump station was tracked, the levels of bacteria reaching SLR from these stations at those events were so diluted, the caffeine content was below our detection limit.

Work will continue to confirm the initial finding of the characterization of the source of FIB in SLR and in Branciforte Creek. Work planned includes studies of sediment loads and fecal sterol ratios, studies of sediment loads and caffeine concentrations, and additional tracer studies from identified pump stations feeding into SLR.

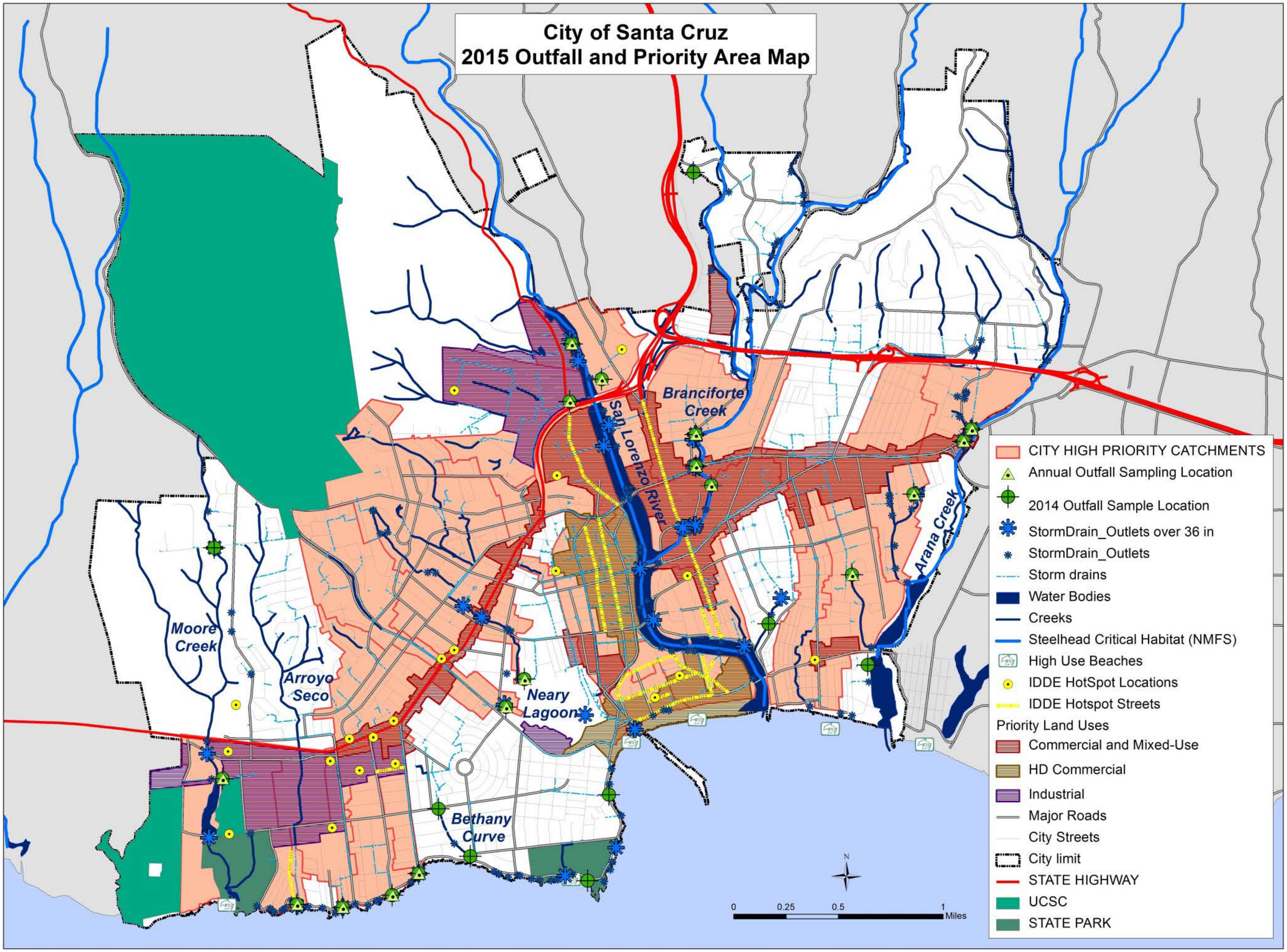
2.4.3 Priority Areas for Pollutant Generation and Illicit Discharge Monitoring

Certain watershed catchments of the City are considered priority areas because they are likely to have higher pollutant generation rates or they drain towards sensitive water bodies. These areas include:

- Industrial, commercial and mixed-use areas,
- Areas with a history of illicit discharges and/or illegal dumping, identified as hot spots by the City's Environmental Compliance Inspectors,
- Areas with onsite sewage disposal systems,
- Areas that drain to outfalls greater than 36 inches discharging to the ocean,
- Areas draining to water bodies that provide habitat for steelhead trout, or to beaches that serve more than 50,000 people between April and October.

These priority areas are shown on Figure 2 below. Figure 2 identifies locations where the City found flowing outfalls during dry weather, which were sampled in FY 2014-15. Figure 2 also shows outfalls that will continue to be monitored during dry weather annually because they are associated with priority areas.

Figure 2: Priority Watershed Catchments



3 Program Water Quality Objectives

Pollutant	Source	Target Audience	Program Water Quality Objectives (CASQA outcome level)
Sediment	Construction sites (disturbed land, stockpiles)	Erosion control designers, construction contractors	• Awareness of construction BMPs (2) • Proper design and implementation of construction BMPs (3) • Minimize sediment runoff from construction (4)
	Industrial facilities (stockpiles)	Facility managers/owners	• Improve implementation of material storage BMPs (3)
	Private property – residential and commercial (deposition, disturbed land)	Developers Designers Property Managers	• Awareness of post-construction and commercial BMPs (2) • Proper design and construction of erosion control and post-construction BMPs (3) • Reduce runoff from private property (4) • Reduce sediment loads in runoff from private property (4) • Improve maintenance of post-construction BMPs (3)
	Residential (small home projects)	Homeowners	• Awareness of BMPs for small home projects (2)
	Parks (disturbed land)	Municipal operations staff	• Awareness of Municipal Operation BMPs (2) • Reduce sediment load in runoff from trails and disturbed slopes (4)
	Municipal facilities (stockpiles)	Municipal operations staff	• Awareness of Municipal Operation BMPs (2) • Improve implementation of material storage BMPs (3)
	Commercial facilities (deposition)	Pressure washing operations	• Improve implementation of pressure washing BMPs (3)
	Infrastructure: streets and storm drains (deposition, conveyance)	Municipal operations staff	• Awareness of Municipal Operation BMPs (2) • Reduce sediment load and associated pollutants going into the gutter and storm drain from streets (4) • Reduce sediment load and associated pollutants going from storm drain to creeks (4)
Pathogens	Municipal sewers (leaking sewer lines, overflows)	Municipal operations staff	• Identify and reduce sewer leaks (4) • Identify and stop illicit connections (4) • Minimize the potential for receiving water impact from sewer overflows (4)
	Residential (laterals)	Private property owners	• Increase awareness of lateral maintenance needs (2) • Increase proper management of laterals by private property owners (3)

POLLUTANT	SOURCE	TARGET AUDIENCE	PROGRAM WATER QUALITY OBJECTIVES (CASQA OUTCOME LEVEL)
	Illicit dumping	General public, municipal staff, transient population	• Increase awareness and reporting of illegal dumping (2) • Reduce occurrence of illegal dumping (3) • Reduce impacts of illegal dumping on creeks (4)
	Pet waste	General public	• Increase pickup of pet waste by owners (3)
	Human waste (direct)	Transient homeless population	• Reduce occurrence of human waste deposition in creeks (3)
	Industrial facilities (improper storage)	Facility owners / managers	• Awareness of material storage BMPs (2) • Improve implementation of material storage BMPs (3)
	Commercial facilities (food waste)	Business owners	• Awareness of food service BMPs (2) • Improve implementation of food service BMPs (3)
	Infrastructure: streets and storm drains (littering, other pathogen sources, conveyance)	Municipal operations staff	• Awareness of Municipal Operation BMPs (2) • Reduce pathogens going into the gutter and storm drain from streets (4) • Reduce pathogens going from storm drains to receiving waters (4)
Trash	Infrastructure: streets and storm drains (littering, trash mgmt, conveyance)	General public, Children and youth, Municipal operations	• Reduce littering (3) • Reduce trash going into the gutter and storm drain from streets (4) • Reduce trash going from storm drains to creeks (4)
	Visitor/commercial neighborhoods (littering, trash mgmt)	General public, Children and youth	• Increase awareness of storm drainage system connection to receiving waters (2) • Increase awareness of trash impacts on environment (2) • Reduce littering (3) • Increase trash removal (4) • Reduce trash receptacle management issues (3)
	Commercial properties (littering, trash mgmt)	Business owners	• Increase awareness of trash impacts on environment (2) • Reduce littering (3) • Reduce use of excessive packaging or non-biodegradable products (3) • Reduce trash receptacle management issues (3)
	Parking lots (littering)	General public	• Reduce littering (3)
	Private property (trash mgmt, littering)	Developers Designers Property Managers	• Proper design and maintenance of trash enclosures to minimize stormwater impacts (3) • Proper maintenance to reduce trash going into storm drains from private developments (3)

4 BMP EFFECTIVENESS ASSESSMENT METHODOLOGY

The purpose of the Program Effectiveness Assessment and Improvement Plan is to track annual and long-term effectiveness of the Storm Water Program at protecting water quality. Results of the assessment will allow the City to adaptively manage its Storm Water Program by providing supporting documentation for proposed modifications.

In order to evaluate individual BMPs and program elements on a city-wide basis, the program effectiveness assessment will include a BMP effectiveness assessment matrix that will be used to evaluate the implementation and effectiveness of program BMPs annually and that will provide a rationale for proposed BMP modifications.

Individual BMPs and program elements will be evaluated in terms of the following outcome levels:

Level 1: Implementation of program activities (no effectiveness assessment)
Level 2: Awareness of target audiences
Level 3: Behavior change of target audiences
Level 4: Pollutant load reductions achieved

The BMP effectiveness assessment matrix will list the evaluation method used for assessing BMP effectiveness and will be used to answer the following management questions:

1) Were BMPs implemented in accordance with permit requirements and did they meet their respective measurable goals?
2) For BMPs assessed at outcome level 2, to what extent did they achieve increased awareness of target audiences?
   These BMPs will generally be assessed using public or training awareness surveys.
3) For BMPs assessed at outcome level 3, to what extent did they change the target audience's behavior?
   These BMPs will generally be assessed using behavioral surveys and inspections to observe practices.
4) For BMPs assessed at outcome level 4 and 5, to what extent did they achieve a reduction in pollutant loads from their sources to the storm drain system?
   These BMPs will generally be assessed using direct measurement of load reduction during inspections and maintenance activities and/or land-use-load estimation modeling where feasible.

Additionally, the program effectiveness assessment will also include a spatial analysis for a subset of source control BMPs and treatment BMPs using a land use load estimation model. This model will help provide a geographic characterization of load reductions achieved by the program and will help target BMP implementation in MS4 areas where they are most needed.

The results of the matrix and spatial analysis, together with monitoring data on MS4 discharge water quality and receiving water conditions where available, will be used to assess the program as a whole and to answer the following long-term program management questions:

1) Is the implementation of the Program improving the water quality of urban runoff and discharges?
2) Is the implementation of the Program having an effect on receiving water quality?
3) Are exceedances of water quality objectives persisting despite implementation of the Program?

4.1 Prioritized BMPs

The following BMPs have been prioritized because they can be assessed in terms of load reduction and they have been identified as potentially significant in reducing pollutant loads to receiving waters.

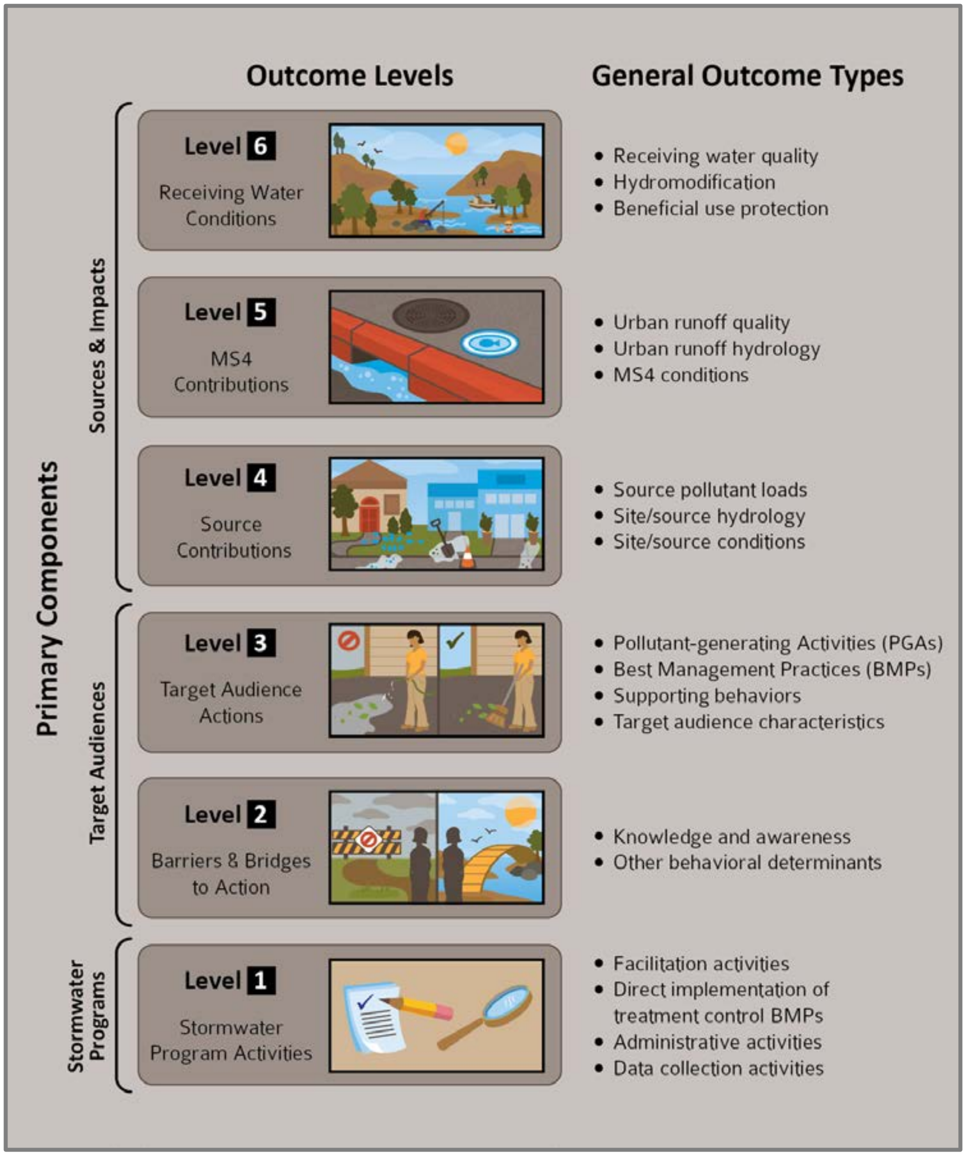
Permit Section	New or Existing BMP #	BMPs	MEASURABLE GOALS	Target Priority Pollutant(s)
E.9 ILLICIT DISCHARGE DETECTION AND ELIMINATION				
E.9.c	**NEW BMP**	**During outfall inventory, sample any outfalls that are flowing or ponding more than 72 hours after the last rain event; also conduct dry weather sampling of outfalls annually identified as priority areas**		Pathogens
E.9.d	**ID-7**	**Implement Corrective Measures and Enforcement Procedures in Accordance with the Storm Water Ordinance**	Eliminate 100% of identified illicit discharges	Trash, Pathogens
E.9.d (d) (e)	**ID-2**	**Conduct Spill and Illegal Discharge Response**	Respond to 100% complaints and reports of illegal discharges	Trash, Pathogens
N/A	**MO-17**	**Dry Weather Diversion from Neary Lagoon to Wastewater Treatment Facility**	Divert lagoon water 108 days per year	Pathogens
N/A	**MO-18**	**Clean Neary Lagoon Storm Drain Lines and Discharge Bacteria Laden Water to the Sanitary Sewer System**	Clean storm drain lines and discharge the water to the sewer system annually	Pathogens
E.10 CONSTRUCTION SITE STORM WATER RUNOFF CONTROL PROGRAM				
E.10.c	**NEW BMP**	**Use legal authority to implement procedures for inspecting public and private construction projects and conduct enforcement if necessary**		Sediment
E.10.c.	**CON-1**	**Planning/Building Inspectors Will Inspect All Construction Sites Requiring a Grading Permit.**	1. During the grading process, 100% of small sites (less than 1/2 acre) will be inspected 2 times and 100% of large sites will be inspected 3 times	Sediment
			2. Inspect 100% of high priority sites prior to forecasted rain events	Sediment
			3. After major rain events, 50% or more of “open” sites will be inspected	Sediment
E.11 POLLUTION PREVENTION/GOOD HOUSEKEEPING FOR PERMITTEE OPERATIONS PROGRAM				
E.11.f	**MO-4**	**Inspection, Cleaning, and Repair of City Catch Basins and Inlets**	3. After large storm events during the wet season, inspect 90% of catch basins in the Downtown, Beach Flats, and lower Ocean Street areas and re-clean them as needed.	Sediment, Trash
E.11.f	**MO-4**		4. Inspect 50% of the catch basins in the outlying areas of the City annually and clean as needed.	Sediment, Trash

E.11.g	**NEW BMP**	**Begin Maintenance of all high priority storm drains on an on-going schedule according to procedures & priorities developed per E.11.f**		Sediment, Trash
E.11.g	**MO-4**	**Inspection, Cleaning, and Repair of City Catch Basins and Inlets**	1. Clean 90% of catch basins and inlets located in the Downtown, Beach Flats, and lower Ocean Street areas annually in the Fall	Sediment, Trash
E.11.g	**MO-6**	**Clean Pump Stations along the San Lorenzo River**	Clean twice per year (Spring and Fall) Additional cleanings, as needed.	Sediment, Trash
E.11.g	**MO-7**	**CDS Unit Maintenance**	1. Clean twice per year in Fall and Spring	Sediment, Trash
E.11.g	**MO-7**		2. Inspect and clean, if necessary, monthly during rainy season	Sediment, Trash
E.15	**MO-10**	**Replace or Rehabilitate Sanitary Sewer Main Lines**	Replace or rehabilitate sewer main pipeline as needed each year	Pathogens
E.15	**MO-11**	**Development and Implementation of a Lateral Inspection Program**	Implementation of Program starting 2016	Pathogens
E.15	**MO-13**	**CBI Grant #1: Dry Weather Diversion of Storm Water from SLR Pump Stations 1, 2, and 1A to the Wastewater Treatment Facility (WWTF)**	Divert the SLR pump station water to the WWTF during the dry season until the SLR shoals	Sediment, pathogens, trash
E.15	**MO-14**	**CBI Grant #2: Dry Weather Diversion of Storm Water from SLR Pump Stations 1B & 3 to the WWTF**	Divert the SLR pump station water to the WWTF during the dry season until the SLR shoals	Sediment, pathogens, trash
E.11, E.15	**MO-1**	**Sweep City Streets By Mechanical Sweepers**	Sweep primary streets in downtown & main beach areas once to twice per week	Sediment, trash
			Sweep primary streets in other commercial areas twice per month	Sediment, trash
			Sweep 75% of residential streets once per month	Sediment, trash
E.11, E.15	**MO-3**	**Sweep Public Parking Lots and Parking Garages Regularly**	Clean lots w/a mechanical sweeper 2 or more times per week	Sediment, trash
E.12 POST CONSTRUCTION STORMWATER MANAGEMENT PROGRAM				
E.12.k	**NEW BMP**	**Post Construction Storm Water Management Requirements Based on Assessment and Maintenance of Watershed Processes**	Implement the RWQCB's Post-Construction Requirements for all new regulated development and redevelopment projects	Sediment, pathogens, trash
			2. Enforce the proof of annual BMP inspection and maintenance at 100% of sites	Sediment, pathogens, trash
			3. Implement a spot inspection program at 10% of sites annually	Sediment, pathogens, trash
	PC-7, CON-2	**PW Staff Will Inspect Installation of Post-construction Treatment Systems**	Inspect systems at 100% of development sites greater than or equal to one acre	Sediment, pathogens, trash

4.2 BMP Effectiveness Assessment Matrix Elements

The successful operation of the Storm Water Program is a function of the level of implementation of program elements (are we meeting implementation measurable goals?) and the effectiveness of those elements at achieving the program's water quality goals (are BMPs having any effect?). The City will use a Program Effectiveness Assessment Matrix to assess the effectiveness of individual BMPs at achieving program water quality objectives. The matrix is included in Attachment A and will include the following fields:

- **CASQA Outcome Levels:**



- **Level of implementation:** measure of whether BMP implementation achieved measurable goals (as defined in the Guidance Document). Ranked from "None" if the BMP was not implemented at all to "Full" if the BMP was fully implemented and achieved its measurable goal. A BMP will be classified as "Partial" if it was implemented but not fully achieving its measurable goal.

- **Effectiveness:** measure of the *impact* of a BMP in terms of reducing a priority pollutant's load or reaching a target audience. Ranked from "Low" if a BMP is not very effective to "High" if the BMP achieves a significant impact. *BMPs assessed at CASQA Outcome Level 1, which only documents implementation, will not be assigned an effectiveness measure because they are not assessed in terms of load reductions or target audience reach.*

- **Priority Pollutants Targeted:** a BMP will be included in the BMP Effectiveness Assessment Matrix if it targets at least one of the priority pollutants of concern in the City of Santa Cruz: sediment, pathogens, or trash. *BMPs that do not target priority pollutants will not be included in the Effectiveness Assessment*; however, they will continue to be tracked and their implementation will be documented in our Annual Reports.
- **Evaluation Methods:** Data to support the program effectiveness assessment will be collected using the following methods:
  - ✓ **Documentation** by Stormwater Program of implementation data. Documentation consists of recording whether a task has been completed and has met its measurable goal (as described in the Guidance Document) and is used to support assessment of Outcome Level 1.
  - ✓ **Tabulation** by Stormwater Program of implementation data. Tabulation consists of accounting data for implementation (e.g. number of development projects required to implement LID), public outreach (e.g. website hits), and load reductions (e.g. pounds of trash collected). It can be used to support assessment of Outcome Levels 1-4.
  - ✓ **Site Inspections** conducted by stormwater programs to directly observe or assess a practice. Inspections are conducted to assess implementation of best practices at commercial and industrial facilities, construction sites, and municipal facilities. Facility inspection results can be used to support assessment of Outcome levels 2 through 4.
  - ✓ **Surveys** by stormwater programs of third parties or stormwater program staff to discern knowledge, attitudes, awareness, behavior of a target audience. Surveys are used to support assessment of Outcome Levels 2 and 3 and include public awareness surveys to gauge public knowledge on a particular topic and effectiveness of various public outreach efforts, and training surveys to assess the effectiveness of a training program.
  - ✓ **Monitoring and Sampling data** obtained directly by stormwater programs or contractors are used to assess pollutant levels in a storm drain structure or receiving water body. They can support assessment of Outcome levels 4 through 6.
  - ✓ **Land-use-load estimation** from modeling efforts, external data sources and best-available knowledge. To support our program effectiveness assessment, the City will be using the TELR model to estimate pollutant load reductions in storm water runoff achieved by several source control and treatment BMPs. The TELR model will also provide estimates of relative pollutant load by catchment, which will inform our program priorities. The pollutant load modeling methodology is further described in Section 5 below.
- **Related Program Water Quality Objective:** the water quality objective(s) supported by the BMP and based on which the BMP will be evaluated.
- **Proposed modifications:** where the effectiveness assessment indicates a BMP is ineffective, this field will include proposed changes and rationale for modifications.

5 Pollutant Load Modeling Methodology

This section outlines our intended approach for quantification of pollutant loads and reductions for stormwater program elements that can be reasonably and credibly quantified using a land-use-load estimation model, including treatment BMPs (e.g., LID facilities, water quality treatment units, detention/retention basins) and certain Pollution Prevention / Good Housekeeping BMPs (e.g., street sweeping, catch basin cleaning, etc.) that provide pollutant source control and can be quantified on a land use basis. The pollutant load model we intend to use is referred to as the Tool for Estimating Load Reductions (TELR). TELR is being developed as a regional collaborative effort between the Central Coast Low Impact Development Initiative, 2nd Nature LLC, Central Coast municipalities, and the Central Coast Regional Water Quality Control Board.

The TELR model will serve two functions in assessing the effectiveness of storm water program:

- Estimating pollutant load reductions achieved by our program elements that can be quantified using land-use load estimates;
- Estimating relative pollutant loading by catchment in our MS4 to inform our stormwater program priorities.

5.1 BMPs Included In Spatial Analysis

The BMPs listed below will be modeled using the TELR pollutant load model to provide an estimate of overall load reductions from Municipal Operations and to also provide a spatial analysis of pollutant sources and BMP effectiveness. If during the course of model development, it is found that additional BMPs can be incorporated in the spatial analysis, they may be added as well.

Source Control BMPs:

- Maintenance of high-priority storm drains on an on-going schedule (E.11.g)
- Inspection, cleaning and repair of catch basins and inlets (MO-4)
- Public parking lot sweeping (MO-3)
- Street sweeping (MO-1)
- BMPs associated with good housekeeping training and enforcement (MO-2, IF-1, ID-1, IF-3)

Treatment BMPs:

- Post-Construction Requirements for all new development and remodel projects (E.12.k)
- Inspection of installation of Post-Construction Treatment Systems (PC-7)
- Program to ensure long-term LID BMP inspection and maintenance on private property (PC-8)
- CDS Unit Maintenance (MO-7)
- Pump Station Maintenance (MO-6)
- Clean Neary Lagoon Storm Drain Lines and Discharge water to Sanitary Sewer (MO-18)

5.2 Tool for Estimating Load Reductions (TELR) Objectives

The approach to estimate our MS4 pollutant loading and reductions is guided by five fundamental objectives:

- **Create credible pollutant load estimations**: The approach must generate scientifically defensible and relatively accurate estimations of average annual loading for the MS4 by catchment(s).

- **Modelling pollutants representative of urban impacts:** Most urban pollutants, including pathogens and sediment, are typically associated with stormwater runoff volume and/or Total Suspended Solids (TSS) (Chen and Chang 2014). TSS has further been documented to also correlate with trace metals, hydrocarbons, and phosphorus in urban runoff (National Stormwater Quality Database v1.1). Therefore, using pollutant loading estimates of runoff volume and TSS as proxies for other pollutants significantly reduces cost and complexity while providing reliable information to guide the implementation and management of our stormwater quality improvement program.

- **Sensitivity to water quality improvement actions:** The approach must be sensitive to pollutant loading reductions from stormwater Best Management Practices (BMPs) and isolate the variability in urban pollutant loading from natural climatic variability.
- **Applicable to the entire MS4:** The method should be applicable and the results scalable to the entire MS4. The results should (1) inform meaningful spatial comparisons to identify catchments with the greatest current pollutant loading to the receiving waters and (2) allow program-wide documentation of pollutant load reduction estimates over time.
- **Ease of initial set-up and on-going use:** The approach must be easy to use and include clear user guidance. Results must be reported in useable and simple formats that inform program decisions and track water quality improvement progress of the MS4 stormwater program.

5.3 TELR Model Structure

The information below summarizes how TELR will estimate urban catchment pollutant loads, prioritize catchments for stormwater improvement actions, and estimate the annual load reduction benefits of the actions implemented.

5.3.1 Model Inputs And Pollutant Load Estimation

TELR will use regionally relevant precipitation data, local soils, slope, and land use to inform a probability distribution approach to estimate average annual catchment volumes. All of the required inputs will be readily available through a variety of information sources including MS4 mapping products and online source. Pollutant generation by land use will be further refined by the defined relative condition of the individual catchment's land use.

TELR will run on regionally representative precipitation using a probability-based integration approach of daily rainfall and runoff intensities. Precipitation inputs will be held constant between Land Use and Current Load scenarios to document the estimated load reductions due to BMP implementation and performance.

The MS4 catchment/outfall mapping will include a complete delineation of the MS4 into unique drainage catchments and a number of associated catchment attributes (i.e. catchment area, impervious area, land use distribution, hydrologic connectivity, etc.) that are important to develop pollutant load estimates, including:

- Location of outfalls
- Catchment drainage area delineations
- Land use contributions and imperviousness
- Location of water bodies receiving direct discharges from outfalls
- Hydrologic connectivity of each catchment to the receiving waters

The pollutant load reductions associated with the installation and condition of treatment BMPs will be directly integrated into catchment load estimates. The effectiveness of source control and small scale structural BMPs at reducing pollutants of concern will be a function of the density of implementation by land use, literature values regarding performance, PCR design requirements, and/or annual effectiveness assessments. Larger scale centralized BMP performance will incorporated event volume accounting and treatment performance also informed by existing literature and annual effectiveness assessments.

TELR will be developed to generate catchment results that will generally correlate with estimates using more complex modeling platforms. The intent is to have confidence that the priorities and/or relative load reductions identified by TELR are reasonably accurate, thereby providing the correct information to guide effective stormwater management.

5.3.2 *Sensitivity to Water Quality Improvement Actions*

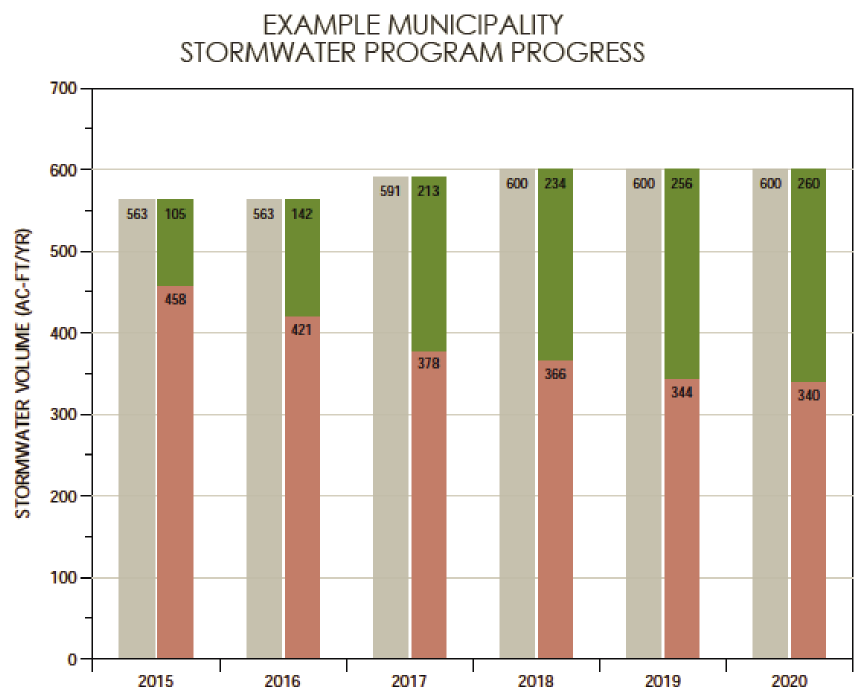
Precipitation inputs will be held constant for all load estimation scenarios to eliminate any result variability due to climatic differences. This will help isolate the load reduction estimates attributed to stormwater quality improvement actions.

Land Use Loads will be calculated to estimate catchment loading without any BMPs in place. Catchment Current Loads for each water year will include the estimated benefits of source control programs (e.g., street sweeping, erosion control), LID implementation on urban land uses, dispersed and centralized structural BMPs (e.g., treatment systems, dry basins).

Each year, Current Loads will be subtracted from Land Use Loads to estimate the load reduction associated with the implementation and maintenance of the stormwater program actions within each catchment (see Figure 3).

5.3.3 *MS4 Program Applicability*

A customized user input template coupled with automated data reporting formats will be created to simply translate inputs into pollutant load results for all catchments within the MS4. The results will be presented in graphical formats to inform program decisions and track progress over time. The difference between the pollutant loads estimated without the implementation of stormwater program actions (i.e. Land Use Load) and the Current Load as a result of the stormwater program provides a quantitative measure to track annual MS4 program progress over time (see Figure 3).



	2015	2016	2017	2018	2019	2020
Land Use Load	563	563	591	600	600	600
Current Load	458	421	378	366	344	340
Load Reduction	105	142	213	234	256	260

Figure 3. Example MS4 program reporting formats. Using TELR results, the aggregation of the load reductions estimated for each catchment is used to document the estimated MS4 pollutant load reduction each year.

5.3.4 *INITIAL SET UP AND ON-GOING USE*

The initial set up will require us to populate TELR with the required data for all MS4 catchments. Once TELR is populated with existing mapping and water quality BMP data, on-going use will be simple and relatively low maintenance. Modifications year after year will be primarily focused on catchments where water quality improvement actions are prioritized and implemented.

5.4 TELR MODEL OUTPUT

TELR will be used to generate two pollutant load scenarios for an urban catchment; a “Land Use Load” and a “Current Load”.

- **Land Use Load:** A catchment land use load is the baseline estimated average annual load without any stormwater program actions or improvements. The land use load is based solely on land use distribution and unmodified hydrologic connectivity of the catchment to the receiving waters.
- **Current Load:** The current load is the estimate of the average annual pollutant load with the implementation and assumed effectiveness of stormwater program actions including source control and structural BMP implementation in the catchment for the respective year evaluated.

LAND USE LOAD – CURRENT LOAD = LOAD REDUCTION

The difference between the Land Use Load and Current Load is the estimated **Load Reduction** achieved as a result of the stormwater program for the year and catchment of interest.

Each year the current load value for each catchment area can be normalized (e.g. acre feet per acre per year; termed **Current Loading Rate**) and integrated and ranked for all catchments within the municipality. The catchments with the highest Current Loading Rate per unit area will be the catchments with the potential greatest risk to receiving water quality for the current year. The results of this prioritization will be mapped to simplify communication of priority catchments. Figure 4 illustrates example catchments shaded purple and red where stormwater improvements and associated maintenance should be prioritized to achieve and sustain reductions in stormwater pollutant loading to the receiving waters over time. The results of this mapping will be used to inform proposed program improvements in subsequent permit terms.

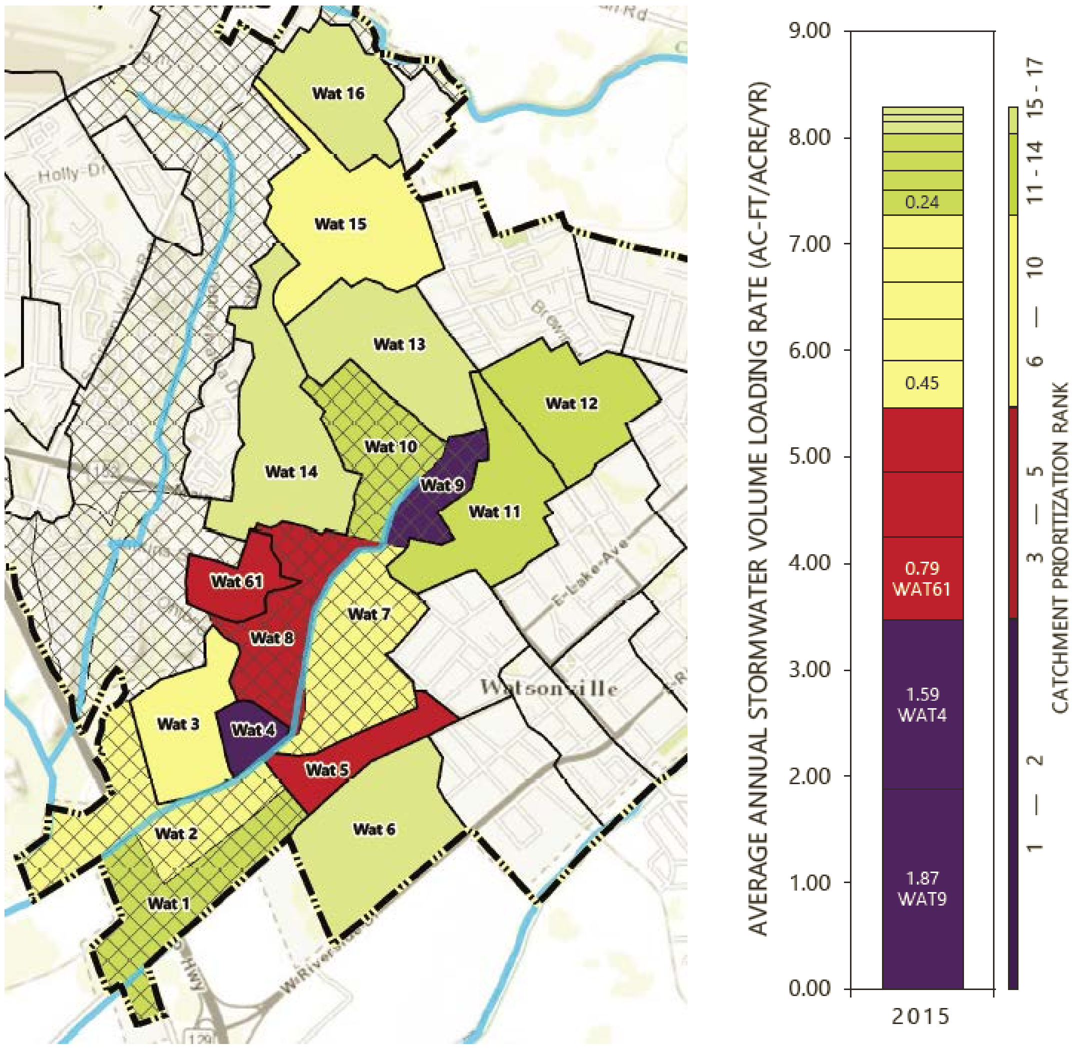


Figure 4: MS4 catchment pollutant loading results are mapped to illustrate the catchments with the greatest potential risk per unit area to the receiving water quality (i.e., purple and red catchments) and are therefore priorities for stormwater program BMPs.

6 PROGRAM EFFECTIVENESS ASSESSMENT REPORTING

6.1.1 ANNUAL REPORTING

The BMP effectiveness assessment matrix will be used to annually report on BMP evaluation outcomes. The matrix will provide a summary of the results of program evaluation activities in a useable format for program review purposes. Specifically, the matrix will be used to answer the following management questions:

1) Were BMPs implemented in accordance with permit requirements and did they meet their respective measurable goals?

   BMPs will receive a rating of "None" if the BMP was not implemented at all to "Full" if the BMP was fully implemented and achieved its measurable goal. A BMP will be classified as "Partial" if it was implemented but not fully achieving its measurable goal.

2) For BMPs assessed at outcome level 2, to what extent did they achieve increased awareness of target audiences?

   BMPs will be ranked from "Low" if a BMP only marginally increases awareness of target audiences to "High" if the BMP achieves a significant increase in awareness.

3) For BMPs assessed at outcome level 3, to what extent did they change the target audience's behavior?

   BMPs will be ranked from "Low" if a BMP only marginally changes the behavior of target audiences to "High" if the BMP achieves a significant behavior change.

4) For BMPs assessed at outcome level 4, to what extent did they achieve a reduction in pollutant loads from their sources to the storm drain system?

   BMPs will be ranked from "Low" if a BMP does not significantly reduce pollutant loads to the storm drain system to "High" if the BMP achieves a significant load reduction.

For BMPs receiving low effectiveness ratings, the matrix will also list proposed modifications to improve BMP and program effectiveness.

6.1.2 LONG-TERM ASSESSMENT AND REPORTING

We anticipate developing the TELR land use load estimation tool and beginning to apply it to the City watersheds during Permit Year 3 (FY 2015-16). The TELR tool will be refined and calibrated during Permit Year 4 (FY 2016-17) and will begin providing land use load information and spatial characterization of pollutant sources and BMP effectiveness by the end of that Permit Year. In Permit Year 5 (FY 2017-18), the City will continue to refine and incorporate additional BMP information into the model. The information added in Year 5 will begin to integrate pollutant load trends.

Based on the results of the annual BMP effectiveness assessment matrix, the land-use-load estimation model, and the results of continued receiving water quality monitoring, the program effectiveness assessment report at the end of Permit Year 5 (FY 2017-18) will qualitatively and quantitatively answer the following long-term program management questions:

1) Is the implementation of the Program improving the water quality of urban runoff and discharges?
2) Is the implementation of the Program having an effect on receiving water quality?
3) Are exceedances of water quality objectives persisting despite implementation of the Program?
4) Are there significant data gaps that need to be addressed?

The program effectiveness assessment report will also provide recommendations for programmatic as well as catchment-based improvements to the Program to benefit receiving water quality.

APPENDIX A

Program Effectiveness Assessment Matrix