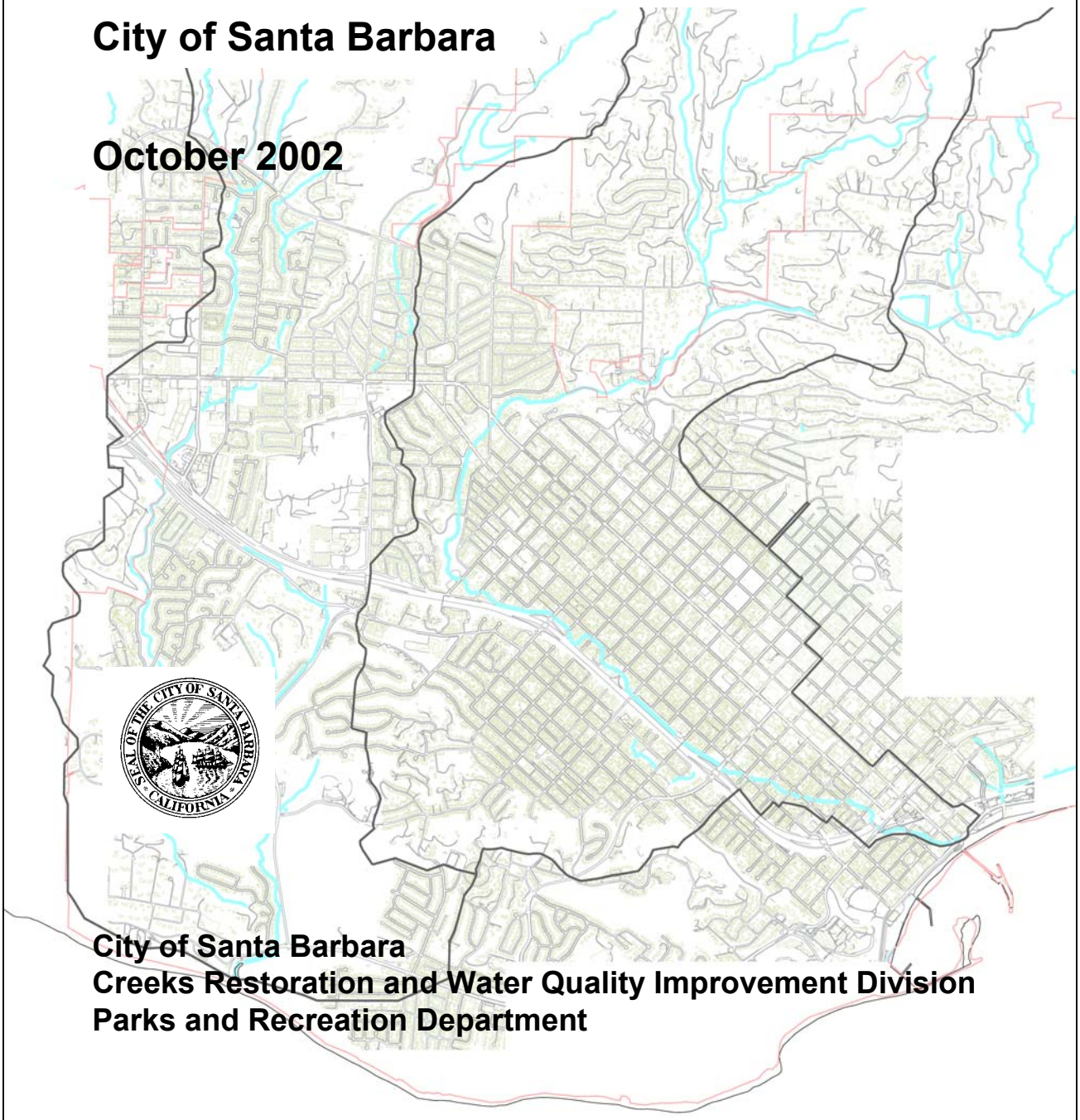
Condensed Version

STORMWATER TREATMENT OPTIONS FOR REDUCING BACTERIA IN ARROYO BURRO AND MISSION CREEK WATERSHEDS

City of Santa Barbara

October 2002



City of Santa Barbara
Creeks Restoration and Water Quality Improvement Division
Parks and Recreation Department

CONDENSED VERSION

Stormwater Treatment Options for Reducing Bacteria in Arroyo Burro and Mission Creek Watersheds

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1. INTRODUCTION

1.1 DEFINITION OF THE PROBLEM

For the past several years, the City of Santa Barbara has been sampling water in the two major creeks that traverse the city: Arroyo Burro and Mission Creek (Figure 1). In addition, the County of Santa Barbara, Environmental Health Department, conducts weekly sampling of ocean water at the beaches at the mouth of these creeks – East Beach and Arroyo Burro County Beach. The results of the sampling show high levels of coliform and enterococcus bacteria, which are indicators of pathogens that cause adverse health effects such as skin rashes, sinus infections, and gastrointestinal illness. The public is exposed to health risks by swimming in ocean water at the two beaches, or in the brackish water lagoons that form at the mouths of Arroyo Burro and Mission Creek. In addition, the public is also exposed to health risks by contact with water in these creeks on private property or in public parks. There are many potential sources of indicator bacteria in the watersheds, including pet and animal waste, wildlife, malfunctioning septic tanks, sewer spills, and transient use of the creeks.

The City is committed to improving water quality in the creeks and at the beaches to reduce public health risks, enhance recreational uses, enhance aquatic and riparian habitats, and generally improve the quality of life in the City. The City is pursuing several different approaches to achieve these goals, including reduction in the sources of pollution, treatment of stormwater and urban runoff to reduce bacteria levels, and public education. While pathogen pollution is a high priority due to its immediate and well-known health risks, the City is also concerned about other pollutants, including sediments, nutrients, oil and grease, trash, oxygen-demanding compounds, toxic substances, and heavy metals.

1.2 STUDY OBJECTIVES

This study was completed to specifically address the high levels of indicator bacteria in Arroyo Burro and Mission Creek watersheds, including both creeks and beaches. *The objectives of the study are to identify and evaluate potential stormwater treatment "best management practices" (BMPs), active treatment systems, and low-flow diversions to the sanitary sewer that could be implemented by the City to reduce bacterial pollution in the creeks and at the beaches of two watersheds.* The study provides a comprehensive evaluation of the treatment and diversion opportunities in each watershed. It identifies and ranks specific projects based on various feasibility, effectiveness, and environmental criteria. The study represents a master plan for funding and constructing treatment projects over the next several years.

Arroyo Burro and Mission Creek watersheds were selected for study because they are the largest watersheds in the city, and because the popular beaches at the bottom of these watersheds exhibit high bacteria levels occur. This study was funded through the State Water Resources Control Board's Clean Beaches Initiative, authorized through the Costa-Mochado Water Act of 2000 (Proposition 13). The

Clean Beaches Initiative is an element of the Board's Non-point Source Control Program. The objective of the Clean Beaches Initiative is to provide support for local government agencies to reduce pollutants at public beaches through various pollution reduction and treatment projects.

1.3 PROGRAM OBJECTIVES

The overall objectives of the bacterial reduction program to be implemented based on this study are as follows:

- ✓ Reduce bacteria loading from the City's storm drain system from both the "first flush" stormwater events (i.e., flows from the first major storm of the winter season), and from year-round urban runoff (i.e., from urban water uses) and natural dry weather stream flows (i.e., groundwater discharge).

- ✓ As feasible, reduce bacteria in creeks and surface drainages outside of the municipal storm drain system

- ✓ Implement a strategic, watershed-based plan that uses a combination of treatment BMPs, decentralized active treatment facilities, and low flow diversion to the sanitary sewer system

The program will be implemented with grant funding from the Clean Beaches Initiative program, City Creeks Program, and other grant funding, as available. Watershed-wide program implementation is a long-term endeavor that requires significant funds for construction and operation.

The program will be implemented in an incremental manner, focusing on high priority opportunities to reduce known significant bacteria sources in the most cost effective manner. It will also be flexible in order to adapt to new conditions, information, and/or priorities that may arise as the program is implemented.

In 2001, the City established the Creeks Restoration and Water Quality Improvement Division (Creeks Program), Parks and Recreation Department, to lead efforts to improve water quality and habitat along creeks in the City. The stormwater treatment program will be administered by the Creeks Program. It will represent one of several major efforts by the City to improve creek and beach water quality, in addition to creek habitat restoration and public education.

1.4 SCOPE OF STUDY

The study addressed the following elements in the Arroyo Burro and Mission Creek watersheds:

- ✓ Characterize the surface drainage units and storm drain systems
- ✓ Identify and map predominant land uses and possible sources of bacteria pollution

- ✓ Characterize the level of bacteria pollution in the creek based on current City sampling data
- ✓ Identify treatment BMPs, decentralized treatment facilities, and low-flow diversions to sanitary sewer approaches to be considered for implementation
- ✓ Identify and prioritize site-specific opportunities for stormwater and urban runoff treatment

1.5 STUDY AREA

The study area encompasses the urbanized portions of the Arroyo Burro and Mission Creek watersheds. The study areas are shown on Figures 1 and 2 for Arroyo Burro and Mission Creek watersheds, respectively. The acreages of the study areas are 3,186 and 3,855 acres for the Arroyo Burro and Mission Creek watersheds, respectively. While the study is focused on land within the City limits, it also includes urbanized unincorporated areas in and adjacent to the study area.

2. OVERVIEW OF WATERSHEDS

A brief overview of the study area watersheds is provided below. A more detailed description is provided in the main report.

2.1 ARROYO BURRO

Arroyo Burro begins in the Santa Ynez Mountains and flows south until it empties into Arroyo Burro Beach (Figure 1). Major tributaries to Arroyo Burro are described below. A tidal lagoon is present at the end of the creek at Arroyo Burro County Park.

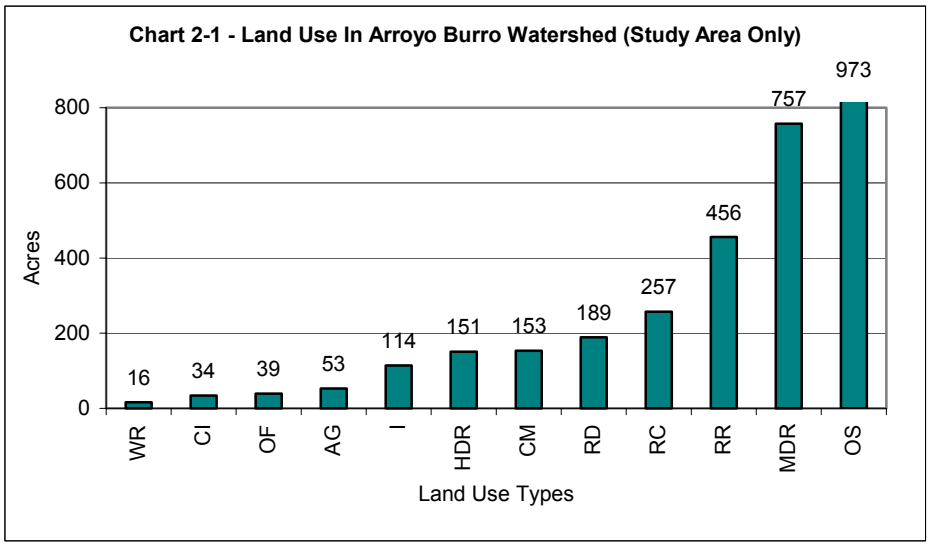
There are two main tributaries that make up the upper reaches of the Arroyo Burro watershed. Barger Canyon and San Roque Creek (Figure 1). These creeks are mostly unlined earthen channels with cobbly substrate and scattered to dense riparian vegetation, often abutting dense landscaping associated with adjacent residential areas. There are several small tributaries in the upper watershed – Northridge West, Northridge East, and Foxen drainages. These drainages are all unlined earthen channels with varying amounts of native vegetation. Lauro Reservoir is a man-made drinking water reservoir that stores water derived from Cachuma Lake. A small drainage occurs downstream of the dam that traverses urbanized areas below Foothill Road, eventually terminating in a storm drain.

The largest tributaries to Arroyo Burro below San Roque Creek are Mesa and Las Positas Creeks (Figure 1). Mesa Creek is an earthen channel with dense oak woodland and riparian vegetation that drains the western portion of the Mesa. Las Positas Creek extends from Highway 101 to its confluence with Arroyo Burro (Figure 1). The lower 2,200 feet of the creek parallel to Las Positas Road contains a fully lined concrete channel.

The total length of creek and surface drainage channels in the watershed study area is estimated to be 12.9 miles. There are various bank and bed modifications to the creeks and drainages to prevent bank erosion, channel bed scouring, and/or overbank flooding.

There are perennial flows in Arroyo Burro and San Roque Creek downstream of State Street due to groundwater discharge, springs, and urban runoff. Perennial flow is also present in Las Positas Creek, Portesuello Drainage, and Mesa Creek.

A summary of the land use types in the study area is provided in Chart 2-1. Residential land uses account for about 1,364 acres, or 44 percent of the watershed study area. Open space accounts for about 31 percent of the watershed study area. Commercial land uses account for less than five percent of the watershed study area, while parks account for about eight percent. Land uses which are scarce in the watershed include commercial/industrial, office complex, and agriculture.



Code	Land Use Type
CM	Commercial
CI	Commercial/Industrial
I	Institutional
OF	Office Complex
HDR	High Density Residential
MDR	Medium Density Residential
RR	Rural Residential
AG	Agriculture
RC	Parks and Recreation
OS	Open Space
WR	Water

2.2 MISSION CREEK

Mission Creek begins in the Santa Ynez Mountains above the Santa Barbara Botanical Gardens in Rattlesnake Canyon and winds its way down through the City of Santa Barbara until it reaches the ocean east of Stearns Wharf (Figure 2). There are three main tributaries, Rattlesnake Creek, Las Canoas Creek, and Old Mission Creek. A lagoon is present at the creek mouth that extends 1,000 to 1,200 feet across the beach, depending upon tidal and streamflow conditions.

Upstream of Highway 101, Mission Creek is an earthen channel with a cobbly substrate and varying density of oak and riparian woodland on the banks. A man-made uniform trapezoidal channel is located along the Highway 101 corridor (Figure 1). It includes two reaches of fully-lined concrete channel, as follows:

- Below Pueblo Street to below Mission Street – 1,700 feet
- Above Arrellaga Street to Canon Perdido Street – 4,000 feet

The reach of Mission Creek downstream of Canon Perdido to the ocean at Cabrillo Boulevard contains a highly disturbed rectangular or trapezoidal channel constructed of various materials including concrete or stone retaining walls, rock rip-rap, concrete banks, gabion walls, and earthen banks. The bed of the channel is mostly unlined,

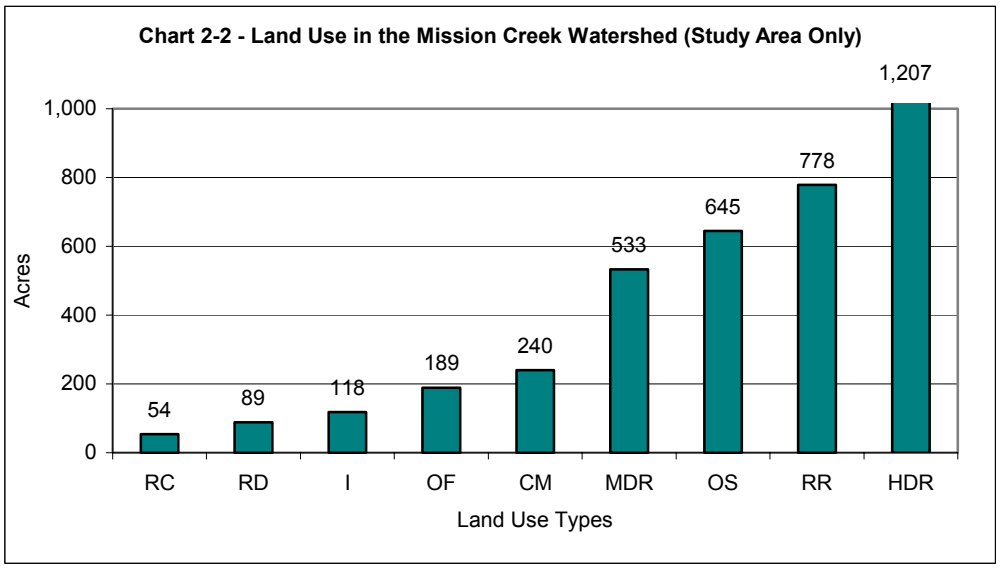
consisting of cobbles and sand substrate. Dense vegetation on the banks is mostly present, including both native riparian plants and landscaping from adjacent residences and businesses.

Old Mission Creek occurs in the west side of the city (Figure 2). It is a remnant of the original Mission Creek, which was relocated to the north side of Highway 101. Old Mission Creek is a short earthen channel that traverses Bohnett Park, and a small residential area. The creek receives water from three storm drain outlets, as well as year-round groundwater infiltration. Old Mission Creek discharges to the concrete-lined section of Mission Creek. Flows are conveyed through a culvert under Highway 101.

The total length of creeks and drainage channels in the watershed study area is about 4.8 miles. There are various bank and bed modifications to Mission Creek, primarily downstream of State Street.

Perennial flows are present in Old Mission Creek, and along Mission Creek downstream of its confluence with Old Mission Creek near Figueroa Street. The flows at the end of Mission Creek are due to a combination of the Old Mission Creek flows and groundwater discharge along the lower reaches in downtown Santa Barbara. The creek between Alamar Road and Old Mission Creek is generally dry in a typical summer and fall. Perennial flows occur upstream of Alamar Road in the foothills where the creek is fed by springs.

A summary of land use types in the study area is provided in Chart 2-2. The dominant land uses are rural residential and high-density residential (i.e., apartments, small lot houses). Land uses which are relatively scarce in the watershed include recreational and institutional.



3. SOURCES AND LEVELS OF BACTERIAL POLLUTION

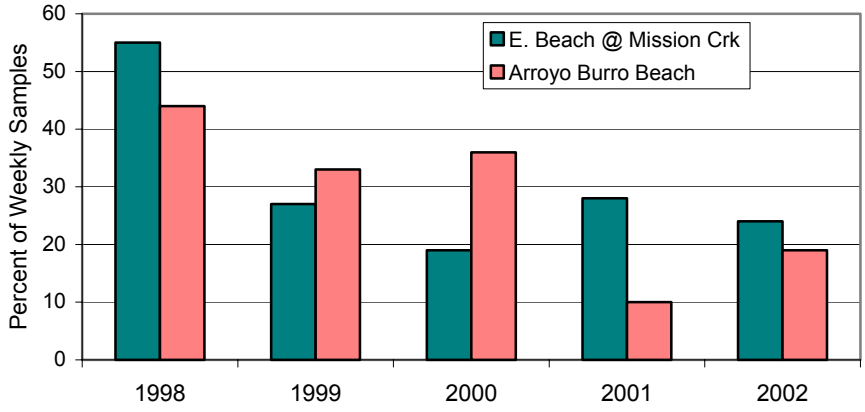
3.1 SUMMARY OF BEACH WATER QUALITY MONITORING

Under State law, the County of Santa Barbara is required to sample public beaches and post warning signs when the water quality standards are exceeded. Total coliform, fecal coliform, and enterococcus are to be used as indicator bacteria for monitoring marine recreational water quality. Indicator bacteria are selected groups of microorganisms which indicate the likelihood of the presence of disease-causing pathogens. Indicator bacteria only suggest the presence of disease-causing organisms, and generally are not pathogenic themselves.

Total coliforms consist of a large group of bacteria that may inhabit the intestinal tracts of humans, pets, and wildlife. They may also be found in water as well as occurring naturally on leaves and in the soil. Fecal coliforms are a subgroup of total coliform bacteria. Their presence is highly correlated with fecal contamination from warm-blooded animals. Enterococcus, sometimes referred to as fecal streptococcus, is also an intestinal bacterium used to indicate fecal contamination from mammals and birds.

Since the sampling program began in 1997, the data indicate that Arroyo Burro Beach and East Beach at Mission Creek exhibit high mean concentrations in total coliform, fecal coliform, and enterococcus. One or more of the beach bacteriological standards have been exceeded 10 to 55 percent of the time, depending upon the beach and year, as shown on Chart 3-1. In general, the number of exceedances of bacteriological standards has decreased since 1998 when there were prolonged flows to the ocean due to the El Nino weather conditions.

Chart 3-1 Frequency of Exceedances of Beach Bacteria Standards (any one of three standards)



The frequency of exceedances of bacteriological standards and the concentration of indicator bacteria vary from month to month. For example, the frequency of exceedances are generally greater during the winter months when creeks flow to the ocean, carrying contaminants from the watershed to the nearshore waters. The frequency of exceedances is typically lower during the summer months when the creek flows are insufficient to reach the ocean and a closed waterbody forms at the mouth of the creek.

There are exceptions to these observed patterns of exceedances and bacteria concentrations the beach. For example, the lagoon at the mouth of Arroyo Burro may open occasionally during the summer due to hydrostatic pressure, or due to partial breaching by beach users. Under these circumstances, there is a potential for creek water to increase the bacteria levels in the ocean and possibly cause exceedances. Beach bacteria concentrations in the summer may also be relatively high (in the absence of runoff) due to other factors, such as:

- Bacteria loading in the lagoons from sea gulls and waterfowl, or from high dry weather flows (i.e., urban runoff) with high bacteria concentrations
- Bacteria loading in the nearshore waters from sea gulls and dog feces

3.2 BACTERIA LEVELS IN THE WATERSHED, 2001-2002

In June 2001, the City began a comprehensive weekly bacteriological sampling program along Arroyo Burro and Mission Creek. Weekly samples are collected when water is present, and analyzed for total coliform, fecal coliform, and enterococcus. Sampling sites were chosen throughout the watershed to provide a broad, geographically-based characterization of bacteria levels in these watersheds to provide information for this study and other efforts by the City to reduce bacteria pollution. The are 14 sampling sites in the Arroyo Burro watershed, all of which are located along creeks except for one storm drain site at the Hope Avenue Drain. There are 15 sampling sites in the Mission Creek watershed; three of the sites are located at storm drain outlets (Old Mission Creek outlet at Mission Creek; Westside Drain; Haley St. Drain).

The results of the sampling for fecal coliform in the Arroyo Burro and Mission Creek watersheds are presented in Charts 3-2 and 3-3, respectively. Median concentrations are displayed with the standard deviations. The data were divided into dry weather months (May through October) and wet weather months (November through April) in order to detect any differences due to runoff from rain events and a continuous flow condition from the foothills to the ocean. A summary of the key trends and differences within and between watersheds is provided below.

Arroyo Burro Conditions

- The highest **wet** season concentrations were observed at the head of the Las Positas Creek drainage channel, immediately downstream of Union Pacific Railroad; Las Positas Creek at its confluence with Arroyo Burro at Veronica Springs Road; and Hope Ave. Drain

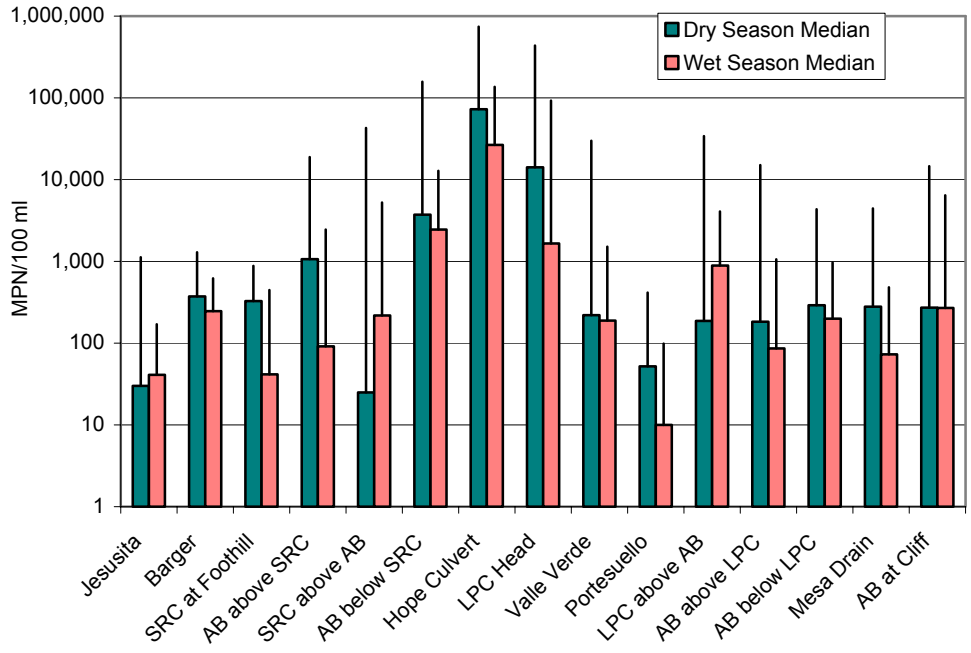
- The highest **dry** season concentrations were observed on Arroyo Burro above its confluence with San Roque Creek near Hope Avenue; the head of the Las Positas Creek drainage channel, immediately downstream of Union Pacific Railroad; and Hope Avenue Drain.

- In general, fecal coliform concentrations in dry months are greater than in wet months, presumably due to the dilution effect from winter runoff.

- The high concentrations in Arroyo Burro between State Street and Highway 101 and in the Hope Drain indicate high bacteria loading in this predominantly commercial area.

- There is no obvious trend of increasing bacteria concentration with distance down the watershed.

Chart 3-2 - Fecal Coliform Values, Arroyo Burro, June 2001-May 2002



Mission Creek Conditions

- The highest **wet** season concentrations were observed at the Haley Drain; along Mission Creek at Haley Street; along Mission Creek at Gutierrez Street; and along Mission Creek at the Union Pacific Railroad.

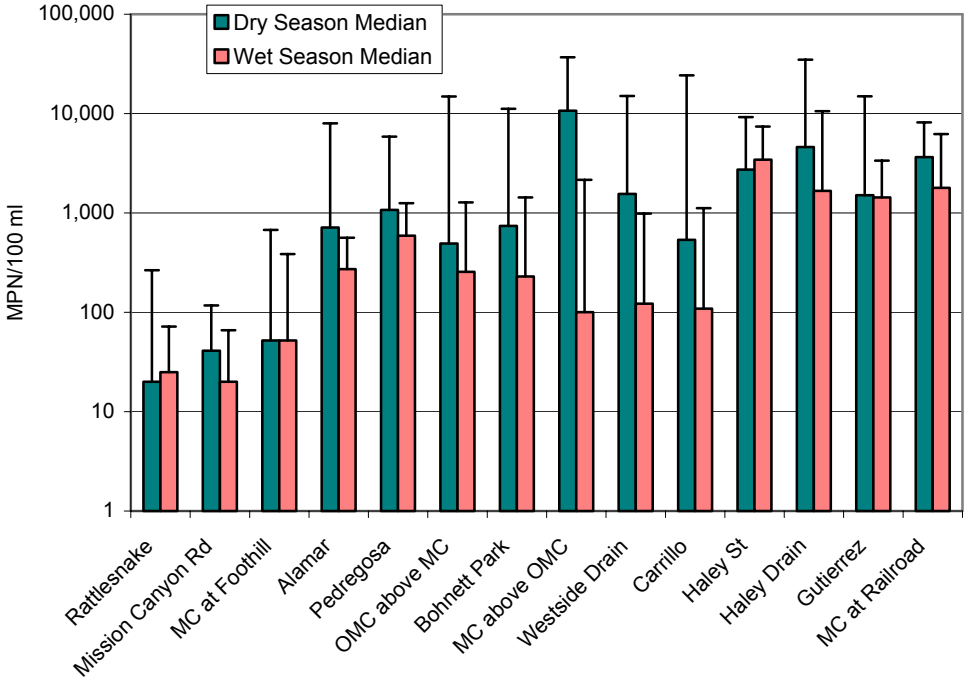
- The highest **dry** season concentrations were observed at the same locations for the wet season (see above), plus along Mission Creek above Old Mission Creek confluence (near Anapamu Street).

- Moderately high concentrations were observed in both wet and dry seasons at sites along the concrete lined portions of Mission Creek adjacent to Highway 101.

- In general, fecal coliform concentrations in dry months are greater than in wet months, presumably due to the dilution effect from winter runoff.

- There is a trend of increasing bacteria concentration with distance down the watershed.

Chart 3-3 - Fecal Coliform Values, Mission Creek, June 2001-May 2002



3.3 SOURCES OF BACTERIA

Indicator bacteria, such as coliform bacteria and enterococcus, are non-virulent single cell organisms used to assess potential health risks in water. Coliform bacteria, including total and fecal coliform, are found in the digestive tract of warm-blooded animals, as well as in other animals and in some plant and soil environments. Enterococcus is group of bacteria that is restricted to warm-blooded animals. These bacteria groups are used to indicate the presence of fecal wastes in

water, which could include pathogens. A pathogen is a microbial species that causes disease under certain conditions, and include harmful bacteria (*Salmonella, Shigella*), protozoas (*Giardia*, *Cryptosporidium*), and viruses.

Microbes are nearly always present in moderate to high stormwater and urban runoff, but the concentrations are highly variable. The highest concentrations are usually associated with "first flush" stormwater runoff, or sewage spills or leakage. There is no consistent pattern in the concentration of coliform bacteria in stormwater flows versus baseflows based on data from throughout the United States. The seasonal pattern of coliform concentrations is often unique to specific climatic regions, or in some instances, to specific watershed conditions.

The sources of indicator bacteria in the Arroyo Burro and Mission Creek watersheds are varied, and include both human and non-human sources. General sources are described below, listed in no particular order. At this time, there are insufficient data on the sources of bacteria pollution in these watersheds to rank these sources.

Human-Related Sources

- Illegal Sewer Connections to Storm Drain System. In this situation, a sewer line is illegally connected to a City-owned storm drain system. It may convey grey water (kitchen, laundry water) and/or sanitary wastes.

- Illegal Disposal to Storm Drain System. This source is highly variable and difficult to detect. It typically involves individuals dumping trash, lawn clippings, and fluids into storm drain catch basins along streets.

- Illegal Disposal to Creeks and Improved Channels. This type of illegal dumping is widespread throughout both watersheds, and includes landscaping wastes, paper trash, bulk trash, livestock waste (e.g., horse manure), and pet waste (e.g., dog waste).

- Human Feces in Creeks. There are many locations along Arroyo Burro and Mission Creek which are used as outdoor latrines by transients, homeless, unsupervised children or teens, and outdoor workers (e.g., construction and landscaping crews).

- Accidental Sewer Spills or Leaks. Sewer lines traverse Arroyo Burro and Mission Creek at specific known locations. In the event of an accidental spill or leak, untreated sewage could be released to the creek. The City conducts year-round testing of the sewer system to detect leaks and identify potential weak pipes or joints.

- Pets, Domestic Animals, and Livestock. Pet waste occurs in private yards, along road rights of way with grass strips, at parks and school yard, along foothill trails, and at the beaches. Many large lot residences in the Arroyo Burro and Mission Creek watersheds contain horses and chickens, and in some cases, pet pigs and goats.

- Failing Septic Tanks. Malfunctioning septic tanks can discharge coliform bacteria to groundwater, which in turn, could discharge to surface water. There are only a few locations in the watersheds with septic systems.

Non-Human Sources

- Wildlife. Feces from reptiles, birds, and mammals contribute to bacteria loading throughout a watershed. Urban wildlife can be a significant source because of the high number of animals that thrive in urbanized areas, using structures and storm drains for refuge. Typical urban wildlife include pigeons, skunks, mice, rats, raccoons, and opossums.

3.4 BACTERIA AND LAND USES

There have been several studies to assess the concentration of bacteria in stormwater from different land uses. Based on these studies, land uses can be generally ranked as sources of coliform bacteria as follows (in decreasing order):

1. High Density Residential – possible specific sources: pets, trash, landscaping waste, urban wildlife
2. Moderate Density Residential - possible specific sources: pets, trash, landscaping waste, urban wildlife
3. Commercial – possible specific sources: trash, urban wildlife, illegal dumping, transient use of adjacent drainages, restaurant wastes
4. Industrial - possible specific sources: trash, urban wildlife, illegal dumping, transient use of adjacent drainages
5. Office Complex – possible specific sources: urban wildlife, trash

There are insufficient data to rank the following land uses: recreational; institutional (e.g., schools, care centers); open space; agriculture; and rural residential.

4. OVERVIEW OF STORM DRAIN SYSTEM

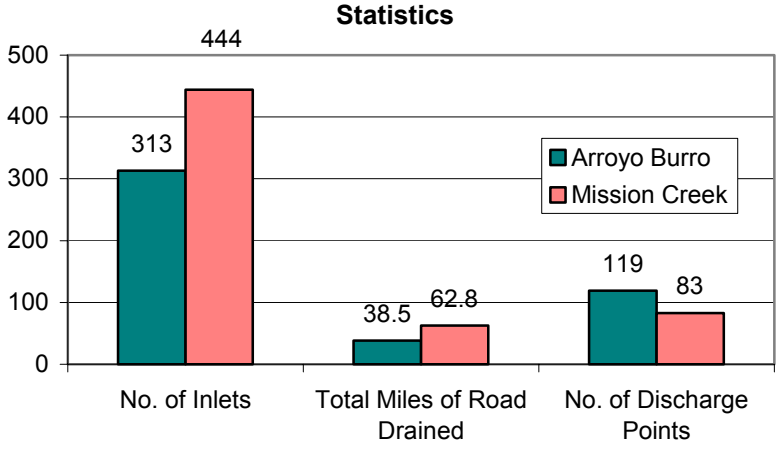
4.1 STORM DRAIN SYSTEM

The City's maintains a municipal storm drain system in the Arroyo Burro and Mission Creek watersheds. It consists of various catch basins along roads and drop inlets in parking lots and flat areas that convey stormwater runoff to buried pipes. The system of pipes discharge the collected stormwater to creeks and man-made drainages that convey flows to the ocean. The system primarily collects runoff from public roads, which conveys stormwater runoff from adjacent developed and undeveloped land.

The drainage area served by the storm drain system in the Arroyo Burro and Mission Creek watersheds is about 3.8 and 4.9 square miles, respectively. The number of miles of creeks and drainage channels in the Arroyo Burro watershed is more than twice that in the Mission Creek watershed.

Storm drain inlets are located in areas with high runoff due to urbanization. A total of 313 storm drain inlets occur in Arroyo Burro watershed and 444 in the Mission Creek watershed (including private and Caltrans inlets), as shown in Chart 4-1. The length of roads drained by the storm drain system is also less in the Arroyo Burro watershed.

Chart 4-1 Comparison of Storm Drain System Statistics



Storm drain outlets along creeks and channels of the Arroyo Burro and Mission Creek watersheds are shown on Figures 3 and 4, respectively. The number of outlets in the Arroyo Burro watershed is greater than in Mission Creek, as shown in Chart 4-1.

4.2 KEY STORM DRAIN OUTLETS

A complete inventory of the storm drain system in the Arroyo Burro and Mission Creek watersheds was conducted during the study and is described in the main report. Data include the number and diameter of each outlet; length of pipe associated with each outlet; and the number of catch basins and drop inlets contributing to each outlet. The lengths of road, key street name, dominant land use, and surface drainage area associated with the storm drain outlet were also documented.

Arroyo Burro Watershed

Based on the storm drain system inventory, creek and reaches in the watershed were identified that appear to have relatively high concentrations of stormwater discharges. These creeks and reaches are listed below in Table 4-1. They could exhibit elevated coliform bacteria levels that are generally associated with stormwater discharges from a storm drain system. These creeks and reaches are consistent with sampling sites with the highest concentrations (see Section 3.2).

TABLE 4-1
SUMMARY OF CREEKS AND REACHES WITH POTENTIALLY HIGH BACTERIA LEVELS ASSOCIATED WITH THE STORM DRAIN SYSTEM (ARROYO BURRO)

Reach	Potential Bacteria Sources
Arroyo Burro between State Street and Highway 101 (Auto Center Reach)	Commercial areas along Hope and Hitchcock; drainage from La Cumbre and Five Points shopping centers (commercial sources)
Arroyo Burro estuary (below Cliff Drive)	Residential areas on the Mesa
Drainage facilities at the Earl Warren Fairgrounds (state property)	Multiple sources on fairgrounds, including high concentrations of trash, people, and domestic animals
Las Positas Creek (from UPRR to Arroyo Burro confluence)	Low density residential lots; greater source is likely to be fairgrounds upstream
San Roque below State Street	Commercial areas along Hitchcock and State St; residential areas south of State St.
Lauro Canyon Drainage below Foothill Road	Residential areas

Key storm drain outlets in the Arroyo Burro watershed that could exhibit elevated bacteria levels were identified by the following criteria. They must drain a large area, as demonstrated by the diameter of the outlet (more than 24 inches), the length of road drained by the outlet, the number of inlets, and the surface drainage area. These outlets must also drain areas with land uses that have a moderate to high

potential for bacteria loading. A list of these key outlets is provided below in Table 4-2 in no specific order, and shown on Figure 5.

TABLE 4-2
KEY STORM DRAIN OUTLETS IN THE ARROYO BURRO WATERSHED

Outlet	Diameter of Discharge (inches)	No. Inlets	Primary Road Drained	Total Roadway Length Drained (feet)	Dominant Land Use*
C04-10	42	2	Foxen drainage; Woodley Ct	400	MDR
C04-15	36	4	Sunset Dr, Foxen Dr	4,300	MDR
C05-10	50	20	State St; most of San Roque area	17,000	
B05-05	30	7	South Ontare Rd	6,000	HDR
B05-03 (Hope Drain)	48	17	La Cumbre, State St	2,600	CM
B06-12	21	3	Hitchcock Rd	2,000	CM
B06-X	42	7	Calle Real, Hope Ave	4,200	RD
B07-16	24	6	La Cumbre Cr	3,700	HDR
B07-22	27	8	Mariana Way	5,500	HDR
B08-23	18	6	Senda Verde	2,800	HDR
B08-18	36	4	Palermo Dr	6,200	HDR
C07-19	56	48	G.C./Fairgrds/Hwy 101/Modoc		INS
C07-17 (includes C07-13)	66	19	Area N of hwy/Hwy 101/Modoc	18,000	RD,CM,HDR
Y C08-10 Caltrans	42	7	Las Positas Mdws, Las Pos. Rd	2,800	MDR
C08-23	24	2	Las Positas Pl, Veronica Sprgs	900	MDR, LDR
C09-09 Caltrans	30	1	Portesuello Ave	4,100	MDR
C10-X	2X 36	8	Jerry Harwin, James Dr, Manitou	6,000	REC, OS, MDR
C11-44	42	5	Alan Rd, Vista del Mar	3,700	MDR
C11-37 (Mesa Ck)	66	1	Cliff Dr, western Mesa area	20,000	OS, MDR
C12-08/B12-01	36	4	Braemer Rd, Cliff Dr, overflow parking	2,000	RR, RD

* CM = commercial; HDR = high density residential; INS = institutional; LDR = low density residential; MDR = moderate density residential; OS = open space; RD = roadways; RR = rural residential; REC = parks.

The predominant land uses in the drainage areas for the key storm drain outlets are medium density residential, open space, commercial, high density residential, and

recreation. The residential and commercial land uses are represented in a higher proportion in the drainage areas compared to the entire watershed. The recreation land use category consists of the municipal golf course and Earl Warren Fairgrounds.

Mission Creek Watershed

Based on the storm drain system inventory, reaches in the watershed were identified that appear to have relatively high concentrations of stormwater discharges. These reaches are listed below in Table 4-3. They could exhibit elevated coliform bacteria levels that are generally associated with stormwater discharges from a storm drain system. These reaches are consistent with sampling sites with the high concentrations (see Section 3.2).

TABLE 4-3
SUMMARY OF CREEKS AND REACHES WITH POTENTIALLY HIGH BACTERIA LEVELS ASSOCIATED WITH THE STORM DRAIN SYSTEM (MISSION CREEK)

Reach	Potential Bacteria Sources
Alamar (State St. to Junipero)	Commercial areas along State St and de la Vina St; high density residential; Oak Park
Highway 101 (Junipero to Figueroa)	Residential areas
Lower Mission (101 to ocean)	Commercial areas; high concentrations of trash and people (tourists); transients; houses directly adjacent to creek; beach users at lagoon; ducks and sea gulls
Old Mission Creek (Bohnett Park to Highway 101)	High density residential lots; high concentration of people, pets, and trash at Bohnett Park

Key storm drain outlets in the Mission Creek watershed that could exhibit elevated bacteria levels were identified by the following criterion. They must drain a large area, as demonstrated by the diameter of the outlet (more than 24 inches), the length of road drained by the outlet, the number of inlets, and the surface drainage area. These outlets must also drain areas with land uses that have a moderate to high potential for bacteria loading (see Section 3.4). A list of these key outlets is provided below in Table 4-4 in no specific order, and shown on Figure 6.

TABLE 4-4
KEY STORM DRAIN OUTLETS IN THE MISSION CREEK WATERSHED

Discharge Point	Diameter of Discharge (inches)	No. Inlets	Primary Road Drained	Total Roadway Length Drained (feet)	Dominant Land Use*
E05-04	36	12	Puesta Del Sol	4,000	MDR
D05-05	42	16	Alamar St	9,400	MDR, CS
D06-11	42	41	Calle Laureles	26,000	MDR
D07-21	24	2	Junipero St	14,000	MDR, HDR
E08-07	42	68	State St.	42,000	HDR, MDR
F09-04	36	16	Sola St	39,200	HDR, CM
F09-14	72	39	Victoria St	9,200	HDR, MDR
F09-28	36	17	Figueroa St	10,600	HDR, CM
G10-22	12	4	Chapala St	5,000	CM
H10-08	54	15	State St.	8,000	CM
E09-02	30	11	San Pascual St	8,600	HDR
E09-01	84	45	San Andreas St	67,900	MDR
F10-01	42	20	Carrillo St	9,600	HDR

* CM = commercial; HDR = high density residential; INS = institutional; LDR = low density residential; MDR = moderate density residential; OS = open space; RD = roadways; RR = rural residential; REC = parks.

The predominant land use in the drainage areas of the key storm drain outlets is high density residential, which is represented in a higher proportion in the drainage areas compared to the entire Mission Creek watershed.

5. TREATMENT OPTIONS

5.1 BACKGROUND INFORMATION

Methods of Reducing or Killing Bacteria

Fecal coliform bacteria do not fare well when exposed to the outside environment. Overtime, most fecal coliform will gradually die-off. Reducing the amount of bacteria in water can be achieved by direct mortality, as well as by sequestering the bacteria in bottom sediments and soils where they are not measured. The primary factors that either cause bacteria die-off or reduce the concentration of bacteria in creeks and storm drain systems are listed below.

- Exposure to Sunlight. Bacteria are killed when exposed to an ultraviolet light such as sunlight.
- Sedimentation. Individual fecal coliform bacteria typically absorb to sediment particles, and many will settle from the water column.
- Soil Filtration. Bacteria are removed from waterbodies by filtering through the soil profile. Septic systems utilize this method.
- Inhibition of Growth and Predation. Several natural factors slow the growth rate of bacteria and/or increase mortality such as low temperature, low nutrient levels, low moisture, and natural predators (e.g., larger microbes).
- Chemical Disinfection. Bacteria are rapidly and effectively killed through disinfection by chlorine or ozone.

Effectiveness of Stormwater Treatment BMPs and Systems

The range of fecal coliform concentrations in Arroyo Burro and Mission Creek is about 100 to 5,000 MPN/100 ml. The single sample beach standard is 200 MPN/100 ml. To meet the beach standard, a removal rate of over 90 percent would be required to reduce concentrations of 5,000 MPN/100 ml to the beach standard. During storms, peak values reach 20,000 to 100,000 MPN/100 ml. A 99 percent removal rate would be required under these circumstances to achieve the beach standard. No stormwater treatment BMP, except for active treatment systems, has achieved these levels of effectiveness for removing coliform bacteria.

Typical coliform bacteria removal rates for treatment BMP (excluding active systems involving disinfection or diversions) are 30 to 75 percent. The removal effectiveness rate varies greatly with the type of BMP, concentration of inflows, and maintenance practices. Based on available monitoring data from throughout the United States, typical coliform bacteria concentrations in the outflow from stormwater treatment BMPs (such as detention ponds, constructed wetland, vegetated swales) is 2,000 to 5,000 MPN/100 ml.

5.2 STORMWATER AND URBAN RUNOFF TREATMENT METHODS

Treatment options for reducing bacteria in creeks and storm drain system are listed below. There are three major options for treating stormwater and urban runoff: active treatment systems (i.e., disinfection), stormwater treatment "best management practices" (BMPs), and diversion to sanitary sewer system. Detailed information about the technologies and facilities associated with stormwater treatment BMPs and active treatment systems are presented in the main report.

5.2.1 Active Treatment Facilities

Active treatment systems are highly effective (almost 100 percent) in reducing bacteria. They can be sized for different flow requirements and available space. There are three types, as listed below:

- Chlorination. This system requires the handling and storage of chlorine (gas or liquid), which is a dangerous material. This treatment option creates potentially hazardous disinfection by-products.
- UV Light and Ozonation. These treatment systems are highly effective and reliable, and exhibit very few drawbacks.

5.2.2 Stormwater Treatment BMPs

Filtration

- *Vegetated Swales and Strips*. These BMPs are most suitable along roads and at parking lots. They are inexpensive, but vulnerable to sedimentation. They have a low to moderate effectiveness in reducing bacteria.
- *Sand Filters Inlets and Basins* – These BMPs are highly suitable for urbanized settings, especially for retrofitting storm drain facilities. They require pre-treatment to remove bulk trash. They are moderately effective in reducing bacteria.
- *Media Filter* - This BMP is also highly suitable for urbanized settings. It requires pre-treatment to remove bulk trash, and has a moderate effectiveness in reducing bacteria.

Infiltration

- *Infiltration Trenches and Strips*. These BMPs are highly effective in reducing bacteria. The space requirements vary based on the amount of runoff to be treated. They require pre-treatment to remove sediments.
- *Infiltration Basin*. This BMP is highly effective in reducing bacteria, but requires a very large area.
- *Permeable Pavement*. The effectiveness of this BMP in reducing bacteria levels is unknown. It is only suitable in low-traffic areas, and is prone to blockage over time from sediments.

Detention Ponds

- *Wet Ponds and Dry Extended Ponds*. These BMPs have a low to moderate effectiveness in reducing bacteria levels. They require large areas, engineered flow facilities, and year-round or prolonged flows.

Constructed Wetlands

- *Constructed Wetlands*. This BMP is commonly used to reduce bacteria levels, as it can be very effective. However, it requires sufficient water to support wetland plants.

Structural Storm Drain Systems

- *CDS Units*. This BMP is designed to capture bulk trash and coarse sediment. It has little to no effect on reducing bacteria levels.
- *Catch Basin Inserts and Filters*. These BMPs are designed to capture oil and grease, and coarse sediment. They have a low effectiveness in reducing bacteria levels.
- *Manhole Sediment Traps*. This BMP is designed to capture bulk trash and coarse sediment. It has a low effectiveness in reducing bacteria levels.

5.2.3 Diversions To The Sanitary Sewer

Diversion of stormwater and urban runoff to sanitary sewers is becoming a more common treatment option. It is a highly reliable and effective method that involves low capital expenditures because the major piping and the treatment facilities are already constructed. A low flow diversion structure consists of a pre-treatment chamber that collects water from the storm drain system by gravity or pump. The initial chamber collects trash and floatables through the use of bars, screens, or filters. Water is then conveyed to a sump well where it is pumped to the sanitary sewer with a backflow valve. The low-flow diversion can be constructed underground in roadways.

The advantages of diversions are four-fold: (1) simple and effective; (2) highly reliable; (3) low capital costs; and (4) effective with varying flows. The disadvantages are listed below:

a) Requires pre-treatment to remove trash and to prevent entry of hazardous materials
b) Possible disruption of wastewater treatment process due to high pesticides/herbicides, TDS, spilled gasoline or dumped oil, and nutrients
c) Significant implications if wastewater treatment plant is disrupted, including possible shut-down of the entire City sewer system or discharge of untreated sewage to the ocean
d) Possible ecological effects from stream diversions which could disrupt movement of fish, and/or reduce water supporting downstream riparian habitat

5.3 SUITABLE TREATMENT OPTIONS

Based on the evaluation in Section 5.2, the following treatment BMPs and systems are considered viable options to apply to specific projects in the Arroyo Burro and Mission Creek watersheds, as appropriate. The BMPs are listed below in decreasing order of effectiveness.

Highly Effective and Reliable Treatment BMPs and Systems

1. Diversion to Sanitary Sewer
2. Ultraviolet Light and Ozonation (equally effective)
3. Infiltration Trenches and Basins

Moderately Effective Treatment BMPs

4. Constructed Wetlands
5. Sand and Media Filters
6. Wet Ponds or Dry Extended Ponds
7. Vegetated Swales and Strips
8. Permeable Pavement

The following treatment BMPs are not considered to be effective in reducing coliform bacteria in the storm drain or creek systems: CDS units; catch basin inserts and filters; and manhole sediment traps. In addition, disinfection by chlorination was determined to be undesirable due to environmental concerns about disinfection by-products and public safety issues associated with on-site chlorine storage and use.

There is a wide range of capital costs for the various treatment options. Planning level costs are presented in Table 5-1. The capital costs for a diversion to sanitary sewer is limited to infrastructure improvements such as manholes, sump pumps, and gas monitoring systems because the treatment facility is already operating (i.e., El Estero Treatment Plant). Capital costs for stormwater BMP systems, such as infiltration basins and media filter units, are generally less than active treatment facilities because of their mechanical simplicity. The costs of active treatment systems range greatly depending upon the treatment technology, capacity, and infrastructure improvements (e.g., piping, weirs, electrical controls).

Operation and maintenance costs vary greatly amongst the treatment options. Passive BMPs such as infiltration basins and wetlands require minor annual maintenance, but will eventually require periodic system rehabilitation (such as sediment removal) to ensure long-term effectiveness. Diversions to sanitary sewer involve additional treatment costs at El Estero Treatment Plan. The volume of stormwater to be treated would minor compared to the sewer inflows; hence, operational costs would be minor. Operations and maintenance costs associated with pumps at the diversion unit would also be minor.

Operations and maintenance costs for active treatment system would also be minor (e.g, typically less than $5,000 to $10,000 per year), consisting of electricity, routine inspections by personnel, and periodic equipment or material replacement.

TABLE 5-1
PLANNING LEVEL COSTS FOR TREATMENT OPTIONS

Treatment Options	Capital Cost or Cost Range*	Comments
Treatment BMPs (typical facility with 25-100 gpm capacity)		
UV Light, Ozonation	$150,000 – 500,000	Costs will vary greatly depending upon capacity, vendor, pre-treatment requirements, controls, and infrastructure requirements. Higher costs for underground facilities and automated controls.
Filtration (small units at end of storm drain; less than 10,000 sq ft in size)		
Vegetated Swales and Strips	$25,000 for typical unit	Typical unit cost are $10-30 per linear foot for a 10-foot wide swale
Sand filter inlets and basins	$25,000 – 75,000 for typical unit	Lower range for perimeter filter and high range for below-grade filters
Media Filters	$25,000 – 75,000 for typical unit	Lower range for perimeter filter and high range for below-grade filters
Detention Facilities (small off stream units, less than one acre)		
Wet Ponds	$100,000 – 150,000 per acre	Typically at higher end of range of $0.5 to 1.0 per cubic foot of storage
Dry Extended Detention Ponds	$75,000 – 125,000 per acre	Typically less than wet ponds
Constructed Wetlands	$75,000 – 150,000 per acre	Typically at higher end of range of $0.5 to 1.0 per cubic foot of storage
Infiltration Basins (small off stream units, less than 10,000 sq ft in size)		
Infiltration Trenches and Strips	$25,000 – 75,000 for typical unit	
Infiltration Basins	$25,000 – 52,000 for typical unit	
Permeable Pavement	$75,000 per acre	
Diversion to Sanitary Sewer		
Diversion system	$100,000 – 150,000	Includes three manholes with trash screen, pumps, and gas monitoring system.

*Estimated capital cost at a planning level. Does not include design, permitting, land acquisition or new buildings. Costs are based on typical facility sizes using cost data from EPA (1997) and adjusted for inflation. Operations or maintenance costs are not included.

6. RECOMMENDED PLAN

The recommended plan involves two parallel elements: treat stormwater and dry weather flows from both storm drain outlets and from creeks. The analyses of treatment options for storm drain outlets and creeks are presented below in separate sections. The analyses involved the following three steps: (1) identify locations in the watershed with high bacteria loading or concentrations; (2) identify suitable treatment options for each location; and (3) prioritize the various treatment projects.

6.1 TREATMENT OPTIONS AT STORM DRAIN OUTLETS

6.1.1 High Priority Storm Drain Outlets

The key storm drain outlets identified in Section 4 were ranked based on the potential bacteria concentrations in both dry weather flows and first flush flows. Data considered in this ranking process included measured concentrations at the storm drain outlets, land use in the drainage unit, position of the storm drain in the watershed and proximity to the beach, and presence of year-round flows.

The results for Arroyo Burro watershed are presented in Table 6-1. Three storm drain outlets were considered the highest priority for potential bacteria pollution: Hope Avenue Drain outlet to Arroyo Burro near State Street; Las Positas Creek outlet from the Fairground and Golf Course at Modoc Road; and Mesa Creek outlet to the Arroyo Burro estuary near Cliff Drive.

The results for Mission Creek watershed are presented in Table 6-2. There are six storm drain outlets along the lower portions of the creek that exhibit high bacteria concentrations and year-round flow. Three of them occur on Old Mission Creek (Westside Drain, San Pasqual Street, and Fiqueroa Street) and three occur along Lower Mission Creek (Haley Street, Mason Street, Carrillo Street).

6.1.2 Application of Active Treatment Systems at Key Storm Drain Outlets

The suitability of active treatment units at the key storm drain outlets was rated using the following set of criteria in order to provide a basis for a priority ranking of projects at specific storm drain outlets. A “high” rating indicates a favorable condition for each criterion.

- Site Conditions – availability of space for facilities
- Hydraulic Considerations and Ease of Construction – site elevation and access
- Landowner Status – publicly owned land is a favorable condition
- Property and Land Use Conditions – potential conflicts with adjacent land uses
- Environmental Considerations – impact on environmental resources at the site

TABLE 6-1
RANKING OF KEY STORM DRAIN OUTLETS BASED ON POTENTIAL OR KNOWN BACTERIAL LOADING (ARROYO BURRO)

Outlet (see Figure 5a,b)	Location of Outlet	Severity of Potential Bacteria Loading	Comments
High Priority Storm Drain Outlets			
B05-03 (Hope Drain)	Arroyo Burro at Hope Ave Bridge	High	High concentrations observed, perennial flows
C07-19	Las Positas Ck at Modoc Rd	High	High concentrations observed; perennial flow; known source
C11-37 (Mesa Ck)	Mesa Ck at Arroyo Burro near Cliff	High	Moderate observed concentrations; perennial flows residential area
Moderate Priority Storm Drain Outlets			
C07-17	Modoc Drainage at Las Positas Creek	Moderate	Large sized residential area
C11-44	Vista del Mar Drainage at Arroyo Burro	Moderate	Moderate sized residential area; low in watershed
C05-10	San Roque at State	Moderate	Large sized residential area, first flush site
B07-22	Arroyo Burro at Calle de los Amigos Bridge	Moderate	Moderate sized residential area; prolonged flows
B08-18	Arroyo Burro at Palermo (e side of creek)	Moderate	Moderate sized residential area; first flush opportunity
B05-05	San Roque at Hitchcock	Moderate	Moderate sized residential area; prolonged flows
B08-23	Arroyo Burro at Torino (w side of creek)	Moderate	Moderate sized residential area; prolonged flows
B06-12	Arroyo Burro at Graham Motors	Moderate	Small residential/commercial; perennial flow; concrete channel
B06-X	Arroyo Burro at Calle Real	Moderate	Small residential/commercial; perennial flow; concrete channel
B07-16	Arroyo Burro at Mariana Way	Moderate	Small residential area; prolonged flows
Low Priority Storm Drain Outlets			
C08-23	Veronica Sprs Drainage at Las Positas Pl	Low	Small residential area; perennial flow; high concentrations in LPC
C12-08/B12-01	Arroyo Burro Beach Park	Low	Small residential area; perennial flow; high concentrations in LPC
C10-X	Elings Drainage at Arroyo Burro	Low	Park with dogs; low runoff
C08-10 Caltrans	Las Positas Creek along Las Positas Rd	Low	Small residential area; perennial flows; high concentrations in Las Positas Creek (LPC)
C04-10	San Roque near Ontare	Low	Small residential areas
C04-15	San Roque near Ontare	Low	Small residential area
C09-09 Caltrans	Portesuello Drainage at Arroyo Burro	Low	Moderate sized residential area; perennial flow; probably spring water with low concentrations

TABLE 6-2
RANKING OF KEY STORM DRAIN OUTLETS BASED ON POTENTIAL OR KNOWN BACTERIAL LOADING (MISSION CREEK)

Outlet (see Figure 6a,b)	Location of Outlet	Severity of Potential Bacteria Loading	Comments
High Priority Storm Drain Outlets			
E09-01	West Side Drain outlet	High	Large residential area
G10-22	Haley St outlet	High	Small residential area; high concentrations in creek
H10-08	Mason St outlet	High	Moderate sized residential/commercial; high concentrations in creek
F09-28	Carrillo St outlet	High	Large residential/commercial area; high concentrations in creek
E09-02	San Pasqual outlet	High	Moderate sized residential area
F10-01	Figueroa St outlet	High	Moderate sized residential area
Moderate Priority Storm Drain Outlets			
F09-14	Victoria St outlet	Moderate	Large residential/commercial area; above live stream
F09-04	Sola St outlet	Moderate	Moderate sized residential area; above live stream
E08-07	Islay St outlet	Moderate	Large residential area; above live stream
Low Priority Storm Drain Outlets			
D06-11	Downstream of de la Vina at Calle Laureles	Low	Large residential area; upper watershed
D07-21	Junipero St bridge	Low	Moderate sized residential; upper watershed
D05-05	Mission Creek at State St bridge	Low	Small residential area; upper watershed
E05-04	Mission Creek upstream of State St	Low	Small residential area; upper watershed

The potential suitability of active treatment systems (UV light or ozonation) to the key storm drain outlets is shown in Table 6-3 for Arroyo Burro and Table 6-4 for Mission Creek. The highest ranked storm drain outlets for active treatment units in the Arroyo Burro watershed include outlets on Arroyo Burro at Hope Avenue (B05-03, Hope Drain); Arroyo Burro at Torino (B08-23), Arroyo Burro at Graham Motors (B06-12), Arroyo Burro at Calle Real (B06-X) and Mesa Creek near Cliff Drive (C11-37). The locations of these outlets are shown on Figures 5a and 5b.

All of the key storm drain outlets in the Mission Creek watershed with high to moderate levels of bacteria concentrations are highly suitable for active treatment units as shown in Table 6-4. Two outlets show a slightly higher ranking than others due to greater availability of space for a unit, the presence of City-owned land, and their occurrence on Old Mission Creek, which has generally elevated bacteria levels: the Westside Drain in Bohnett Park and the Fiqueroa Street outlet to Old Mission Creek. The locations of these outlets are shown on Figures 6a and 6b.

6.1.3 Applicability of Treatment BMPs at Key Storm Drain Outlets

The suitability of passive BMP systems at the key storm drain outlets was rated using the above described set of criteria in order to provide a basis for a priority ranking of projects at specific storm drain outlets.

The potential suitability of passive BMP units to the key storm drain outlets is shown in Table 6-5 for Arroyo Burro and Table 6-6 for Mission Creek. The highest ranked storm drain outlets for passive BMP units in the Arroyo Burro watershed are located on Mesa Creek near Cliff Drive (C11-37) and on Elings Park Drainage near Las Positas Drive (C10-X). The locations of these sites are shown on Figure 7.

The highest ranked storm drain outlets for passive BMP units in the Mission Creek watershed are located at the Westside Drain in Bohnett Park and the Fiqueroa Street outlet to Old Mission Creek (Figure 8). Both locations appear to have sufficient space and City owned land for a BMP unit.

6.1.4 Diversion to Sanitary Sewer

Most of the key storm drain outlets in both watersheds are located in proximity to a sewer line, which would provide an opportunity to divert dry weather flows to the wastewater treatment plant. Sewer lines are located 10 to 100 feet from the storm drain outlets. The sewer lines are located at lower elevations than the storm drain outlets. Hence, diversions to the sewer line from the storm drain would likely require a sump and pump. One key storm drain outlet is not considered suitable for diversion to sanitary sewer: drainage outlet from Bel Air Knolls, which conveys year-round spring water to Arroyo Burro (C09-09). A diversion is not considered appropriate because of the high flows and good water quality typically associated with springs. One of the Mission Creek storm drain outlets would not be suitable for diversion because of the difficulty associated with connecting to the nearest sewer line (E09-02).

TABLE 6-3
RATING STORM DRAIN OUTLETS FOR ACTIVE TREATMENT SYSTEMS (ARROYO BURRO)

Key Storm Drain Outlet (see Figure 5a,b)	Location of Outlet	Suitability Rating for Key Criteria (H=high, M=medium, L=low)*						Rank Order for Prioritizing Active Treatment System Projects (1=highest priority)
		Site Conditions	Hydraulic Conditions and Ease of Construction	Land-owner Status	Property and Land Use Conditions	Environ-mental Conditions	Composite Rating**	
High Priority Storm Drain Outlets								
B05-03 (Hope Drain)	Arroyo Burro at Hope Ave Bridge	H	M	L	H	H	2.4	1
C07-19	Las Positas Ck at Modoc	H	L	L	H	L	1.8	3
C11-37	Mesa Ck at Arroyo Burro near Cliff	H	M	H	H	M	2.6	1
Moderate Priority Storm Drain Outlets								
C07-17	Modoc Drainage at Las Positas Creek	H	L	L	M	M	1.8	3
C11-44	Vista del Mar Drainage at Arroyo Burro	L	M	L	M	M	1.6	4
C05-10	San Roque at State	M	M	M	M	M	2.0	2
B07-22	Arroyo Burro at Calle de los Amigos Bridge	M	H	M	M	L	2.0	2
B08-18	Arroyo Burro at Palermo	M	M	L	M	H	2.0	2
B05-05	San Roque at Hitchcock	M	M	L	L	L	1.4	4
B08-23	Arroyo Burro at Torino	M	H	H	H	M	2.6	1
B06-12	Arroyo Burro at Graham Motors	H	M	L	H	H	2.4	1
B06-X	Arroyo Burro at Calle Real	H	M	M	H	H	2.6	1
B07-16	Arroyo Burro at Mariana Way	L	L	M	M	M	1.6	4

Key Storm Drain Outlet (see Figure 5a,b)	Location of Outlet	Suitability Rating for Key Criteria (H=high, M=medium, L=low)*						Rank Order for Prioritizing Active Treatment System Projects (1=highest priority)
		Site Conditions	Hydraulic Conditions and Ease of Construction	Land-owner Status	Property and Land Use Conditions	Environ-mental Conditions	Composite Rating**	
Low Priority Storm Drain Outlets								
C08-23	Veronica Sprs Drainage at Las Positas Pl	No active treatment systems are recommended for these outlets because the relatively high cost of disinfection treatment units would not be cost-effective for these outlets						
C12-08/B12-01	Arroyo Burro Park							
C10-X	Elings Drainage at Arroyo Burro							
C08-10 Caltrans	Las Positas Creek along Las Positas Rd							
C04-10	San Roque near Ontare							
C04-15	San Roque near Ontare							
C09-09 Caltrans	Portesuello Drainage at Arroyo Burro							

* See text for explanation of basis of ratings for each key criterion. ** Ratings were converted to numeric scores for determining the rank order.

TABLE 6-4
RATING STORM DRAIN OUTLETS FOR ACTIVE TREATMENT SYSTEMS (MISSION CREEK)

Key Storm Drain Outlet (see Figure 6a,b)	Location of Outlet	Suitability Rating for Key Criteria (H=high, M=medium, L=low)*						Rank Order for Prioritizing Active Treatment System Projects (1=highest priority)
		Site Conditions	Hydraulic Conditions and Ease of Construction	Land-owner Status	Property and Land Use Conditions	Environ-mental Conditions	Composite Rating**	
High Priority Storm Drain Outlets								
E09-01	West Side Drain outlet	M	M	H	M	H	2.4	1
G10-22	Haley St outlet	L	M	M	H	H	2.2	2
H10-08	Mason St outlet	L	M	M	H	H	2.2	2
F09-28	Carrillo St outlet	L	M	M	H	H	2.2	2
E09-02	San Pasqual outlet	L	M	M	H	H	2.2	2
F10-01	Figueroa St outlet	H	M	H	M	M	2.4	1
Moderate Priority Storm Drain Outlets								
F09-14	Victoria St outlet	L	M	M	H	H	2.2	2
F09-04	Sola St outlet	L	M	M	H	H	2.2	2
E08-07	Islay St outlet	L	M	M	H	H	2.2	2
Low Priority Storm Drain Outlets								
D06-11	Downstream of de la Vina at Calle Laureles	No active treatment systems are recommended for these outlets because the relatively high cost of disinfection treatment units would not be cost-effective for these outlets						
D07-21	Junipero St bridge							
D05-05	Mission Creek at State St bridge							
E05-04	Mission Creek upstream of State St							

* See text for explanation of basis of ratings for each key criterion. ** Ratings were converted to numeric scores for determining the rank order.

TABLE 6-5
RATING STORM DRAIN OUTLETS FOR BEST MANAGEMENT PRACTICE SYSTEMS (ARROYO BURRO)

Key Storm Drain Outlets (see Figure 5a,b)	Location of Outlet	Suitability Rating for Key Criteria (H=high, M=medium, L=low)*						Rank Order for Prioritizing Active Treatment System Projects (1=highest priority)
		Site Conditions	Hydraulic Conditions and Ease of Construction	Land-owner Status	Property and Land Use Conditions	Environ-mental Conditions	Composite Rating**	
High Priority Storm Drain Outlets								
B05-03 (Hope Drain)	Arroyo Burro at Hope Ave Bridge	H	L	L	H	H	2.2	2
C07-19	Las Positas Ck at Modoc	H	L	L	H	L	1.8	3
C11-37	Mesa Ck at Arroyo Burro near Cliff	H	H	H	H	M	2.8	1
Moderate Priority Storm Drain Outlets								
C07-17	Modoc Drainage at Las Positas Creek	H	L	L	M	M	1.8	3
C11-44	Vista del Mar Drainage at Arroyo Burro	M	M	L	M	M	1.8	3
C05-10	San Roque at State							
B07-22	Arroyo Burro at Calle de los Amigos Bridge	H	M	M	M	L	2.0	2
B08-18	Arroyo Burro at Palermo (e of creek)	L	L	L	M	H	1.6	3
B05-05	San Roque at Hitchcock	L	L	L	L	L	1.0	4
B08-23	Arroyo Burro at Torino (w of creek)	L	L	H	H	M	2.0	2
B06-12	Arroyo Burro at Graham Motors	M	L	L	H	H	2.0	2
B06-X	Arroyo Burro at Calle Real	L	L	M	H	H	2.0	2
B07-16	Arroyo Burro at Mariana Way	L	L	M	M	M	1.6	3
Low Priority Storm Drain Outlets								
C08-23	Veronica Sprs Drainage at Las Positas Place	L	L	M	M	H	1.8	3

Key Storm Drain Outlets (see Figure 5a,b)	Location of Outlet	Suitability Rating for Key Criteria (H=high, M=medium, L=low)*						Rank Order for Prioritizing Active Treatment System Projects (1=highest priority)
		Site Conditions	Hydraulic Conditions and Ease of Construction	Land-owner Status	Property and Land Use Conditions	Environ-mental Conditions	Composite Rating**	
C12-08/B12-01	Arroyo Burro Park	L	M	H	L	M	1.8	3
C10-X	Elings Drainage at Arroyo Burro	H	M	M	H	H	2.6	1
C08-10 Caltrans	Las Positas Creek along Las Positas Rd	L	L	M	M	H	1.8	3
C04-10	San Roque near Ontare	L	L	L	M	L	1.2	4
C04-15	San Roque near Ontare	L	L	L	M	L	1.2	4
C09-09 Caltrans	Portesuello Drainage at Arroyo Burro	H	L	L	H	L	1.8	3

* See text for explanation of basis of ratings for each key criterion. ** Ratings were converted to numeric scores for determining the rank order.

TABLE 6-6
RATING STORM DRAIN OUTLETS FOR PASSIVE, BEST MANAGEMENT PRACTICE SYSTEMS (MISSION CREEK)

Key Storm Drain Outlet (see Figure 6a,b)	Location of Outlet	Suitability Rating for Key Criteria (H=high, M=medium, L=low)*						Rank Order for Prioritizing Active Treatment System Projects (1=highest priority)
		Site Conditions	Hydraulic Conditions and Ease of Construction	Land-owner Status	Property and Land Use Conditions	Environ-mental Conditions	Composite Rating**	
High Priority Storm Drain Outlets								
E09-01	West Side Drain outlet	M	L	H	M	H	2.2	1
G10-22	Haley St outlet	L	L	M	H	H	2.0	2
H10-08	Mason St outlet	L	L	M	H	H	2.0	2
F09-28	Carrillo St outlet	L	L	M	H	H	2.0	2
E09-02	San Pasqual outlet	L	L	L	L	M	1.2	4
F10-01	Figueroa St outlet	H	H	M	M	M	2.4	1
Moderate Priority Storm Drain Outlets								
F09-14	Victoria St outlet	L	L	M	H	H	2.0	2
F09-04	Sola St outlet	L	L	M	H	H	2.0	2
E08-07	Islay St outlet	L	L	M	H	H	2.0	2
Low Priority Storm Drain Outlets								
D06-11	Downstream of de la Vina at Calle Laureles	L	L	M	M	H	1.8	3
D07-21	Junipero St bridge	L	L	M	M	H	1.8	3
D05-05	Mission Creek at State St bridge	H	H	L	M	L	2.0	2
E05-04	Mission Creek upstream of State St	L	L	L	L	L	1.0	4

* See text for explanation of basis of ratings for each key criterion. ** Ratings were converted to numeric scores for determining the rank order.

6.1.5 Summary of Suitable Treatment Options for Key Storm Drain Outlets

The suitability of various treatment options at the key storm drain outlets is summarized in Tables 6-7 and Table 6-8 for the Arroyo Burro and Mission Creek watersheds, respectively. In addition, initial recommendations on the most suitable treatment options for each storm drain are presented in the tables. For most storm drain outlets, there are two treatment options that would be suitable. The final selection of the most appropriate treatment option will be based on site-specific considerations of flow, hydraulic constraints, available above-ground and below-ground space for a facility, land ownership, and costs.

6.2 EVALUATION OF POTENTIAL WETLAND, INFILTRATION, & POND BMP SITES

In addition to treatment of discharges from storm drains, the City is interested in opportunities to treat water in the creek that contains high levels of bacteria. There are many challenges with treatment of creek water that make it less attractive than treatment of runoff from the storm drain system, such as:

- Difficult to reliably capture water from creeks due to the seasonal and yearly variability in flows, substrate, and location and depth of low flow channels.
- Diversion structures are prone to damage from flooding
- Stormwater volume in creeks is typically much greater than in most storm drains, and as such, requires a comparatively larger facility to provide effective treatment.
- Creek water often has high organic matter and suspended solids, requiring pretreatment (i.e., filtration) prior to treatment by disinfection or diversion to the sewer system.

Treating water from creeks requires removal of the water from the creek, either on a short term basis for treatment and return to the creek (e.g., off-line wetland or disinfection unit), or on a permanent basis (e.g., diversion to sanitary sewer). Removal of water can disrupt aquatic habitats and organisms in the creek channel. Permanent removal can degrade downstream aquatic and riparian habitats reliant on flows in the creek. The magnitude of the impact would depend upon the size of the diversion structure, timing of diversions, and amount of diversion.

The most suitable treatment options for creek water are constructed wetlands, infiltration basins, and stormwater ponds. These facilities are typically located off-stream, requiring pumping from the creek to a facility at a slightly higher elevation. Diverting creek water to the sanitary sewer is not considered a viable treatment option at this time due to the potential environmental impacts associated with such the diversion, and because of the dissolved solids and organic matter in creek water that could interfere with the sanitary sewer treatment plant operations.

TABLE 6-7
SUMMARY OF TREATMENT OPTIONS FOR KEY STORM DRAIN OUTLETS (ARROYO BURRO)

No.	Key Storm Drain Outlets (see Figure 5a,b)	Location of Outlet	Severity of Potential Bacteria Loading	Diversion to Sanitary Sewer Feasible?	Ranking for Active Trmt	Ranking for BMPs	Recommendation
High Priority Storm Drain Outlets							
1	B05-03 (Hope Drain)	Arroyo Burro at Hope Ave Bridge	H	Y	1	2	Diversion or Active Trmt
2	C07-19	Las Positas Ck at Modoc Rd	H	Y	3	3	Diversion
3	C11-37 (Mesa Ck)	Mesa Ck at Arroyo Burro near Cliff	H	Y	1	1	Active Trmt or BMP
Moderate Priority Storm Drain Outlets							
4	C07-17	Modoc Drainage at Las Positas Creek	M	Y	3	3	BMP
5	C11-44	Vista del Mar Drainage at Arroyo Burro	M	Y	4	3	BMP or Diversion
6	C05-10	San Roque at State	M	Y	2	NA	Diversion
7	B07-22	Arroyo Burro at Calle de los Amigos Bridge	M	Y	2	2	BMP
8	B08-18	Arroyo Burro at Palermo (e side of creek)	M	Y	2	3	Diversion
9	B05-05	San Roque at Hitchcock	M	Y	4	4	Diversion
10	B08-23	Arroyo Burro at Torino (w side of creek)	M	Y	1	2	Diversion or Active Trmt
11	B06-12	Arroyo Burro at Graham Motors	M	Y	1	2	Diversion or Active Trmt
12	B06-X	Arroyo Burro at Calle Real	M	Y	1	2	Diversion or Active Trmt
13	B07-16	Arroyo Burro at Mariana Way	M	Y	4	3	Diversion
Low Priority Storm Drain Outlets							
14	C08-23	Veronica Sprs Drainage at Las Positas Pl	L	N	NA	3	BMP
15	C12-08/B12-01	Arroyo Burro County Park	L	Y	NA	3	BMP
16	C10-X	Elings Drainage at Arroyo Burro	L	Y	NA	1	BMP
17	C08-10 Caltrans	Las Positas Creek along Las Positas Rd	L	Y	NA	3	BMP
18	C04-10	San Roque near Ontare	L	Y	NA	4	BMP
19	C04-15	San Roque near Ontare	L	Y	NA	4	BMP
20	C09-09 Caltrans	Portesuello Drainage at Arroyo Burro	L	Y	NA	3	BMP

TABLE 6-8
SUMMARY OF TREATMENT OPTIONS FOR KEY STORM DRAIN OUTLETS (MISSION CREEK)

No.	Key Storm Drain Outlets (see Figure 6a,b)	Location of Outlet	Severity of Potential Bacteria Loading	Diversion to Sanitary Sewer Feasible?	Ranking for Active Trmt	Ranking for BMPs	Recommendation
High Priority Storm Drain Outlets							
1	E09-01	West Side Drain outlet	H	Y	1	1	Diversion or Active Trmt
2	G10-22	Haley St outlet	H	Y	2	2	Diversion or Active Trmt
3	H10-08	Mason St outlet	H	Y	2	2	Diversion or Active Trmt
4	F09-28	Carrillo St outlet	H	Y	2	2	Diversion or Active Trmt
5	E09-02	San Pasqual outlet	H	N	2	4	Active Trmt
6	F10-01	Figueroa St outlet	H	Y	1	1	Diversion or Active Trmt
Moderate Priority Storm Drain Outlets							
7	F09-14	Victoria St outlet	M	Y	2	2	Diversion or Active Trmt
8	F09-04	Sola St outlet	M	Y	2	2	Diversion or Active Trmt
9	E08-07	Islay St outlet	M	Y	2	2	Diversion or Active Trmt
Low Priority Storm Drain Outlets							
10	D06-11	Downstream of de la Vina at Calle Laureles	L	Y	NA	3	Diversion or BMP
11	D07-21	Junipero St bridge	L	Y	NA	3	BMP
12	D05-05	Mission Creek at State St bridge	L	Y	NA	2	BMP
13	E05-04	Mission Creek upstream of State St	L	Y	NA	4	BMP

The use of off-line satellite disinfection units (involving return treated water to the creek) is also not considered a treatment option at this time because of the operational problems noted above, and because treatment of runoff in man-made drains is a more appropriate focus during the initial stages of the program. If treatment of runoff from the storm drain system does not yield satisfactory results after many years, the City will reconsider the option of treating and returning creek water, and in some instances, the diversion to the sanitary sewer.

Potential sites for stormwater treatment BMPs facilities (wetlands, infiltration, and ponds) were identified along Arroyo Burro and Mission Creek in areas where there is open space to allow such facilities (at least one acre or more), particularly on public lands. The candidate sites are shown on Figure 7 for Arroyo Burro watershed and on Figure 8 for Mission Creek watershed. The characteristics of each site and the potential stormwater treatment BMPs that would be suitable are summarized in Tables 6-9 and 6-10 for Arroyo Burro and Mission Creek watersheds, respectively.

The most promising projects in the Arroyo Burro watershed are at the Amigos site (open meadow), Las Positas Creek concrete channel, Mesa Creek (open space along road), and Modoc Road site (undeveloped low-lying open space). The other sites for in the Arroyo Burro watershed contain severe constraints, and/or appear to provide only modest opportunities.

There are very few opportunities for locating infiltration basins, constructed wetlands, and stormwater ponds along Mission Creek due to the high density of development along the creek banks. The most promising project is at the terminus of Old Mission Creek before it enters a culvert under Highway 101. This short reach is located on both City and private parcels and would be an ideal location for an infiltration basin or constructed wetland. This site is called the Figueroa Street site because it is partially near this street and an unused easement for the street.

One project appears promising for long-term consideration – removing concrete bottom along Mission Creek adjacent to Highway 101 in order to increase infiltration. This project can be limited to the reach below the confluence with Old Mission Creek if the objective is to only address dry weather flows because upstream flows are absent in the summer. The feasibility of a project along the concrete lined reach of the creek is still uncertain, as any modification would need to maintain flood conveyance capacity. If the concrete bottom is removed to allow infiltration and wetland growth, it is likely that a rectangular channel with vertical walls would be required. All other opportunities in the Mission Creek watershed were determined to be infeasible.

TABLE 6-9
SUMMARY OF CANDIDATE SITES FOR CREEK INFILTRATION, WETLAND, AND POND BMPS (ARROYO BURRO)

Site (see Figure 7)	Location	Site Conditions	Primary Treatment Objectives	Potentially Suitable Treatment BMPs	Landowner	Environmental Constraints, Engineering Obstacles, Land Use Conflicts
Willowglen Park	Upper Arroyo Burro	Playing fields and playground adjacent to deeply incised creek	First flush stormwater	Infiltration Basin	City	Site is too high above creek. Infeasible to displace active park for BMPs.
Stevens Park	Upper San Roque near Foothill Rd	Playing fields, picnic areas and playground	First flows stormwater	Infiltration trenches and basins; Constructed wetlands; Wet pond or dry extended pond	City	Large oak and sycamore trees. Infeasible to displace active park for BMPs.
Foxen	San Roque near San Remo Dr	Narrow creek channel with dense riparian vegetation and adjacent landscaping	First flush stormwater and seasonal urban runoff	Infiltration trenches and basins; Constructed wetlands	Private	Too small and narrow. Too close to backyards. Dense cover reduces effectiveness of wetland. Prone to flood damage.
Hitchcock Ranch	San Roque near Hitchcock Rd	Narrow creek channel with dense riparian vegetation	First flush stormwater and seasonal urban runoff	Infiltration trenches and basins; Constructed wetlands	Private	Large sycamore trees. Small and narrow channel. Dense cover reduces effectiveness of wetland. Prone to flood damage.
Hope	Arroyo Burro at Hope Ave	Open dirt lot used for parking by auto dealers.	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	Private	Will require pumping and possible substantial grading. Potential for regional facility. High value commercial lot.
Amigos	Arroyo Burro along Calle de los Amigos	Open meadow next to creek	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	Private	Need to avoid large sycamore and oak trees on the perimeter
Hidden Valley Park	Upper end of Hidden Valley	Small terrace on west side of creek with dense riparian trees	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands	City	Large sycamore and will trees. Small and narrow area. Dense cover reduces effectiveness of wetland. Prone to flooding.
Hillside House	Arroyo Burro at LPC	Terrace and stream channel with dense riparian vegetation	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	Private	Large sycamore and will trees. Dense cover reduces effectiveness of wetland. Prone to flooding and landslides.

Site (see Figure 7)	Location	Site Conditions	Primary Treatment Objectives	Potentially Suitable Treatment BMPs	Landowner	Environmental Constraints, Engineering Obstacles, Land Use Conflicts
Elings Park	Unnamed drainage at park	Open unvegetated drainage at bottom of park with flood control energy dissipator	First flush stormwater	Infiltration trenches and basins; Dry extended ponds.	Semi-private	Insufficient flows for constructed wetlands. Possible conflicts with dissipator or park uses.
Palms	Arroyo Burro near Cliff Dr	Western bank of creek with dense riparian vegetation	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	City	Dense riparian cover would need to be removed. Dense cover reduces effectiveness of wetland. Prone to flooding and back erosion. Will require substantial grading.
Vista del Mar	Unnamed drainage at Alan Rd	Upland vegetation in small side canyon with steep walls	First flush stormwater	Infiltration trenches and basins; Dry extended ponds.	Private	Potential conflicts with adjacent residences
Mesa Creek	Mesa Creek along Cliff Dr	Dense oak and riparian vegetation along steep drainage that ends in 300-ft long culvert	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	Private and City	Very steep and narrow drainage with dense oak woodland. City planning to “daylight” culvert at end of creek and create new wetland (independent project)
Veronica Springs	Unnamed drainage at Las Positas Place	Dense oak and riparian vegetation along steep drainage that ends in culvert	First flush stormwater and seasonal urban runoff	Infiltration trenches and basins; Constructed wetlands; Dry extended ponds.	Private	Dense oaks. Potential conflicts with adjacent residences.
Modoc Drainage	Drainage from under Hwy 101 and UPRR that is conveyed under Modoc Rd	Weedy man-made drainage along Hwy 101 and UPRR with scattered eucalyptus. Cobbly drainage south of Modoc Rd with dense oaks	First flush stormwater	Infiltration trenches and basins; Dry extended ponds. Located in open space between Hwy 101 and UPRR	Caltrans, UPRR, private	Small area between Hwy 101 and UPRR
Modoc Road	Depression between Hwy 101 and Modoc	Low-lying area with dense oaks and eucalyptus trees	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	Private	Low elevations possibly preclude infiltration. Need to remove trees for wetland and pond.
Las Positas Creek	Concrete reach along Las Positas Rd	Concrete banks, barren channel bottom, and gravel road	First flush stormwater and year-round urban runoff	Constructed wetland and infiltration basin in channel by widening and removing concrete	Private with FCD easement	Need to maintain conveyance capacity. Requires retaining walls along road.

TABLE 6-10
SUMMARY OF CANDIDATE SITES FOR CREEK INFILTRATION, WETLAND, AND POND BMPS (MISSION CREEK)

Site (see Figure 8)	Location	Site Conditions	Primary Treatment Objectives	Potentially Suitable Treatment BMPs	Landowner	Environmental Constraints, Engineering Obstacles, Land Use Conflicts
Miradero	Mission Creek upstream of State St	Oak woodland associated with large residential lot	First flush stormwater	Infiltration trenches and basins; Wet pond or dry extended pond	Private	Site is too high above creek. High value property. Likely infeasible to displace residence.
Alamar	Mission Creek at State St Foothill Rd	Small open space with oak woodland adjacent to creek and American Red Cross	First flows stormwater	Infiltration trenches and basins; Constructed wetlands; Wet pond or dry extended pond	Private	Need to avoid large oak trees. Dense cover reduces effectiveness of wetland. Too small to be effective.
Oak Park	Mission Creek near Highway 101	Active park with dense oak woodland – playing fields, picnic area, tennis courts, parking lot	First flush stormwater and seasonal urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet pond or dry extended pond	City	Need to avoid oak trees Dense cover reduces effectiveness of wetland. Prone to flood damage. Infeasible to displace active park for BMPs.
Mission Creek Concrete channel reaches	Mission Creek along Highway 101	Narrow concrete channel with little open space on edges	First flush stormwater and seasonal to year-round urban runoff	Infiltration and constructed wetlands by removing concrete lining, but retaining some type of bank protection	City and Caltrans	Need to maintain conveyance capacity. Will require retaining walls.
Figuero a Street	Old Mission Creek upstream of UPRR and Hwy 101	Dense eucalyptus grove along stream corridor	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet pond or dry extended pond	City and Private	Dense trees limit use of constructed wetlands. Low elevation requires pumping. Possible landowner resistance.

6.3 RECOMMENDED PROJECTS AND PROGRAM IMPLEMENTATION

The program will be implemented in two phases. Under Phase I, several high priority projects will be designed and constructed that appear to be easily implemented and highly effective in addressing the program objectives. Phase II will involve projects that are selected and constructed based on additional feasibility investigations and the performance of projects under Phase I.

The treatment projects that are recommended for consideration in Phase I are presented in Tables 6-11 and 6-12 for Arroyo Burro and Mission Creek watersheds, respectively. Their locations are shown on Figures 9 and 10.

The treatment projects for consideration at storm drain outlets also includes a recommendation for an active treatment system (e.g., ozonation or UV light) at the Laguna Channel Pump Station to treat stormwater and urban runoff prior to the water being discharged to East Beach. Laguna Channel is a man-made channel that drains a significant portion of the downtown and waterfront areas. The channel contains year-round flows with high bacteria levels. The channel invert is located below sea level, and as such, a tide gate and pump station are present at the end of the channel. Under non-storm conditions, water flows into to a concrete chamber at the terminus of the channel where two 100-cfs pumps are located. When the pumps cannot keep up with inflows, the water level in the channel rises to flood stage. At that point, water is released either by opening the tide gates, or by allowing water to pass over an overflow weir. Water from the pump station forms a lagoon on the beach.

The City is currently evaluating options to add a disinfection system to the pump station for treating and releasing low flows to the beach in order to reduce the bacteria loading to East Beach from Laguna Channel. While this channel is located outside of the Mission Creek watershed, it discharges to the same beach and contributes to the high bacteria levels measured in the surf zone.

The proposed disinfection at the Laguna Channel pump station is considered a high priority project that has equal importance to the top ranked projects presented in this report. It will likely have a more direct effect on bacteria levels on the beach than many projects described in this report.

TABLE 6-11
HIGH PRIORITY STORM DRAIN PROJECTS TO BE CONSIDERED IN PHASE I

Storm Drain Outlet (see Figure 9)	Location	Recommended Treatment	Planning Level Capital Cost Range*
Arroyo Burro Watershed			
B05-03 (Hope Drain)	Arroyo Burro at Hope Ave Bridge	Diversion	$150,000 – 250,000
C07-19	Las Positas Ck at Modoc	Diversion	$150,000 – 250,000
C11-37 (Mesa Ck)	Mesa Ck at Arroyo Burro near Cliff	Active Treatment	$350,000 – 700,000
Mission Creek Watershed			
Laguna Channel Pump Station	Pump station that discharges dry weather flows from Laguna Channel to East Beach	Active Treatment	$150,000 – 300,000
E09-01	West Side Drain outlet	Diversion or Active Treatment	$150,000 – 700,000
G10-22	Haley St outlet	Diversion or Active Treatment	$150,000 – 700,000
H10-08	Mason St outlet	Diversion or Active Treatment	$150,000 – 700,000
F09-28	Carrillo St outlet	Diversion or Active Treatment	$150,000 – 500,000
E09-02	San Pasqual outlet	Active Treatment	$250,000 – 500,000
F10-01	Figueroa St outlet	Diversion or Active Treatment	$150,000 – 500,000

Estimated costs include preliminary and final design, permitting, capital costs, and construction management. They do not include any necessary land acquisition or new buildings. Operations or maintenance costs are not included.

The wetland and infiltration basin projects listed in Table 6-12 include constructed wetlands on the City municipal golf course at the head of Las Positas Creek. Drainage from the golf course passes through the Earl Warren Fairgrounds, then under Highway 101 to Las Positas Creek. The City is currently designing wetlands and detention basins on the golf course to reduce bacteria loading to this creek which exhibits high bacteria levels.

TABLE 6-12
HIGH PRIORITY WETLAND AND BASIN PROJECTS TO BE CONSIDERED IN PHASE I

Site (see Figure 10)	Location	Treatment Focus	BMP Treatment Options	Planning Level Cost Range
Arroyo Burro Watershed				
Mesa Creek	Mesa Creek along Cliff Dr	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	$250,000 – 500,000
Las Positas Creek	Concrete reach along Las Positas Rd	First flush stormwater and year-round urban runoff	Constructed wetland and infiltration basin in channel by widening and removing some or all of the concrete	$700,000 – 900,000
Municipal Golf Course	City's Municipal Golf Course	First flush stormwater	Constructed wetland and infiltration basin	$200,000 – 350,000
Arroyo Burro	Storm drain outlet at Calle de los Amigos	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet ponds and dry extended ponds.	$300,000 – 500,000
Modoc Drainage	Drainage from under Hwy 101 and UPRR that is conveyed under Modoc Rd	First flush stormwater	Infiltration trenches and basins; Dry extended ponds. Located in open space between Hwy 101 and UPRR	$300,000 – 500,000
Mission Creek Watershed				
Mission Creek concrete channel reaches	Mission Creek along Highway 101	First flush stormwater and seasonal to year-round urban runoff	Infiltration and constructed wetlands by removing concrete lining but retaining some type of bank protection	Unknown at this time, possibly $1M or more
Figueroa Street	Old Mission Creek upstream of UPRR and Hwy 101	First flush stormwater and year-round urban runoff	Infiltration trenches and basins; Constructed wetlands; Wet pond or dry extended pond	$300,000 – 500,000

Estimated costs include preliminary and final design, permitting, capital costs, and construction management. They do not include any necessary land acquisition or new buildings. Operations or maintenance costs are not included.

Phase I will include additional investigations into the feasibility of the recommended high-priority projects, addressing the typical "fatal flaw" issues such as landowner access or cooperation, utility or easement conflicts, flow and hydraulics conditions (based on more detailed analysis and data gathering than under this study), capital costs, and long-term funding for maintenance. Based on these investigations, the City will make a final determination of feasibility on the initial high-priority projects.

Preliminary designs will be prepared for all feasible projects with funding support. The design information will be used to conduct a CEQA environmental analysis, which may or may not require preparation of an environmental document. Following approval of individual projects by the City Planning Commission, Parks and Recreation Commission, and City Council (as necessary), final design will be completed, property or easements will be acquired (if necessary), permitting sought from applicable state and federal agencies, and funding secured. Phase I will end with the construction of these high priority projects.

It should be recognized that the projects under Phase I are considered "pilot projects." As such, they will closely monitored to determine effectiveness and maintenance requirements. A water quality monitoring program will be established for each project to provide data on the level of bacteria reduction achieved by each project. For active treatment units and BMPs, the monitoring would consist of grab samples above and below the treatment site. For diversions to sanitary sewer, the City may monitor flow of stormwater and urban runoff from diversions by using dyes and other tracers. This information will be useful in determining the contribution to the treatment plant from diversions, and the dilution achieved during different flow conditions.

The City will complete the design and construction of a second suite of projects under Phase II. This set of projects will be selected and designed based in part on new information gathered under Phase I about the performance of recently installed BMPs and treatment systems; information about new technologies in the industry; and more detailed information about bacteria levels in the watersheds.

While the design and construction of the Phase I projects proceed in the winter 2003, the City will continue to collect water quality data to confirm the targeted storm drain outlets and creek reaches identified in this report, and to provide more focused data on the following topics: (1) bacteria levels in the first flush flows at the mouths of storm drain outlets: (2) the magnitude and duration of dry weather flows over the course of a summer and fall; and (3) the bacteria levels in urban runoff compared to winter stormwater.

Phase I will include the following specific monitoring efforts in both watersheds:

- The City will expand the current creek water quality monitoring program to include: (1) measurements of bacteria in first flush events from key storm drains (listed in Tables 4-2 and 4-4) in the winter 2002/2003; and (2) periodic measurements of bacteria in urban runoff during the 2003 summer and fall from these same outlets. These measurements will provide information about bacteria concentrations under the two conditions. The results of the focused monitoring will allow the City to focus on problem outlets and determine if treatment is needed for first flush events, urban runoff, or both.

- The City will also expand its current water quality monitoring program to include weekly estimates of flow from key outlets (using field measurements) during the 2003 summer and fall in order to estimate flows from specific

outlets. This information will be used to prioritize future treatment projects and to develop hydraulic design criteria.

- The City will also initiate a source identification effort that uses a combination of water quality monitoring, storm drain surveillance, and property inspection to identify gross bacteria sources throughout the two watersheds. The results may provide a cost-effective method to reduce bacteria loading, as well as provide more information prioritize treatment projects.