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February 29, 2012

Mr. Raymund Donguines, P.E.
City of Pacifica
155 Milagra Drive
Pacifica, CA 94044

Subject: City of Pacifica Final Storm Drainage System Master Plan

Dear Mr. Donguines:

We are pleased to submit the City of Pacifica (City) Storm Drainage System Master Plan (Master Plan). Enclosed are ten copies of the Master Plan. This report summarizes the work completed as a result of Tasks 1 through 9 of the scope of services, including: development of planning criteria, evaluation of the drainage system, recommendation of improvements to correct existing deficiencies and serve future users, development of a condition assessment and rehabilitation/replacement program, and estimation of costs for these improvements.

The Master Plan is organized in the following format:

Chapter 1 - Background

Chapter 2 - Study Area Description

Chapter 3 - Planning Criteria

Chapter 4 - Storm Drainage System Facilities and Hydraulic Model

Chapter 5 - Capacity Evaluation and Proposed Improvements

Chapter 6 - Condition Assessment and Rehabilitation/Replacement Program

Chapter 7 - Capital Improvement Program

We would like to extend our thanks to you and other City staff whose courtesy and cooperation were valuable components in completing this report.

Sincerely,

CAROLLO ENGINEERS, INC.

Paul Friedlander, P.E.
Project Manager

Maggie J. Dutton
Project Engineer

asw:PF:MJD

Enclosures: Draft Storm Drainage System Master Plan (10)

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City of Pacifica

STORM DRAINAGE SYSTEM MASTER PLAN

FINAL

February 2012

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City of Pacifica

STORM DRAINAGE SYSTEM MASTER PLAN

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LIST OF ABBREVIATIONS

AACE	Association for the Advancement of Cost Engineering
ABAG	Associate of Bay Area Governments
AF	acre feet
BMP	best management practice
Coastal Act	California Coastal Act of 1976
CalTrans	California Department of Transportation
Carollo	Carollo Engineers, P.C.
CCC	California Coastal Commission
CCTV	closed-circuit television
cfs	cubic feet per second
CIP	capital improvement project
City	City of Pacifica
DCIA	directly connected impervious area
DDF	depth duration frequency
DEM	digital elevation model
ENR CCI	Engineering News Record Cost Construction Index
FEMA	Federal Emergency Management Agency
ft	feet
GIS	geographic information system
in/hr	inches per hour
MSL	mean sea level
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service
O&M	operation and maintenance
ROW	right-of-way

R/R	rehabilitation/replacement
RTC	real time controls
SPCWC	San Pedro Creek Watershed Coalition
SWMM	Storm Water Management Model
US EPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant

STORM DRAINAGE SYSTEM MASTER PLAN

ES.1 INTRODUCTION

The City of Pacifica (City) is located along the Pacific Coast of the San Francisco Peninsula, adjacent to the cities of Daly City, South San Francisco, and San Bruno.

The City collects and disposes storm water runoff generated within the City service area. The storm drainage system is designed to manage the runoff of rainwater and minimize the impact of significant rainfall. The City's storm drainage infrastructure includes almost 55 miles of storm drainage lines spanning 4- to 90-inches in diameter, 8.7 miles of open channels, two City-operated pump stations, and ultimately discharges into the Pacific Ocean.

ES.2 STUDY AREA

The 2030 Draft General Plan (General Plan) planning boundary is the study area boundary for this Storm Drainage System Master Plan (Master Plan). The Master Plan study boundary and the 2030 General Plan planning area are synonymous and will be used interchangeably throughout this report.

The City's planning area consists of the City and its sphere of influence (SOI), a total area of 13.6 square miles (8,742 acres). The City's SOI is nearly conterminous with the City limits, with an additional 325 acres of unincorporated land along the City's southern boundary. This Master Plan contains a forecast of storm drainage system improvements only within the current City limits, including planned future development. Since the City has limited potential to expand its City limits, evaluation of future infrastructure needs are focused on planned development and redevelopment within the City limits. Figure ES.1 shows the study area boundary, current City limits, and SOI.

ES.3 EXISTING AND FUTURE SERVICE AREA

The land use assumptions in this Master Plan are based on the City's 2030 General Plan and projected future developments within the General Plan boundary. The type of land use in an area will affect the volume and peak flow of the storm water runoff. Adequately estimating the quantity of storm water runoff from various land use types is important in sizing and maintaining effective storm drainage system facilities. If future planning conditions change from the assumptions stated in this Master Plan (i.e., accelerated growth, more intense developments, etc.), revisions and adjustments to the Master Plan and its recommendations would be necessary.

Figure ES.1
Study Area
Storm Drainage System Master Plan
City of Pacifica

The City provides storm drainage service to residents, businesses, and other institutions within its City limits. The City currently provides storm drainage service to approximately 7,646 acres, or 11.9 square miles. Parks, open space, and beach area comprise the majority of the City's land usage, with 3,604 acres of preserved open space (47 percent of service area). Residential uses comprise 1,957 acres (26 percent) of the service area, and vacant or undeveloped space comprise 1,204 acres (16 percent) of current land use. Other existing land uses include 361 acres of agriculture (4.7 percent), 395 acres of public or community space (5.2 percent), 104 acres of commercial uses (1.4 percent), 18 acres of industrial uses (0.2 percent), and 4 acres of mixed use development (0.1 percent). Planned development or redevelopment of the land within the City limits will add commercial, residential, and open space acreage to the City's service area. However, open space, parks, and beach areas will continue to comprise the majority of the City's land use.

ES.4 HISTORICAL AND FUTURE POPULATION

Pacifica's growth rate is modest and is largely dependent on development trends (i.e. availability of additional housing for permanent residents). Except during the period from 1960 through 1970, when the City experienced rapid annual growth of approximately 5.4 percent, the City's average annual growth has remained low, between 0.2 and 0.5 percent.

The City's General Plan Update considers growth estimates from both the California Department of Finance (DOF) and the Association of Bay Area Governments (ABAG), whose population projections, comparatively, varied based on assumed 2010 population. This Master Plan uses the 2010 population estimates from the DOF, paired with the growth rates proposed by the City.[1] Annual growth rates through 2030 varied between 0.2 and 0.4 percent. Table ES.1 summarizes the existing and projected year 2030 population.

Table ES.1 Existing and Projected Year 2030 Population

Year	Population
2010	37,297$^{(1)}$
2030	39,765$^{(2)}$

Notes:

1. Source: California Department of Finance.
2. Projected using annual growth rates proposed in the City's Existing Conditions and Key Issues report (July 2010), a part of the 2030 General Plan Update.

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1 Source: City of Pacifica. (July 2010). 2030 General Plan, Existing Conditions, and Key Issues Report.

ES.5 HYDROLOGIC AND HYDRAULIC ANALYSIS

The existing storm drainage system collects and conveys surface water runoff throughout the City and ultimately discharges the runoff into the Pacific Ocean. Many neighborhoods in the City rely on small to large natural waterways to convey storm water runoff from developed areas to the ocean. In addition, due to the City's variable terrain, gutters and overland flow are utilized as storm water conveyance facilities. The City does not currently operate detention or storage basins.

The storm drainage system was evaluated using H_2OMAP SWMM modeling software. H_2OMAP SWMM is a commercial version of EPA SWMM 5.0 software. The SWMM Runoff Block, which is included in H_2OMAP SWMM, was used to perform the hydrologic analysis. This analysis conducted rainfall-runoff simulations that accounted for climate, soil, land use, and topographic conditions of the watershed. Once runoff quantity was simulated, and loads at receiving nodes were determined, the routing portion of the software transported the flow through the City's conveyance system of storm drains, open channels, and pump stations to evaluate the capacity of these facilities.

ES.6 CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

In evaluating the adequacy of the storm drainage facilities serving existing and future developments, City streets were allowed to flood under certain conditions and provide additional storage capacity, thus reducing the number of storm drain improvements. When storm drains are located in City streets, the goal was to contain storm flows within the drainage pipelines, with minimal ponding in City streets during the 10 year design storm. The storm drainage criteria allowed City streets to flood up to seven inches above the gutter flow line in the 50 year design storm. If flooding exceeds seven inches and additional street flow capacity is not available, then an improvement is necessary to correct the problem. Other pipe systems that are not within a street that act as an overland flow channel should have sufficient capacity to convey the 50-year design storm, while maintaining a hydraulic grade line below manhole rim elevations.

In general, the existing storm drainage system has sufficient capacity to convey runoff generated during the 10-year design storm. In several locations, however, the existing storm drains lack sufficient capacity to convey the 50-year runoff while meeting the seven-inch criterion. These areas are generally located in the flat, low-lying areas near the coastline where invert elevations are close to or below sea level. Some of these deficiencies are mitigated with pump stations in the City's West Linda Mar neighborhood (southwest area), while others cause regular flooding events that threaten residences and businesses. Capacity improvements are recommended for these areas.

The proposed improvements are recommended to mitigate deficiencies due to either existing use only, or a combination of existing and potential future use. There are no improvements that are required as a result of future development only. Therefore, some proposed improvements are considered to have a shared financial responsibility, weighted by estimated usage of the City's infrastructure based on the hydraulic model. Each of the proposed improvements are necessary to prevent flooding issues in various locations in the City. As the City continues to grow, it is recommended that the pipeline diameters and pump station capacities proposed in this Master Plan be constructed so that the facilities have sufficient capacity for existing and projected development conditions. Building a smaller interim project with the plan of upsizing in the future to account for further growth is not recommended. In this Master Plan, the proposed pipe diameter represents the ultimate diameter for 2030 development conditions.

Figure ES.2 illustrates the proposed storm drainage system improvements required to correct existing deficiencies and serve future development. The proposed pipeline diameter is also shown on the figure. Figure ES.2 shows the proposed improvements in different colors, which identify the implementation timeframe of the improvements and differentiate between near-term and long-term improvements. A detailed inventory of the proposed improvements is included in Chapter 5 of this Master Plan. CIP summary sheets for the three CIP projects recommended in this Master Plan are provided following Figure ES.2.

ES.6.1 Existing Versus Future Improvement

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to prevent flooding in excess of seven inches above the curb line) for existing users. If a project was proposed to correct an existing deficiency, then existing users were assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.

Future growth may require the construction of new facilities to support this growth (i.e. new pipelines to serve vacant or undeveloped areas within the City service area). If a specific project is needed to serve growth exclusively, future users were assigned 100 percent of the future project's benefit and 100 percent of the costs.

The proposed long-term maintenance program (described in Chapter 6) will benefit primarily existing users, but will include future infrastructure once it is constructed. Where a project, such as the maintenance and inspection program, is recommended to serve existing and future growth, the future user benefit was determined based on the additional maintenance incurred as a result of future growth. More information on the breakdown in cost split between existing and future users, and whether a proposed improvement is intended to correct an existing deficiency, to serve a future user, or both, is provided in Chapter 7.

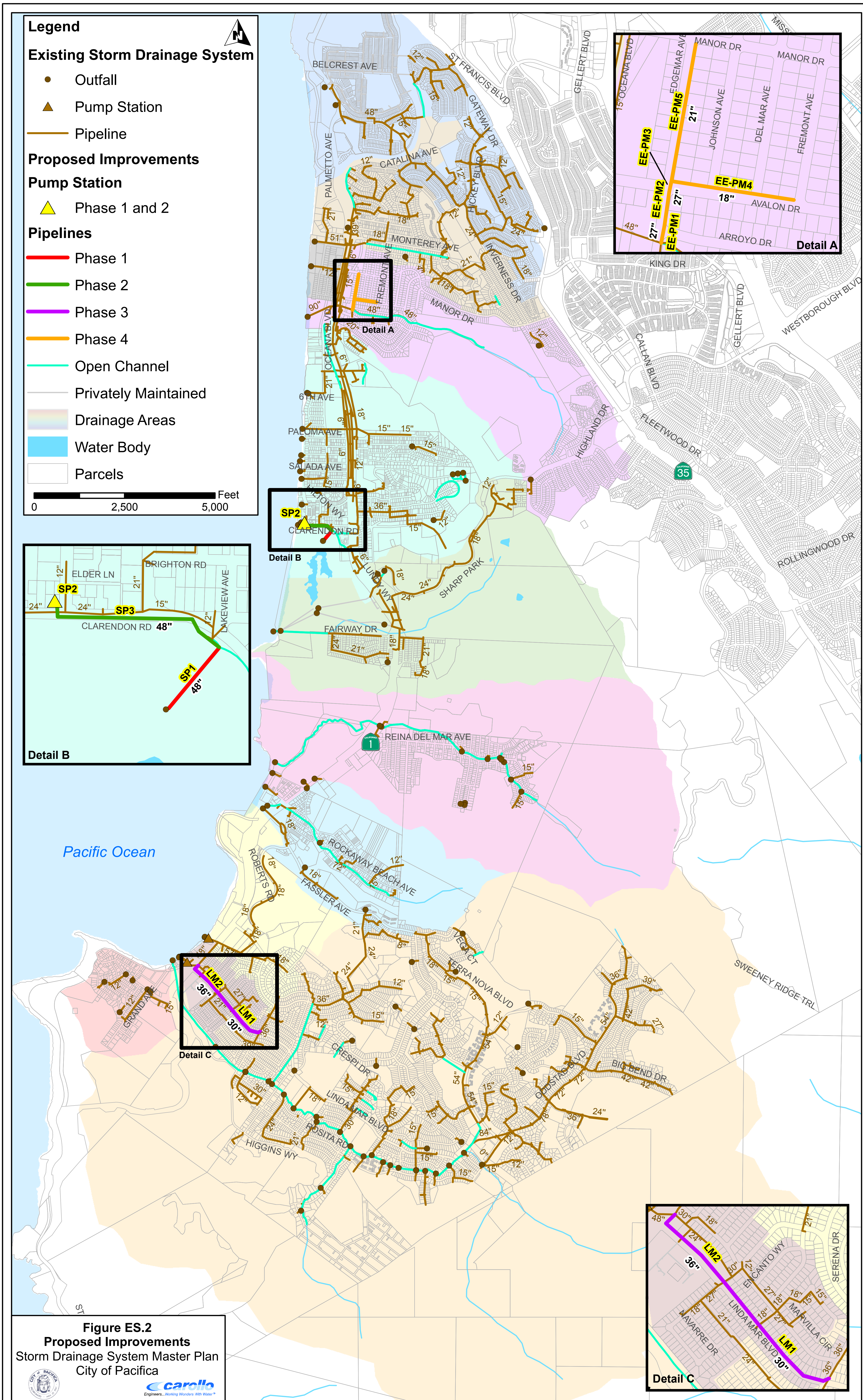

Figure ES.2
Proposed Improvements
Storm Drainage System Master Plan
City of Pacifica

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CAPITAL IMPROVEMENT PLAN PROJECT SHEET
STORM DRAINAGE SYSTEM MASTER PLAN
CITY OF PACIFICA

PROJECT CIP-1
East Edgemar-Pacific Manor
Improvements: EE-PM1 through EE-PM5

Project Benefit

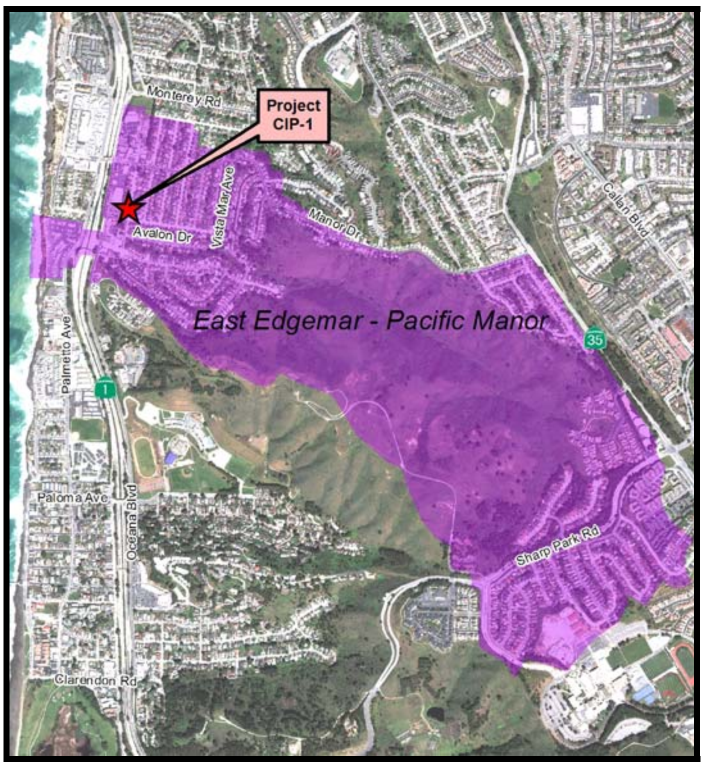
Existing Customers: 100%
New Development: 0%

Implementation Phase

___Phase 1 (2011-15)	_x_Phase 4 (2026-30)
___Phase 2 (2016-20)	___Phase 5 (Post 2030)
___Phase 3 (2021-24)	

Project Location

- Avalon Drive, between Fremont Avenue and Edgemar Avenue
- Edgemar Avenue, between Manor Drive and Arroyo Drive



Project Component(s)

- Replace existing 12" pipelines with 27" pipelines.
- Install two new pipeline segments (18" and 21") and street inlets.

Project Cost Summary (2011 Dollars)

Baseline Construction		$348,000
Construction Contingency (25%)		$87,000
Total Construction Cost		$435,000
Engineering Construction Management Project Administration	(30%)	$131,000
Total Capital Improvement Cost		$566,000

Project Description

Project CIP-1 involves replacing 325 feet of existing 12-inch pipelines with 27-inch pipelines along Edgemar Avenue, between Avalon Drive and Arroyo Drive. In addition, CIP-1 includes construction of an 18-inch pipeline along Avalon Drive and 21-inch pipeline along Edgemar Avenue. The project will help reduce existing flooding that occurs during normal to heavy storm events on the corner or Edgemar Avenue and Avalon Drive by increasing underground storage and conveyance capacity in the subbasin.

CAPITAL IMPROVEMENT PLAN PROJECT SHEET
STORM DRAINAGE SYSTEM MASTER PLAN
CITY OF PACIFICA

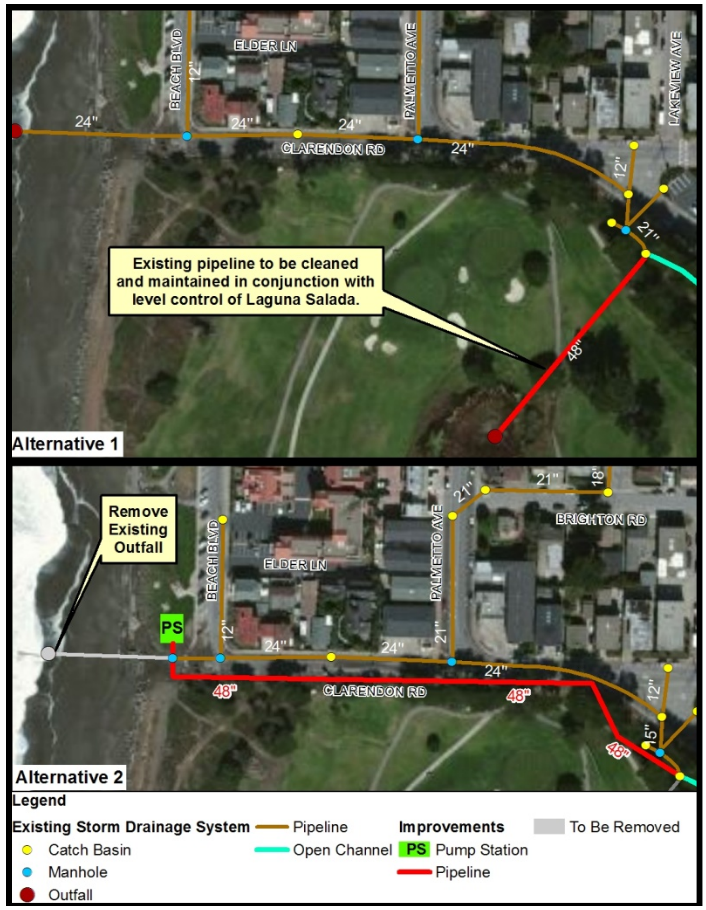
PROJECT CIP-2
East and West Sharp Park
Alternatives 1 and 2
Improvements: SP1 through SP3

Project Benefit
Existing Customers: 75%
New Development: 25%

Implementation Phase
_x_Phase 1 (2011-15)
___Phase 2 (2016-20)
___Phase 3 (2021-24)
___Phase 4 (2026-30)
___Phase 5 (Post 2030)

Project Location
- Lakeside Avenue to Clarendon Road
- Clarendon Road, between Lakeside Avenue and Beach Boulevard
- Sharp Park Golf Course

Project Component(s)
- **Alternative 1:** Provide non-constrictive outflow to Laguna Salada outfall. Establish level control of Laguna Salada.
- **Alternative 2:** Install new pump station, wet well, and pipeline.



Project Cost Summary (2011 Dollars)

		Alt 1	Alt 2
Pump Station		-	$3.00 mil
Pipeline		$2,000	$434,000
Baseline Construction(1)		$2,000	$3.43 mil
Construction Contingency (25%)		$0	$0.86 mil
Total Construction Cost		$2,000	$4.29 mil
Engineering Construction Management Project Administration	(30%)	$1,000	$1.29 mil
Total Capital Improvement Cost		$3,000	$5.58 mil

(1) Does not include modifications to golf course to allow Laguna Salada to overflow to ocean (i.e. levee removal).

Project Description
Project CIP-2 proposes two alternative solutions to mitigate existing system deficiencies. **Alternative 1** involves regular cleaning of the existing 48" outfall to Laguna Salada to provide non-constrictive outflow, and establishing level control of Laguna Salada to reduce backwater effects. **Alternative 2** involves construction of a permanent pump station and wet well at the western edge of Clarendon Road. Both of the proposed alternatives will reduce flooding in the surrounding low-lying residential and commercial area.

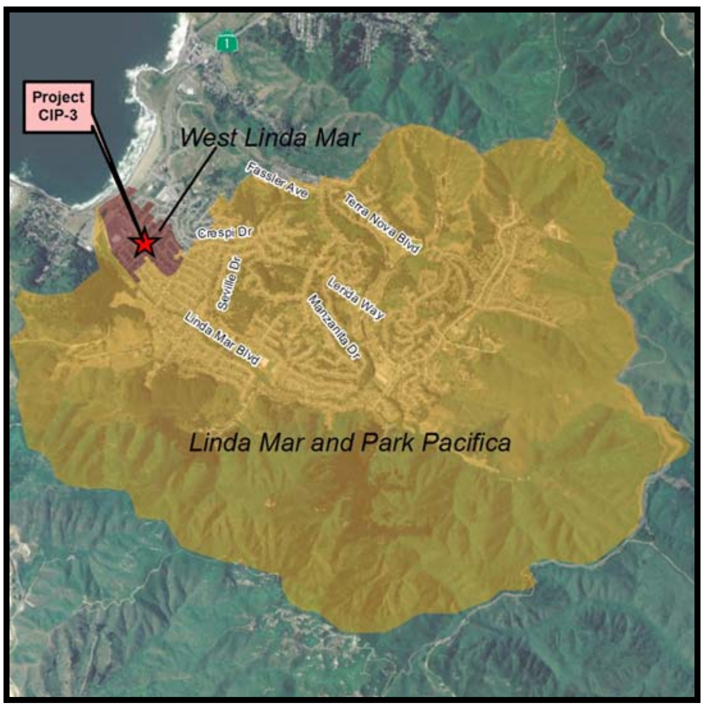
CAPITAL IMPROVEMENT PLAN PROJECT SHEET
STORM DRAINAGE SYSTEM MASTER PLAN
CITY OF PACIFICA

PROJECT CIP-3
West Linda Mar
Improvements: LM1 and LM2

Project Benefit
Existing Customers: 100%
New Development: 0%

Implementation Phase
___Phase 1 (2011-15)   ___Phase 4 (2026-30)
_x_Phase 2 (2016-20)   ___Phase 5 (Post 2030)
_x_Phase 3 (2021-24)

Project Location
- Linda Mar Boulevard, between Peralta Road and Highway 1
- Highway 1, to pump station wet well feed pipeline



Project Component(s)
- Install new segments of 30” and 36” pipeline
- Minimize hydromodification to San Pedro Creek

Project Cost Summary (2011 Dollars)

Baseline Construction		$932,000
Construction Contingency (25%)		$233,000
Total Construction Cost		$1.17 mil
Engineering Construction Management Project Administration	(30%)	$350,000
Total Capital Improvement Cost		$1.52 mil

Project Description
Project CIP-3 involves installing 2,750 feet of 30-inch and 36-inch pipelines along Linda Mar Avenue, between Peralta Road and Highway 1, ultimately connecting to the existing inflow pipeline to the Linda Mar wet well and pump station on Highway 1. Construction of this storm drainage infrastructure will increase subsurface storage and conveyance capacity. In addition, utilization of pipelines along Linda Mar Blvd instead of an outfall to San Pedro Creek reduces the occurrence of hydromodification due to stormwater flows.

ES.6.2 Proposed Existing System Improvements

The majority of the City's recommended improvements are a result of insufficient capacity of the existing storm drainage system to convey peak runoff without exceeding the planning criteria discussed in Chapter 3. Therefore, there are several locations where existing storm drains will need to be replaced by larger diameter storm drains, or new storm drains will need to be constructed to reduce peak flows through hydraulically-deficient storm drain pipes. Detailed descriptions of the proposed existing system improvement projects are provided in Chapter 5.

ES.6.3 Proposed Future System Improvements

As a part of the City's 2030 General Plan Update, the City has prepared residential and commercial development alternatives for future planning and expansion. Currently, these development alternatives are in the public review and comment stage, wherein residents have had the opportunity to voice their opinions about the proposed alternatives. Dyett and Bhatia, the preparers of the General Plan Update, issued a survey to Pacifica residents to rank their preference the proposed development alternatives (Appendix B). Based on the recommendations provided in the memorandum, estimates of future development potential was assumed.

For a majority of the proposed commercial development sites, the nature of the proposed changes is actually a redevelopment of existing land uses. In these cases, impact on storm drainage infrastructure is minimized. Several locations, however, will introduce substantial impervious surfaces to areas with mostly pervious surfaces, resulting in an increase of storm water runoff to the City's drainage system. Details on all proposed future commercial and residential developments in included in Chapter 5.

In general, several options were considered to convey storm water runoff generated in future development or redevelopment areas, including direct discharge of runoff to drainage channels, discharge to existing or future pipeline infrastructure, and use of detention basins. Since the use of detention basins for storm water within the City is unlikely due to topography and available land, future developments were evaluated on their impact to pipeline infrastructure and natural waterways.

To quantify the impact of future development on flows entering the storm drainage system, projected increases in impervious surface area were determined based on existing percentage imperviousness by land use type. These projected storm water flows can be used to facilitate planning of low impact development (LID) opportunities for new construction, to prevent negative impacts to the City's storm drainage infrastructure and reduce hydromodification.

ES.6.4 Low Impact Development

Low impact development (LID) is typically an effective and attractive approach to land development that controls storm water pollution and attempts to minimize changes to natural storm water flow conditions (hydromodification). Many LID options emphasize cost-effective, lot-level strategies that replicate redevelopment hydrology and reduce impacts of development. In addition, implementing LID practices can help prevent polluted runoff from negatively impacting the water quality of receiving waters.

As growth and new development or redevelopment projects occur, the City should consider implementing LID projects to reduce capacity impacts to its storm drainage system. Doing so will ensure that the improvements proposed herein will satisfy capacity conditions through the 2030 planning period, as well as into the extended planning future. In addition, application of LID principles and practices can reduce the impact of built areas on natural and sustainable movement of water within a watershed.

ES.7 CAPITAL PROJECT PRIORITIZATION

The majority of the proposed improvements are driven by existing development, although some improvements will additionally serve proposed future development once it is implemented. When fully implemented, the capital projects will facilitate the collection, conveyance, storage, and discharge of peak storm flows to limit street flooding to the maximum allowed. Prioritizing the required capital improvements for the City's storm drainage system is an important aspect of the Master Plan. The improvement projects were prioritized based on a 10-year, 20-year, and long-term improvement plan addressing storm drainage facilities necessary to mitigate existing deficiencies and meet the needs to proposed development. Special consideration was given to facilities where known system deficiencies already exist and are currently affecting residences and businesses.

All of the proposed CIP improvements are necessary to reduce flooding events and prevent damage to City infrastructure, residences, and businesses. The proposed phasing is provided to prioritize improvements by the risk that existing conditions create and on the likelihood of available funding for the CIP project. Improvement projects were grouped into the following timeframes:

- Phase 1: Years 2012 through 2015
- Phase 2: Years 2016 through 2020
- Phase 3: Years 2021 through 2025
- Phase 4: Years 2026 through 2030
- Phase 5: Post-2030

Phases 1 and 2 represent short-term improvement projects, Phases 3 and 4 represent medium-term improvement projects, and Phase 5 represents long-term improvement projects. The projects shown in Figure ES.2 are color coded according to phase, which reflects their priority.

Proposed improvements within areas identified to have significant existing flooding issues were assigned a higher priority. Areas that experience regular flooding events that threaten residences and businesses received the highest priority. The proposed condition assessment and maintenance program was included through all capital improvement phases, since this program is anticipated to be an annual program carried out over the long-term. Changes in the City's planning assumptions could increase or decrease the priority of each improvement.

ES.7.1 Phase 1 and Phase 2 Projects (2012-2015 and 2016-2020)

Phase 1 and Phase 2 projects include the proposed improvements for the East and West Sharp Park area. Two alternative improvement projects were developed for this area, which were based on two potential future management strategies of the stormwater discharged in this area of the City. Currently, the storm drainage outfall to Laguna Salada is maintained by the operator of the Sharp Park Golf Course (currently the City of San Francisco). Since the outfall facilities are not under the jurisdiction of Pacifica, the City cannot maintain or operate them. Alternative 1 stipulates that the operator of the Sharp Park Golf Course maintain responsibility of the outfall and establish conditions to prevent flooding in the area. This is a much less expensive alternative that establishes more desirable drainage conditions at the Golf Course, but maintains that the City will not have jurisdiction of key storm drainage infrastructure in this area. Alternative 2 creates an opportunity for the City to manage stormwater drainage in the area with the installation of a pump station and bypass of the existing outfall to Laguna Salada. This is a more expensive alternative, but provides the City with a long-term, self-sufficient management strategy of storm drainage.

This area was identified as a priority for improvement implementation because of the recurring flooding issues that occur. Based on the chosen alternative and available funding, the City may choose to implement other capital improvements during these phases in addition to the East and West Sharp Park improvements.

In addition to these capital projects, the City will implement the condition assessment and inspection program, and storm drain rehabilitation and replacement projects as necessary.

ES.7.2 Phase 3 Projects (2021-2025)

Phase 3 projects include the capital improvements to the West Linda Mar drainage area. These proposed improvements are required help to mitigate existing deficiencies caused by an existing system with insufficient capacity, and to supplement conveyance capacity that was reduced with recent changes to the storm drainage infrastructure on Montezuma Drive. The hydraulic model indicates that the existing storm drainage pipeline facilities in this area are insufficiently sized and will cause flooding events to occur during the 10-year design storm above the seven-inch planning criteria. This improvement is a priority to prevent localized flooding.

ES.7.3 Phase 4 Projects (2026-2030)

Phase 4 projects include the capital improvements to the East Edgemar – Pacific Manor drainage area. These improvements will create a pipeline drainage system for a neighborhood that primarily relies on surface flow to convey storm water to natural waterways. The addition of pipelines in this neighborhood is necessary to create underground storage and conveyance capacity of storm flows and to mitigate existing deficiencies that cause localized flooding.

ES.7.4 Phase 5 Projects (Post 2030)

Phase 5 projects include the long-term implementation of the proposed condition assessment, inspection, and maintenance program. This program is recommended for implementation over the course of a 10-year rotational period. The City should plan to incur costs associated with the condition assessment and maintenance program annually, into the post-2030 planning period. The proposed condition assessment and rehabilitation/replacement program is described in detail in Chapter 6 of this Master Plan.

ES.8 CAPITAL PROJECT COSTS

A summary of the capital project costs and the implementation timeframe is presented in Chapter 7. The breakdown in existing and future user cost share by phase is summarized in Table ES.2.

Table ES.2 Existing Versus Future User Cost Share						
Reimbursement Category	**Implementation Phase**					
	Phase 1 2012-15 (mil $)	**Phase 2 2016-20 (mil $)**	**Phase 3 2021-25 (mil $)**	**Phase 4 2026-30 (mil $)**	**Phase 5 Post 2030 (mil $)**	**Total[(2)] (mil $)**
Existing Users[(3)]						
Alternative 1	0.36	1.45	0.96	1.02	0.09	3.79
Alternative 2	4.54	1.45	0.96	1.02	0.09	7.97
Future Users[(4)]						
Alternative 1	0.001	0	0	0	0	0.001
Alternative 2	1.4	0	0	0	0	1.4
Total, mil $ (Alternative 1)	**0.36**	**1.45**	**0.96**	**1.02**	**0.09**	**3.79**
Total, mil $ (Alternative 2)	**5.94**	**1.45**	**0.96**	**1.02**	**0.09**	**9.37**

Notes:

1. All costs are in May 2011 dollars. ENR CCI 20 City average = 9035
2. Total CIP costs for Phases 1 through 4, through the 2030 General Plan planning period. Phase 5 represents average annual costs associated with the long-term maintenance and inspection program.
3. Projects are expected to be funded through user rates.
4. Projects are expected to be funded by developers.

BACKGROUND

1.1 INTRODUCTION

This chapter presents a brief summary of the City of Pacifica's (City) storm drainage service area, the purpose for this Storm Drainage System Master Plan (Master Plan), the objectives of the study. A summary of report organization is also provided to assist the reader in navigating this Master Plan.

1.2 BACKGROUND

Pacifica is located along the Pacific Coast of the San Francisco Peninsula, in San Mateo County (Figure 1.1). The City is bordered on the west by the Pacific Ocean, on the north by Daly City, and on the south and east by ridges of the Coastal Range, the cities of South San Francisco and San Bruno, and unincorporated San Mateo County. Highway 1 is the main highway corridor through the City, which connects to Interstate 280 for regional travel. The City lies approximately 13 miles south of downtown San Francisco and 40 miles northwest of San Jose. The City is highly residential, though tourism and the fishing industries are major components of the City's economy. The City's location along Highway 1 makes it a stopover point for travelers and people visiting the coast, while the Pacifica Pier is a popular location for visitors and anglers alike. The City was incorporated in 1957.

1.3 STORM DRAINAGE SERVICE AREA

The City collects and disposes of storm water runoff generated within the City service area. The storm drainage collection system consists of almost 50 miles of drainage lines, 8.7 miles of open channels, and two City-operated pump stations. The collection system consists of pipes varying in diameter from 4 inches to 90 inches, and ultimately discharges to approximately 22 different outfalls to the Pacific Ocean. Figure 1.2 illustrates the City's current storm drainage system service area.

The land use assumptions in this Master Plan are based on the documents prepared as a result of the City's 2030 General Plan (General Plan) Update process, including the July 2010 Pacifica General Plan Existing Conditions and Key Issues Report. In addition, proposed future developments within the General Plan boundary were considered when developing the hydraulic model to handle future conditions. If future planning conditions change from the assumptions stated in this Master Plan (i.e., accelerated growth, more intense developments, etc.), revisions and adjustments to the Master Plan and its recommendations will be necessary.

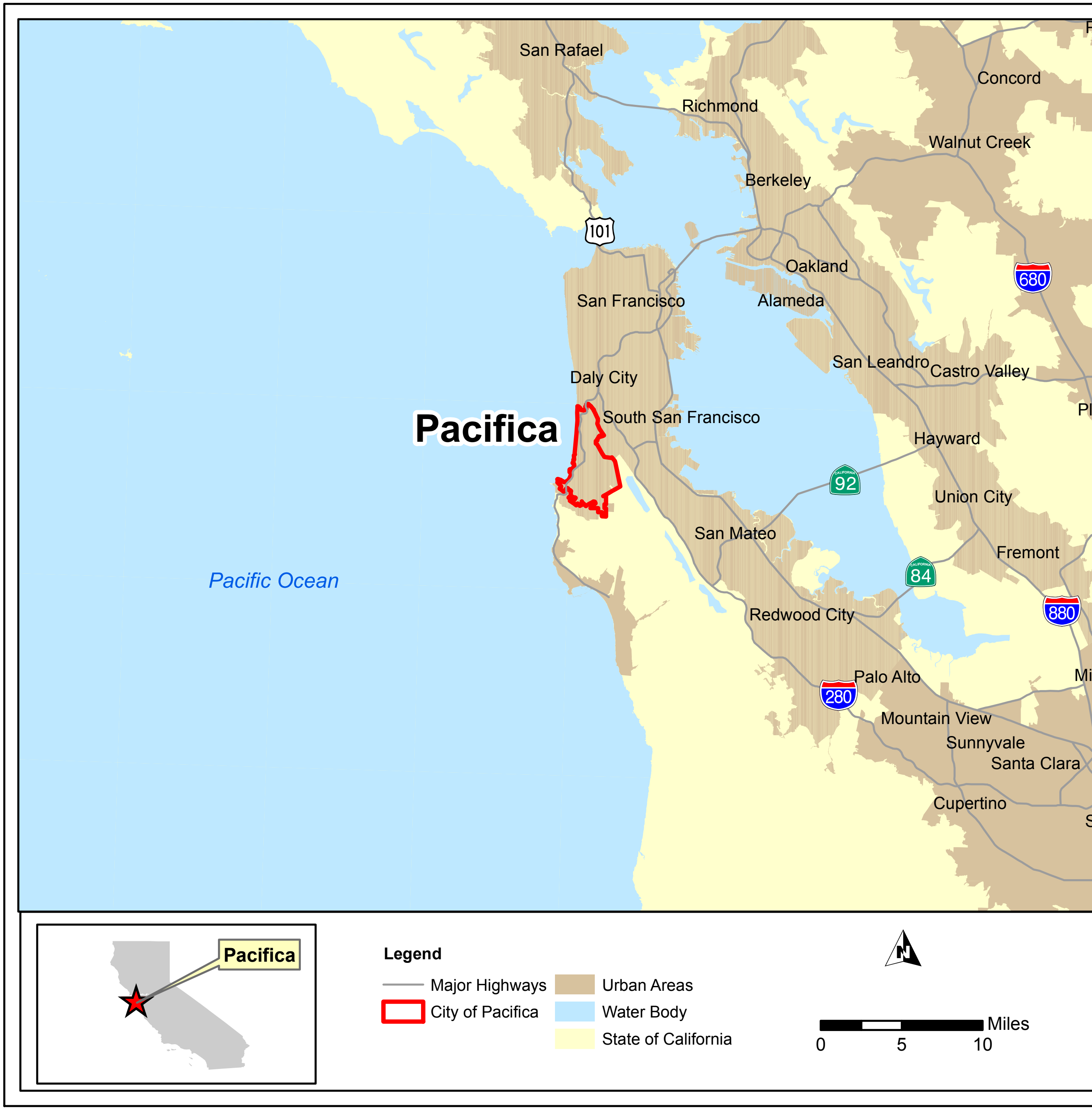


Figure 1.1
Regional Location Map
Storm Drainage System Master Plan
City of Pacifica

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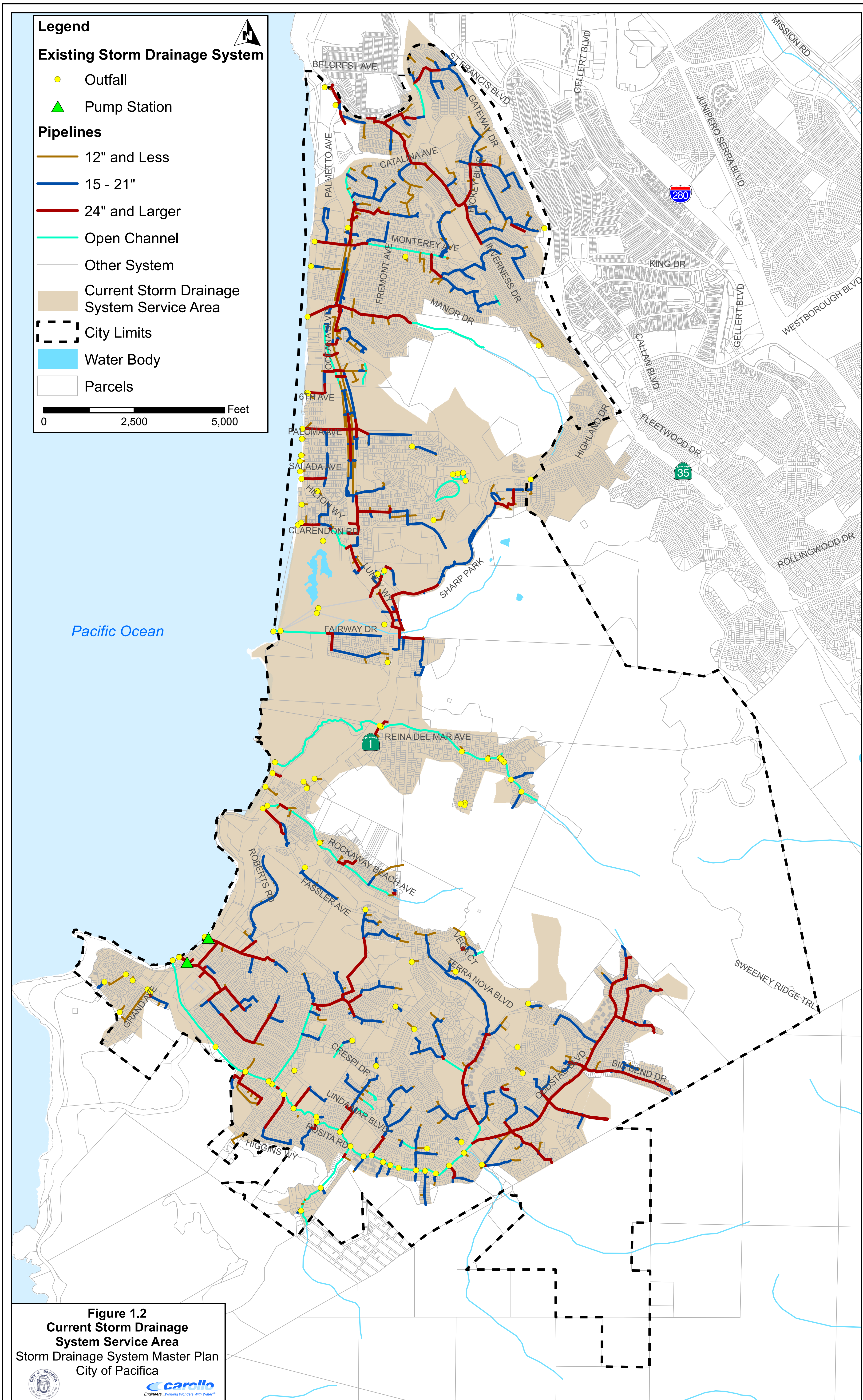

Figure 1.2
Current Storm Drainage System Service Area
Storm Drainage System Master Plan
City of Pacifica

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1.4 SCOPE AND AUTHORIZATION

The purpose of this Master Plan is to identify capacity deficiencies in the storm drainage system, develop feasible alternatives to correct these deficiencies, and plan the infrastructure that will serve future development. On February 14, 2011, the City approved a professional service agreement with Carollo Engineers, Inc. (Carollo) to prepare this Master Plan for the storm drainage system, which included the following main tasks:

- Conversion of existing City storm drain system map to GIS-based map
- Data collection and assessment of existing drain system
- Hydraulic model development
- Storm drainage system analysis and capital project development
- Preparation of a condition assessment and rehabilitation/replacement program
- Long-range Capital Improvement Program (CIP) development
- Master Plan preparation

1.5 REPORT ORGANIZATION

The storm drainage system master plan report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 – Background. This chapter presents a summary of the storm drainage system service area, the purpose, and scope for this Master Plan, and the objectives of the study. Referenced documents are also listed.

Chapter 2 - Study Area Description. This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.

Chapter 3 - Planning Criteria. This chapter presents the planning criteria for evaluating the storm drainage system. The planning criteria address the storm drainage system capacity, gravity storm pipe slopes, maximum flood depths, and storm runoff coefficients.

Chapter 4 - Storm Drainage System Facilities and Hydraulic Model. This chapter presents an overview of the City’s storm drainage facilities. This chapter also describes the development of the City's storm drainage hydrologic and hydraulic models. These models were used for identifying existing system deficiencies and for recommending improvements.

Chapter 5 - Capacity Evaluation and Proposed Improvements. This chapter presents the results of the capacity evaluation of the storm drainage system and the proposed projects that correct capacity deficiencies and serve future users.

Chapter 6 - Condition Assessment and Rehabilitation/Replacement Program. This chapter presents recommendations for the City to develop a storm drainage system maintenance, inspection, and rehabilitation/replacement program.

Chapter 7 - Capital Improvement Program. This chapter presents the capital improvement program and projects, summary of the capital costs, and is organized to assist the City in making finance decisions.

1.6 ACKNOWLEDGMENTS

Carollo Engineers wishes to acknowledge and thank Mr. Van Dominic Ocampo, Director of Public Works/City Engineer; Mr. Raymund Donguines, Associate Civil Engineer; Mr. James McNally, Streets Superintendent; Mr. Raymond Biagini, Field Services Manager; Ms. Maria Aguilar, Associate Civil Engineer. Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report.

1.7 REFERENCE MATERIAL

The following documents were referenced in the preparation of this master plan:

- City of Pacifica, Existing Conditions and Key Issues Report for the 2030 General Plan Update, July 2010, Dyett & Bhatia
- City of Pacifica, 1980 General Plan (and subsequent amendments), City of Pacifica
- City of Pacifica, Design Guidelines, revised 1990, City of Pacifica
- County of San Mateo, Zoning Regulations, 1999 (revised 2002), County Environmental Services Agency, Planning and Building Division
- County of San Mateo, Subdivision Regulations, January 1992, County Environmental Services Agency, Planning and Building Division
- City of Pacifica Storm Drainage System Drawings
- City of Pacifica AutoCAD and Record Drawings

STUDY AREA DESCRIPTION

This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.

2.1 STUDY AREA

The 2030 Draft General Plan (General Plan) planning boundary is the study area boundary for this Storm Drainage System Master Plan (Master Plan). The Master Plan study boundary and the 2030 General Plan planning area are synonymous and are used interchangeably throughout this report.

The City's planning area (Figure 2.1) consists of the City of Pacifica (City) and its sphere of influence (SOI), a total area of 13.6 square miles (8,742 acres). The City limits extend approximately 6.5 miles along the Pacific Ocean (elevation at sea level), and extends 3 miles inland at its widest point. The City's SOI is nearly conterminous with the City limits, with an additional 325 acres of unincorporated land along the City's southern boundary. Land west of Highway 1 in Pacifica is located in the Coastal Zone, which is subject to the regulations in the California Coast Act of 1976. This Master Plan contains a forecast of storm drainage system improvements only within the current City limits.

2.2 PLANNING PERIOD

The Master Plan study area is intended to include the existing development within current City limits and development within the General Plan boundary that could occur through the year 2030. Existing and projected populations and land uses within the study area are discussed in this chapter.

2.3 CLIMATE AND TOPOGRAPHY

The City's coastal location results in a generally wet climate, with cold, wet winters and mild summers. The City's wet season typically extends from October through May, though most of the City's rainfall occurs between November and April. The City receives fog throughout the year that can produce a light to moderate drizzle. Mean annual precipitation in Pacifica is approximately 20.9 inches.[1]

[1] Mean annual precipitation is for San Francisco International Airport, from the Western Regional Climate Center. Period of record July 1996 to December 2008.

Figure 2.1
Master Plan Study Area
Storm Drainage System Master Plan
City of Pacifica
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The topography of the City is highly variable, ranging from coastline elevations of zero to hillside elevations in the Coastal Range of approximately 1,200 feet. Pacifica's topography is salient for its high proportion of open, undeveloped land and rugged ridges that border the City. The City is not organized around a center, rather, its urban structure is subject to the variable coastline topography.

2.4 100-YEAR FLOODPLAIN

Maps indicating "special flood hazard areas" (i.e. floodplains) have been developed through the National Flood Insurance Program (NFIP), which is administered by the Federal Emergency Management Agency (FEMA). Areas of particular importance for insurance purposes are those that are subject to inundation by a 100-year flood event. Figure 2.2 shows the 100-year floodplain boundary for the current City limits and General Plan boundary.

This Master Plan assumes that existing undeveloped land within the 100-year floodplain will not be developed in the future. These areas, therefore, are assumed to generate no future urban storm water runoff through build-out. If any development does occur within the floodplain, the anticipated increase in storm water runoff generated from these projects should have relatively little impact on the proposed storm drain projects in this Master Plan. If the floodplain area changes in size and results in more development, then the City should consider evaluating the impacts on downstream storm drainage facilities as applicable.

2.5 COASTAL ZONE

A portion of the City lies within California Coastal Zone, including all of the City west of and including State Highway 1, and Shelldance Nursery east of the highway. As such, this portion of the City is subject to the regulatory requirements of the California Coastal Act of 1976 (Coastal Act). The City's Coastal Zone (Figure 2.3) area comprises approximately 1,000 acres, or about 13 percent of the land included in the planning area. Under the management of the California Coastal Commission (CCC), the Coastal Act sets forth policies that guide land use and development regulations and actions for the coast. The City's 2030 General Plan Update includes planning decisions that adhere to the land use and planning restrictions set by the Coastal Act.

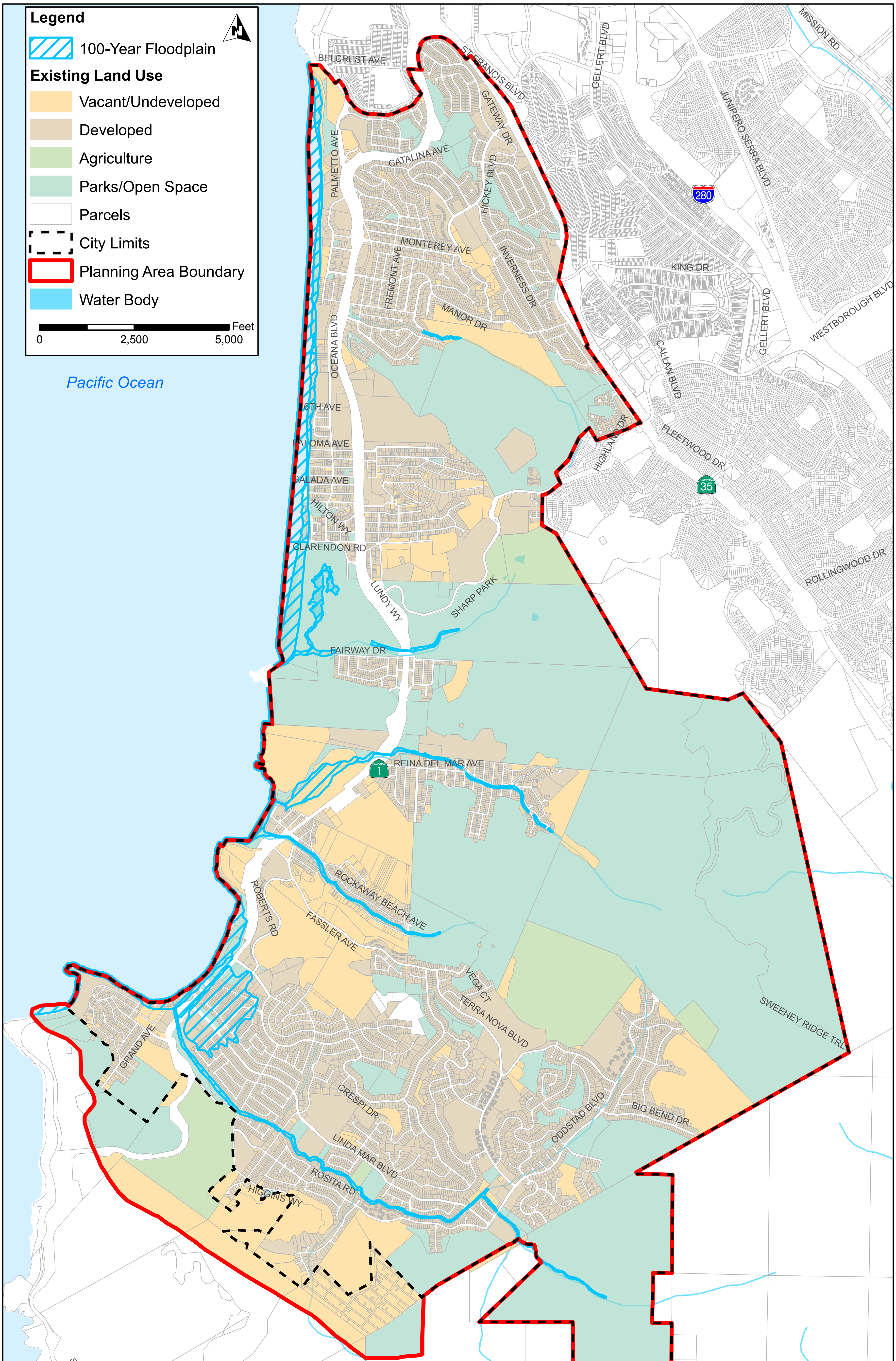

Figure 2.2
100-Year Floodplain
Storm Drainage System Master Plan
City of Pacifica

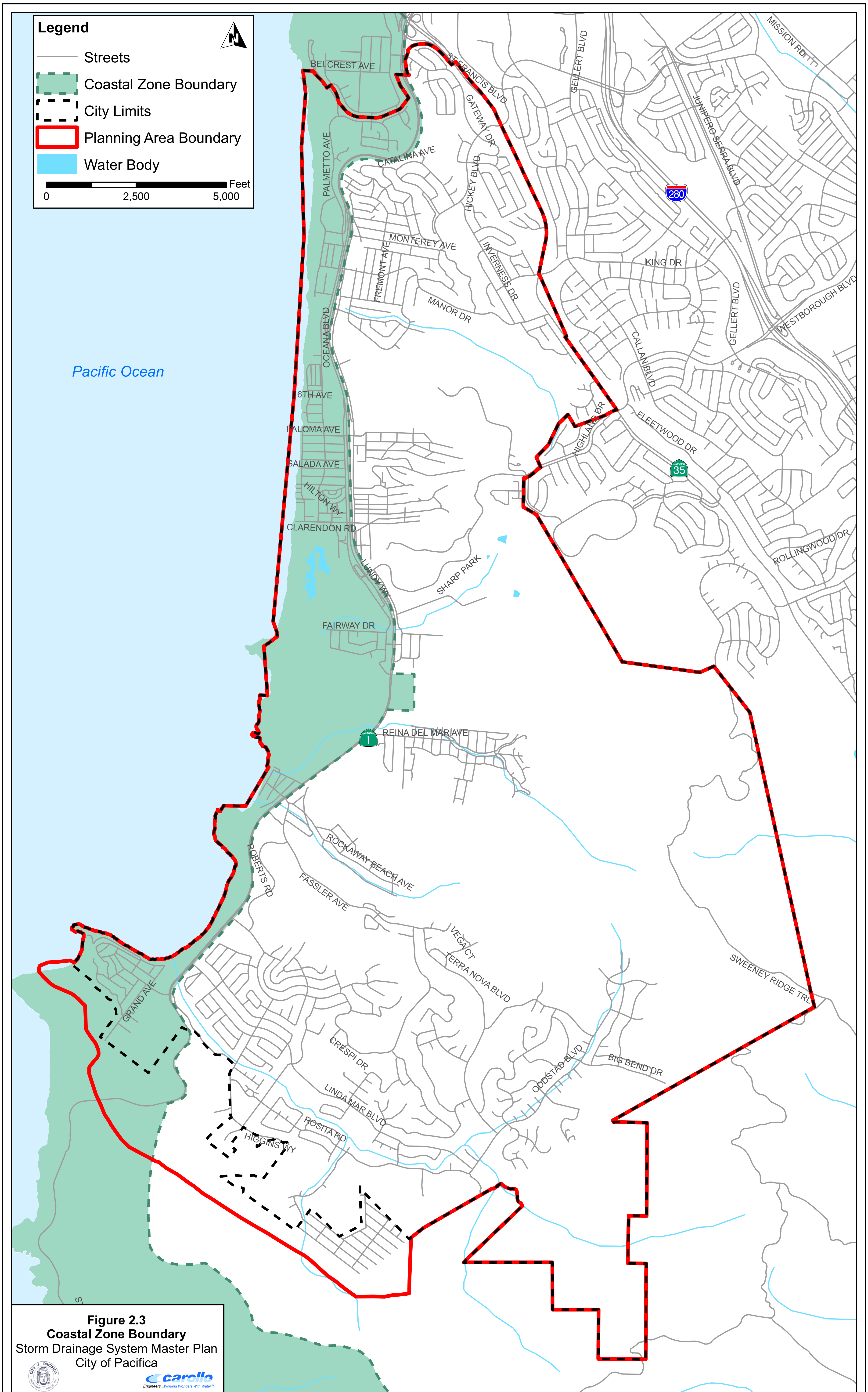

Figure 2.3
Coastal Zone Boundary
Storm Drainage System Master Plan
City of Pacifica

2.6 LAND USE

At the time of writing this Master Plan, the City was in the process of updating its General Plan to revise the overall City vision and policies for land use, economic development, environmental protection, and infrastructure investment through 2030. In July 2010, the City issued an Existing Conditions and Key Issues report, which served as the basis for preparing land use alternatives and transportation plans, formulated policies and implementation actions for the General Plan, and created the environmental setting portion for the Environmental Impact Report for the General Plan Update. The City has also prepared a Land Use Alternatives and Key Policy Issues Report (May 2011), wherein alternative land use scenarios were evaluated based on community priorities. Once adopted, the General Plan will guide development within the planning boundary and establishes the long-range development policies, and provide land use and population projections.

Current and projected land use information is an integral component in determining the amount of storm water runoff generated within the City because the type of land use in an area will affect the volume and peak flow of the storm water runoff. Adequately estimating the quantity of storm water runoff from various land use types is important in sizing and maintaining effective storm drainage system facilities.

Land use assumptions used in this study are consistent with the land use alternatives provided in the supporting documents to the 2030 General Plan Update. Since the land use assumptions forecast the type of growth within the study area, this association to the Master Plan should ensure that the future storm water runoff and facilities required to serve future growth are consistent with the City's guiding document on development. Current General Plan land uses within the City are illustrated in Figure 2.4. Appendix A provides an excerpt from the 2010 Existing Conditions and Key Issues Report that present a detailed description of the City's land use definitions.

2.6.1 Storm Drainage Service Area by Land Use

The following section describes the service area land uses for existing and future development.

2.6.1.1 <u>Existing Service Area Land Use</u>

The City provides storm drainage service to residents, businesses, and other institutions within its City limits. The City's current planning area (including the City limits and SOI) encompasses approximately 8,742 acres (13.7 square miles), and includes areas of ocean and right-of way. Excluding areas of ocean and right-of-way, the City currently provides storm drainage service to approximately 7,646 acres, or 11.9 square miles. Table 2.1

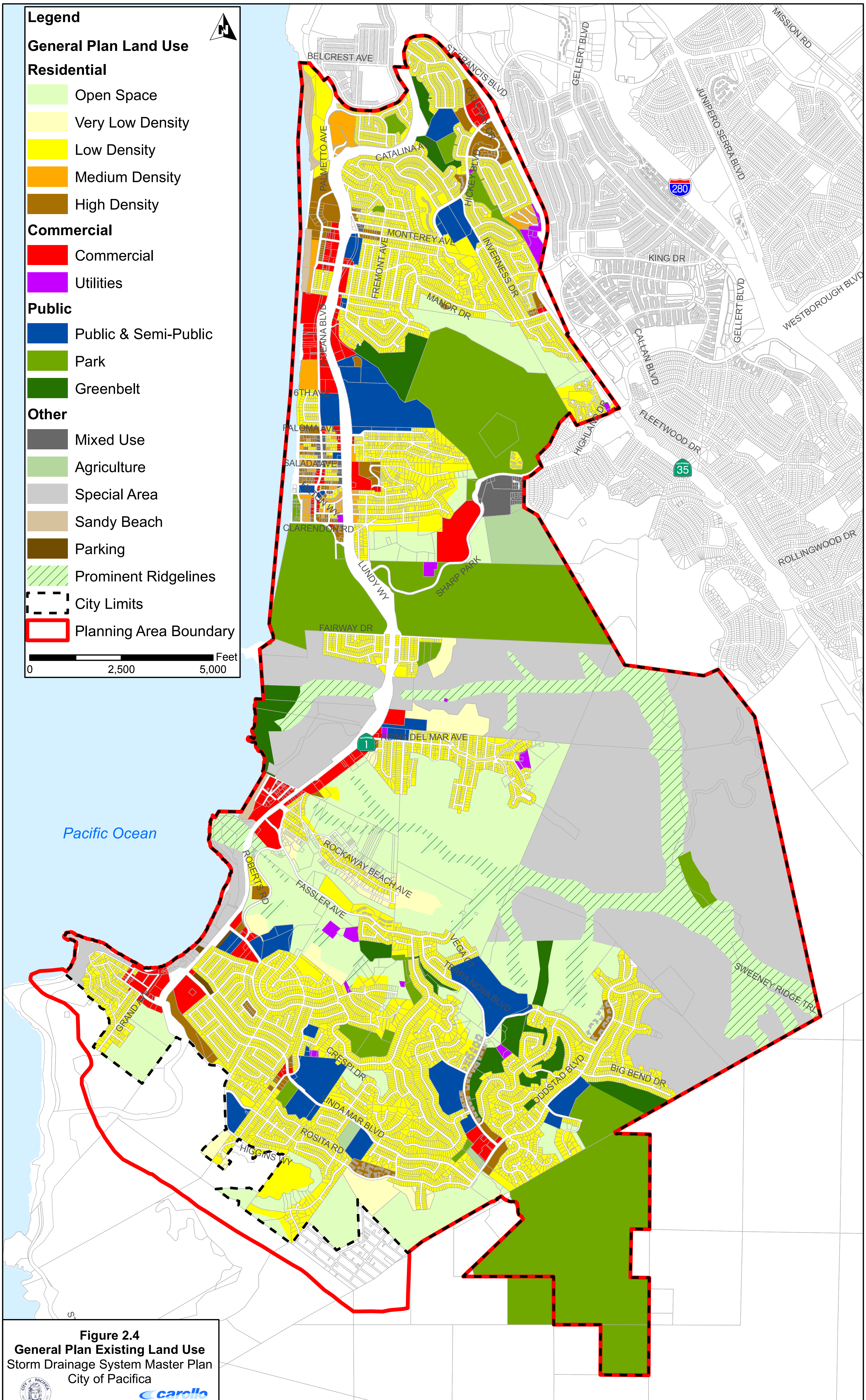

Figure 2.4
General Plan Existing Land Use
Storm Drainage System Master Plan
City of Pacifica

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Table 2.1 Land Use in the Planning Area		
Land Use	**Acres in Planning Area**	**Percent of Planning Area (percent)**
Open Space		
Parks & Accessible Open Space	3,262	42.7
Other Open Space	299	3.9
Beach	43	0.6
Subtotal	**3,604**	**47.1**
Residential Uses		
Single-Family Residential	1,774	23.2
Multi-Family	175	2.3
Mobile Homes	9	0.1
Subtotal	**1,957**	**25.6**
Commercial Uses		
Auto Services	5	0.1
Retail Services and Restaurants	89	1.2
Hotels	7	0.1
Office	4	0.1
Subtotal	**104**	**1.4**
Mixed Use	4	0.1
Subtotal	**4**	**0.1**
Industrial Use	18	0.2
Subtotal	**18**	**0.2**
Public/Community/Institutional Uses		
Schools	238	3.1
Other Public or Community Uses	75	1.0
Churches	28	0.4
Utilities	55	0.7
Subtotal	**395**	**5.2**
Agriculture	361	4.7
Subtotal	**361**	**4.7**
Vacant/Undeveloped	1,204	15.7
Subtotal	**1,204**	**15.7**

Table 2.1 Land Use in the Planning Area		
Land Use	**Acres in Planning Area**	**Percent of Planning Area (percent)**
Total	**7,646**	**100.0**

Notes:

1. Table adapted from Table 2-1 in the City's Existing Conditions and Key Issues report (July 2010).
2. Total acres represent total land use in Pacifica, excluding right-of-way and areas of ocean included in the Planning Area.

summarizes the land use designations, along with gross acreages, for the current City Limits and Planning Area. Table 2.2 summarizes land uses in the Planning Area, Coastal Zone, and outside City limits.

Parks, open space, and beach area comprise the majority of the City's land usage, with 3,604 acres of preserved open space. Residential uses comprise 1,957 acres (26 percent) of the service area, and vacant or undeveloped space comprise 1,204 acres (16 percent) of current land use. Other existing land uses include 361 acres of agriculture, 395 acres of public or community space, 104 acres of commercial uses, 18 acres of industrial uses, and 4 acres of mixed use development.

2.6.1.2 Future Service Area Land Use

The City's potential future service area land use includes current land use, as well as the potential development of some of the 1,204 acres of vacant or undeveloped land currently within the City planning area (Table 2.1). As a part of the 2030 General Plan Update, the City has prepared three commercial development alternatives and one residential development opportunity that are currently being reviewed and discussed by residents and local government. In August 2011, Dyett & Bhatia (the preparers of the City's 2010 Existing Conditions and Key Issues Report) issue a memorandum on recommendations for future development. This memorandum is included in Appendix B and will be used to characterize future development in the City.

At build-out of the General Plan boundary, the City will encompass approximately 8,742 acres. Approximately 8,284 acres within the study area are outside the 100-year floodplain, which encompass the area that is available for development.

Table 2.2 Land Uses in the Planning Area, the Coastal Zone, and Outside the City Limits

Land Use	Acres in Planning Area	Percent of Planning Area (%)	Acres in Coastal Zone	Percent of Coastal Zone (%)	Acres Outside City Limits	Percent of Planning Area Outside City Limits (%)
Open Spaces	3,604	47.1	469	47.5	65	15.9
Public, Community, Institutional	395	5.2	38	3.9	0	0.0
Residential Uses	1,957	25.6	206	20.9	2	0.5
Commercial Uses	104	1.4	38	3.9	0	0.0
Mixed Use	4	0.1	3	0.3	0	0.0
Industrial Uses	18	0.2	13	1.3	0	0.0
Agriculture	361	4.7	9	0.9	104	25.5
Vacant or Undeveloped	1,204	15.7	211	21.4	237	58.1
Total	**7,647**	**100.0**	**988**	**100.0**	**408**	**100.0**

Notes:

1. Table adapted from Table 2-2 in the City's Existing Conditions and Key Issues report (July 2010).
2. Total acres represent total land use in Pacifica, excluding right-of-way and areas of ocean included in the planning area.

2.7 HISTORICAL AND FUTURE POPULATION

Pacifica is highly residential, though tourism and the fishing industries are major components of the City's economy. Because of this, the City's growth rate is modest and is dependent on development trends. Except during the period from 1960 through 1970, when the City experienced rapid annual growth of approximately 5.4 percent, the City's average annual growth has remained low, between 0.2 and 0.9 percent, with some periods of decline. According to data collected from the California Department of Finance (DOF), the City's population for the year 2010 was approximately 37,267, which is below the City's 1990 population. Historical population trends have been variable, with a net increase between 1990 and 2000, followed by decline between 2000 and 2010. The City is still below its highest population of 38,320 in 2000, but has experienced some growth since 2006.

The Association of Bay Area Governments (ABAG) projected that the City will grow an average of 1,500 persons per decade for the next twenty years. The City's Existing Conditions and Key Issues report considers growth estimates from both DOF and ABAG, and recognizes that recent DOF population estimates are higher than those proposed by ABAG due to recent unexpected growth. Table 3-4 of the City's Existing Conditions and Key Issues report uses the 2010 ABAG population estimate even though it is less than the 2009 DOF population estimate. In an effort to provide a design that will meet maximum estimated growth, this Master Plan will assume the 2010 population estimate from the DOF, and will project population using the percent and decade growth rates stated in the City's Existing Conditions and Key Issues Report.

The variable annual growth rates proposed in the City's General Plan Update were used to calculate project populations through 2030. This assumed growth rate corresponds with an estimated population of 37,267 in 2010, 38,209 in 2020, and 39,765 in 2030, as shown in Figure 2.5, shows the historical and projected population trends from 1960 to 2030.

Table 2.3 Historical and Projected Population

Year	Population[1]	Estimated Annual Growth Rate[2] (%)
1960	20,995	--
1970	36,020	5.4
1980	36,866	0.2
1990	37,670	0.2
2000	38,320	0.2
2010	37,267	0.2
2015	37,641	0.3
2020	38,209	0.4
2025	38,980	0.4
2030	39,765	0.4

Notes:

1. Source: 1960 – 2010 populations from Department of Finance Estimates and the City's Existing Conditions and Key Issues report (July 2010). Projected 2015- 2030 populations based on listed estimated annual growth rates.
2. Source: City's Existing Conditions and Key Issues report (July 2010). Values represent growth rates from preceding decade.

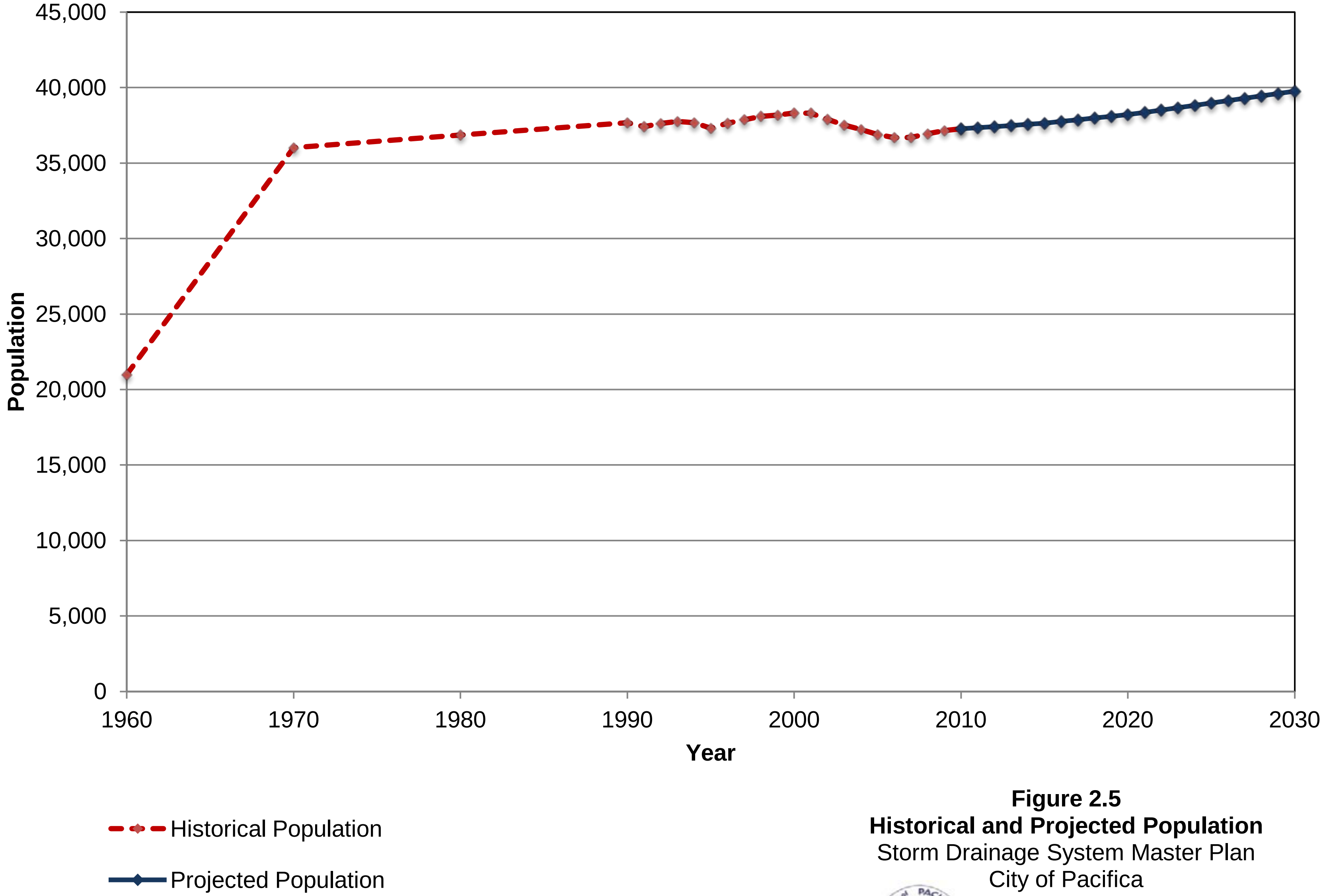


Figure 2.5
Historical and Projected Population
Storm Drainage System Master Plan
City of Pacifica

PLANNING CRITERIA

The capacity of the City of Pacifica's (City) storm drainage collection system was evaluated based on the planning criteria defined in this chapter. The criteria were established to assess the performance of the storm drainage system, as simulated by the computer hydraulic model, and for sizing future facilities. The criteria consisted of specific guidelines recommended by the City, San Mateo County (County), State regulatory agencies, and other planning criteria developed by Carollo based on engineering judgment and past experience.

Precipitation characteristics, design storm duration and frequency, and impervious versus pervious surfaces were reviewed to perform the hydrologic analysis on the system. Facility deficiencies were identified through a comparison of the City's storm drainage system performance and the established planning criteria. Such a comparison defines the type, location, and extent of the facility deficiencies that should be corrected to maintain a storm drainage system with enough capacity to satisfy the selected storm conditions.

3.1 HYDROLOGIC CRITERIA

This section describes the hydrologic characteristics of the City and the design storms that were used to estimate existing and future storm flows.

3.1.1 Precipitation Characteristics

The City's coastal location results in a generally wet climate, with a wet season extending from October through May. However, most of the City's rainfall typically occurs between November and April. The City receives fog throughout the year that can produce a light to moderate drizzle. Mean annual precipitation in Pacifica is approximately 20.9 inches.[1]

3.1.2 Elements of the Design Storms

The capacity of storm drainage facilities depends on the selected level of protection to be provided by those facilities. The level of protection is often expressed in terms of the frequency, or return period, of the storm for which the facilities are to prevent damage or for which the facilities will safely pass the storm water flows. This storm is referred to as the design storm and is an idealized representation of a typical storm with a specified return period. Selection of the design storm can have a significant impact on the size and cost of required drainage facilities. There are three elements of a design storm: precipitation depth, duration, and frequency.

[1] Source: Mean annual precipitation is for San Francisco International Airport, from the Western Regional Climate Center. Period of record July 1996 to December 2008.

3.1.2.1 Precipitation Depth

Precipitation depth is the amount of precipitation occurring during a specified storm duration. The depths of rainfall are statistical depths obtained by studying historical precipitation data to find the depth for each duration and for a particular frequency. Precipitation depth is usually expressed in inches.

3.1.2.2 Duration

Duration is the specified length of storm time considered. Duration of a design storm event should be at least four times the response time of the basin. The response time is the time required for the peak flow to reach the point of interest, such as a structure, outlet, or spillway. When the design of storage facilities is involved, the duration should be sufficiently long so that the runoff and storage volumes return to near their level at the beginning of the simulation. Duration may be expressed in any time unit such as minutes, hours, or days.

3.1.2.3 Frequency

Frequency is the number of occurrences of events with the specified precipitation depth and duration. It is expressed in terms of return period. In order to provide a reasonable level of flood protection, the statistical concept of return period or recurrence interval is utilized, which aids in assigning a probabilistic meaning to a precipitation event.

3.1.3 Design Storms

Two design storms were used for the evaluation of the City's existing storm drainage system and for sizing future storm drainage facilities. The 24 hour, 10 year event was used for evaluating storm conveyance facilities, while the 24 hour, 50 year event was used for evaluating the combined capacity of depression storage areas, streets, and pipes. The 10 year and 50 year recurrence intervals are standard selections in California because they provide a balance between level of service and affordability, and provide reasonable standards of care. Five-minute time steps were used in this analysis. The storm hydrographs were balanced so that 5, 10, 15, etc. minute intensities were nested symmetrically within the 24-hour storm.

The City's design storms were developed using U.S. Department of Agriculture and Natural Resources Conservation Service (NRCS) standardized 24-hour distribution curves (Type II) with historical precipitation data. Depth-duration-frequency (DDF) relationships for this region are available from the Department of Water Resources (DWR), which were used to derive rainfall hyetographs for the City's design storms (Table 3.1).[2] Figure 3.1 illustrates the 24-hour design storms for the 10-year and 50-year recurrence intervals.

[2] DDF data from the City of San Francisco was used in lieu of rainfall data from Pacifica because of the long-term data that was available.

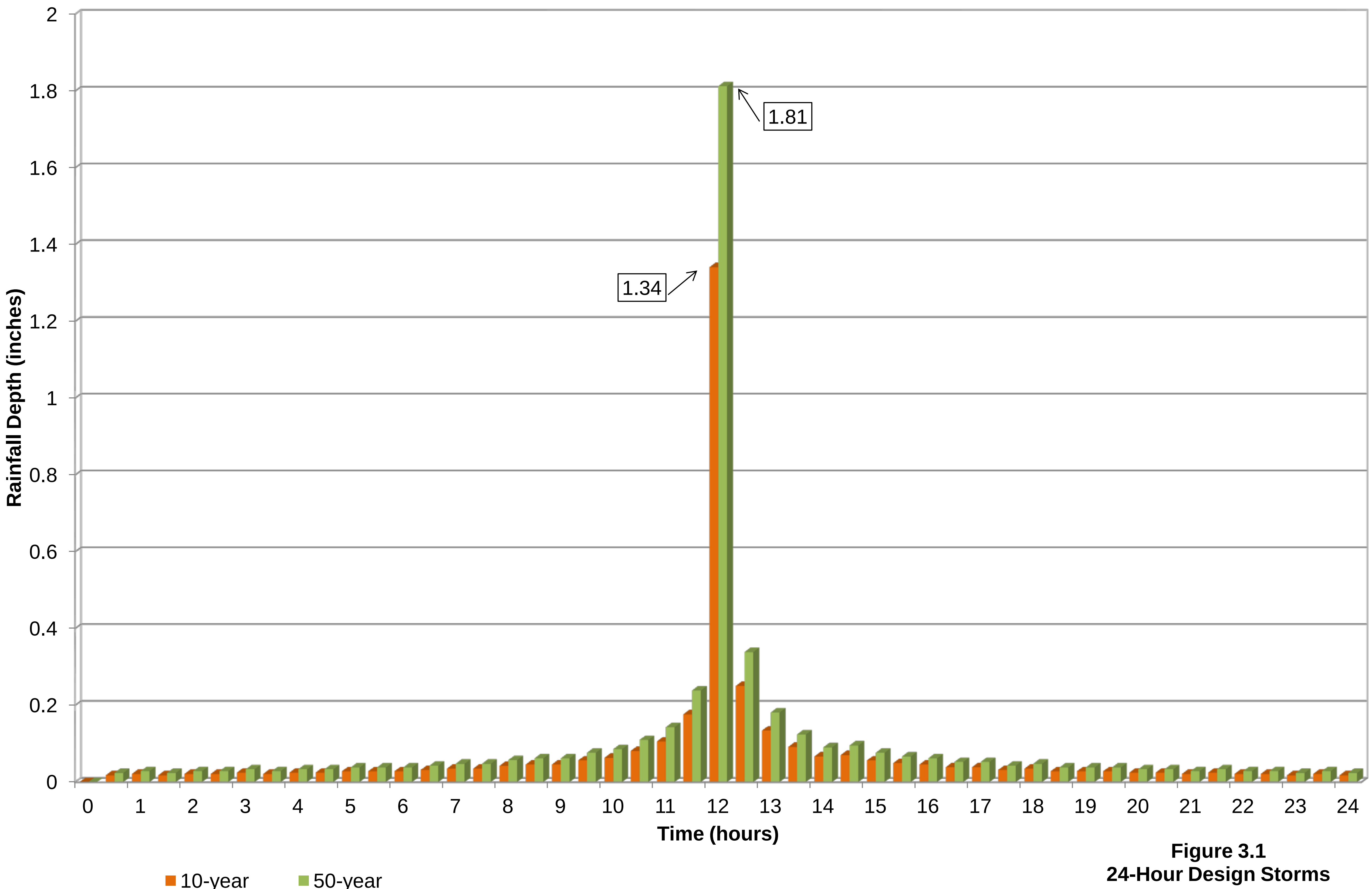


Figure 3.1
24-Hour Design Storms
Storm Drainage System Master Plan
City of Pacifica

Table 3.1 Precipitation Depth-Duration Frequency				
Duration	10-Year		50-Year	
	inches	inches/hour	inches	inches/hour
1-hour	0.85	0.85	1.14	1.14
2-hours	1.19	0.60	1.61	0.81
3-hours	1.43	0.48	1.94	0.65
6-hours	2.01	0.34	2.71	0.45
12-hours	2.67	0.22	3.61	0.30
24-hours(2)	3.53	0.15	4.77	0.20

Notes:

1. Table derived from data collected from the California Department of Water Resources.
2. The 24-hour, 10-year, and 50-year events were used for the evaluation of the City's storm drainage system.

3.1.4 Soil Characteristics

For storm water modeling, key factors relating land use to runoff are percent impervious and percent pervious area of the modeled area. The following sections describe the planning criteria and methods used to characterize the soil and runoff characteristics for the City.

3.1.4.1 Impervious Area

High-resolution WorldView-2 satellite imagery was used to determine land use imperviousness. The 0.5 meter resolution satellite imagery was taken of the City in April 2011, and was selected because of its multispectral characteristics. Multispectral imagery allows for common band combinations, such as near infrared (bands 4, 3, and 2). Near infrared allows the user to identify vegetation, water bodies, and man-made features. Vegetation appear as shades of red, water as shades of blue or black, and urban areas as shades of blue-gray.

An image processing model was developed whereby impervious and pervious surfaces were classified from the satellite imagery bands and then extracted based on user-defined variables. The classification method included 30 samples throughout the study area encompassing all lands uses including multiple areas of vegetation, urban areas, and water. After the initial imager reclassification, the results were extracted and the surfaces were reclassified as either pervious or impervious cover.

The analysis of the satellite imagery was used to determine that relative percent perviousness and imperviousness of the subcatchments in the hydraulic model. However, the hydraulic modeling software used for this study (described in Chapter 4) requires percent directly connected impervious area (DCIA) values to estimate the volume of runoff, rather than percent imperviousness.

3.1.4.2 Directly Connected Impervious Area

The basin proportion of directly connected or effective impervious area is related to land use, storm water drainage system configuration, and recurrence interval. If runoff from an impervious area flows directly into a concentrated flow path, i.e. into a gutter, it is considered directly connected. If it flows over a pervious area before becoming a concentrated flow, it is unconnected. Rainfall on impervious surfaces is not subject to losses by infiltration into the soil; the only losses in impervious areas are due to depression storage. All initial losses for impervious areas, typically 0.02 to 0.08 inches, were assumed to be satisfied by precipitation preceding the design storm.

The imperviousness derived from the satellite imagery represents the total average impervious area in a subbasin. To convert average percent imperviousness to DCIA, the following equation (developed by USGS) was used:

$$\%DCIA = 3.6 + 0.43I \qquad (1)$$

Where: I = percent total impervious area.

Table 3.2 provides the average percents perviousness and imperviousness of the City based on satellite imagery, and the resulting DCIA values that were used to populate the hydraulic model. The values in Table 3.2 were used to determine the percent DCIA for future land uses and proposed developments based on the General Plan Update process. Ultimately, the watershed DCIA-land use relationships shown in Table 3.2 were used in conjunction with proposed General Plan development alternatives to determine future DCIA values for each SWMM model subbasin (described in Chapter 4).

Table 3.2 Percent Impervious/Pervious Area by Land Use

Land Use Category	Percent Impervious	Percent Pervious	Percent DCIA[(1)]
Residential Designations			
Mobile Homes	11	89	42
Multi-Family	53	47	24
Single Family Residential	66	34	18
Commercial Designations			
Auto Services	16	84	40
Commercial	21	79	38
Hotels	21	79	37
Mixed Use	16	84	40
Office	26	74	35
Utilities	83	17	11
Agricultural Designations			
Agriculture	96	4	5
Industrial Designations			
Industrial	15	85	40
Other Designations			
Beach	14	86	41
Church	58	42	21
Other Open Space	96	4	5
Other Public or Community Uses	64	36	19
Parks & Accessible Open Space	98	2	5
Schools	72	28	16
Vacant/Undeveloped	97	3	5
Unknown[(2)]	77	23	13

Notes:

1. DCIA = Directly Connected Impervious Area.
2. Unknown includes street right-of-ways and other land use not classified in the City's existing land use plan.

3.1.4.3 Non-Effective Percent Imperviousness

In residential urban areas, either a portion of the pervious runoff area has no flow path to the drainage system, or the flow path is via groundwater drains, which effectively delays runoff until it does not contribute to the design hydrographs. These areas are typically backyards, swimming pools, dense shrub landscaping, and gardens.

3.1.4.4 Pervious Area Runoff and Infiltration Parameters

The remaining runoff originates from pervious areas. There are several ways to estimate the volume and/or the rate of infiltration of water into a soil. Three excellent estimation methods are Green-Ampt, Soil Conservation Service (SCS) method, and Horton's method. All of these equations provide a relatively accurate assessment of the infiltration characteristics of the soil in question. Infiltration into the soil in pervious areas was estimated for each subbasin by the model using the Horton equation. Horton and Green-Ampt are widely used in SWMM, especially when using SWMM runoff module. The Green-Ampt method accounts for multiple variables that other methods, such as Horton, do not. The Green-Ampt method is a function of the soil solution head, porosity, hydraulic conductivity, and time. Some of these parameters are difficult to estimate.

On the other hand, Horton equation is an empirical formula that states that infiltration starts at a given rate and decreases exponentially with time. After a period of time when the soil saturation level reaches a certain value, the rate of infiltration will become constant. Parameters for the Horton equation can be reasonably estimated from literature and U.S. Department of Agriculture (USDA) soil data.

Because the Horton parameters vary depending on soil type, soil maps were examined to determine the soil type within each drainage area. Weighted average soil properties were determined for each SWMM model subbasin based on the amount of each hydrologic soil group in the subbasin, and typical soil properties for each group.

Four hydrologic soil groups are used. The soils are classified based on water intake at the end of long duration storms after prior wetting, an opportunity for swelling, and without the proactive effects of vegetation. The hydrologic soil groups are:

A. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate infiltration rates when thoroughly wetted and consisting of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with high swelling potential, soils with permanent high water table, soils with claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

By determining the percentages of each hydrologic soil group within a subbasin, maximum and minimum infiltration rates were calculated. The constant decay rate for Horton infiltration analysis was set to 0.0015 per second. Figure 3.2 shows the hydrologic soil groups within the City, which are based on data provided by the Natural Resources Conservation Service (NRCS). As shown in Figure 3.2, the dominant Hydrologic Soil Group with the study area is Hydrologic Soil Group D, with a small portion designated as Hydrologic Soil Groups A and B. Each soil group is associated with the typical infiltration soil properties as listed in Table 3.3.

Table 3.3 Infiltration Rates for NRCS Hydrologic Soil Groups

Soil Group	Maximum Infiltration Rate (inches/hour)	Minimum Infiltration Rate (inches/hour)
A	2.0	0.065
B	1.5	0.050
C	1.0	0.035
D	0.5	0.020

3.1.4.5 Overland Flow

The overland flow travel time is affected by the type of surface cover, and can be modeled using a different Manning's coefficient (n) for various surface types. For each SWMM unit, roughness coefficients were input into the model for both pervious and impervious surfaces. Typical roughness coefficients, based on the types of ground cover, are shown in Table 3.5.

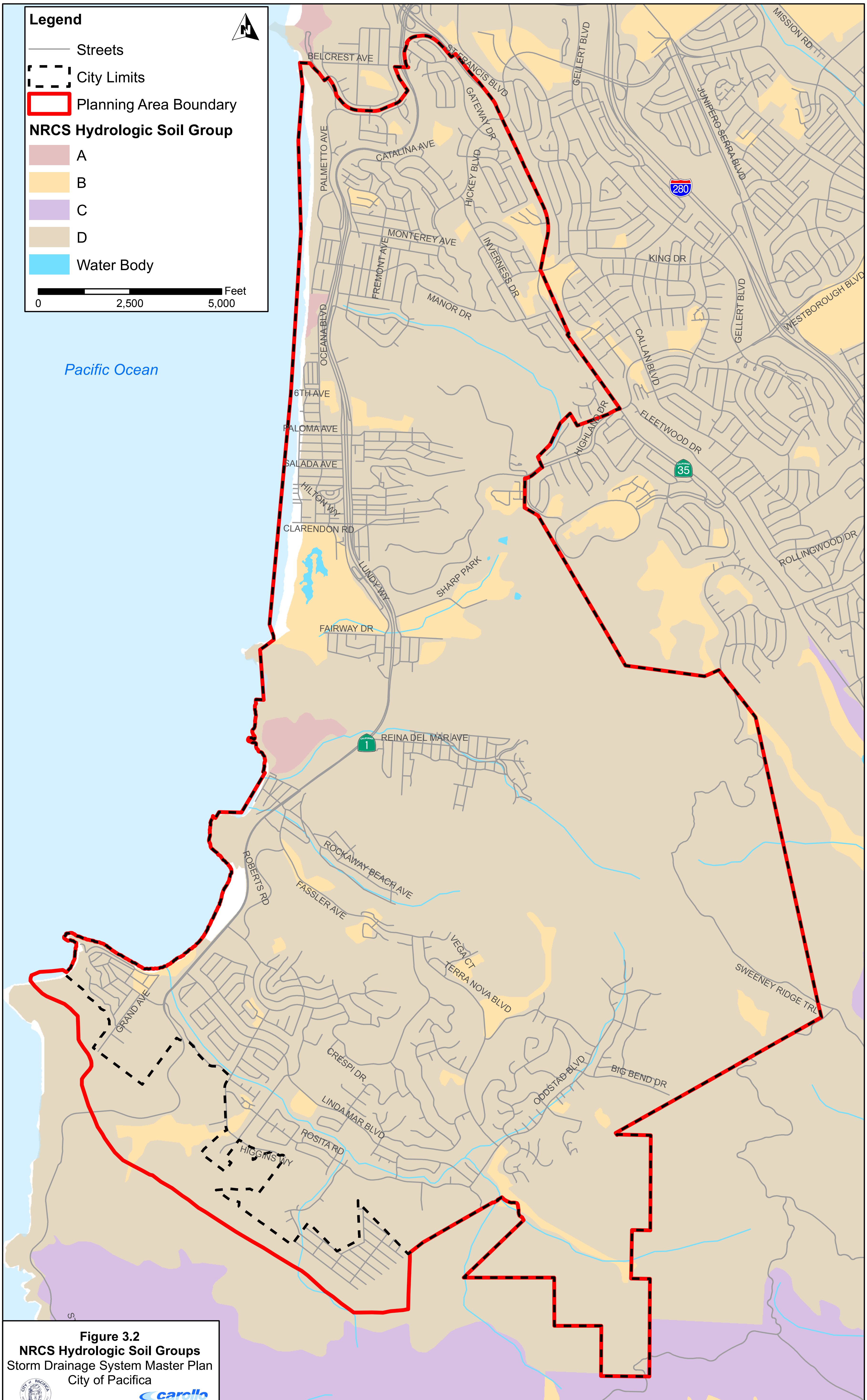


Figure 3.2
NRCS Hydrologic Soil Groups
Storm Drainage System Master Plan
City of Pacifica

Table 3.4 Parameters for Overland Flow		
Surface	**Overland Manning's n**	**Distance/Range (ft)**
Pavement – smooth	0.02	50 – 200
Pavement – rough/cracked	0.05	50 – 200
Bare soil – newly graded areas	0.10	100 – 300
Range – heavily grazed	0.15	100 – 300
Turf – 1-2 in lawns/golf courses	0.20	100 – 300
Turf – 2-4 in parks/medians/pasture	0.30	200 – 500
Turf – 2-6 in natural grassland	0.40	200 – 500
Residential Landscaping	0.60	100 – 300
Few trees – natural grass undergrowth	0.50	300 – 600
Scattered trees – weed/shrub undergrowth	0.60	300 – 600
Numerous trees – dense undergrowth	0.80	300 – 600

Notes:

1. Manning's n for shallow flow depths is not the same as Manning's n for channels.

3.1.4.6 Depression Storage in Pervious and Impervious Areas

Depression storage is a volume that must be filled prior to the occurrence of runoff on pervious and impervious areas and is often used as a calibration parameter. Depression storage is input into the model as an average depth over the entire drainage area. Because this value is difficult to estimate, trial depression storage values were initially assumed for pervious and impervious portions of the City and then adjusted, where necessary, during hydraulic model development.

3.1.4.7 Ground Slope

Ground slopes were determined using the City's elevation data and ArcView GIS. An average overland flow path slope is required for each hydraulic model subbasin. This value was automatically determined through intersection of subbasin areas with the Digital Elevation Model (DEM) derived from the City elevation data points and survey data. The elevation grid was intersected with the subbasins and the slope of each grid cell within the subbasin was calculated. Using the number of cells within each subbasin, the average basin slope was calculated. To verify this procedure, subbasin slopes for selected subbasins were manually estimated using available ground contour elevations and following guidelines provided by the hydraulic model manufacturer (described in Chapter 4).

3.2 HYDRAULIC CRITERIA

The County's subdivision and zoning regulations stipulate general policies of the City and outline storm drain design criteria. If not discussed in this Storm Drainage Master Plan (Master Plan), the reader should assume that the design criteria conform to the City's design criteria. Some of these criteria are discussed below.

3.2.1 Storm Drainage System

The City's topography and disconnected design result in a storm drainage system that has many hydraulically-distinct sections that operate independently of other drainage areas in the City. In general, the City maintains a storm drainage system that consists of a collection system that conveys runoff to natural drainage channels or directly to the ocean. Two areas, Linda Mar and lower Sharp Park, are too low to allow for gravity drainage and rely on two City-operated pump stations to prevent street flooding.

Capacity analysis of the storm drain system was performed in accordance with the criteria established in this chapter. Storm drain capacity is dependent on many factors, including roughness of the pipe, slope of pipe, and other assumptions and criteria defined below.

Conveyance facilities in the City consist mainly of storm drainage pipes with some open channels. The flow capacity of a reinforced concrete storm drainpipe was based on the hydraulic model or on Manning's equation with the pipe flowing full.

3.2.2 Pipe Flow

Manning's equation for pipe flow was used to determine travel time for flow through pipes.

3.2.2.1 Manning Coefficient (n)

The Manning coefficient 'n' is a friction coefficient and varies with respect to pipe material, smoothness of pipe and joints, and build up of debris or other obstructions like root intrusion. For storm drain pipes, the Manning coefficient typically ranges between 0.012 and 0.015 depending on material type. The Manning's n value for all storm drains was assumed to be 0.015 for the hydraulic analysis. This is a conservative estimate for Manning's n value, but is reasonable considering the age of some pipes in the drainage system.

3.2.3 Channel Flow

Manning's equation for open channel flow was used to derive travel time, velocity, flow, and width relationships for channels. The modeling software calculates ditch or channel travel time using entered values of slope, width, bank side slope, and Manning's n. The modeling software required input of a typical contributing area to determine depth of flow.

3.2.4 Surcharge Depth and Street Flooding

Storm drains are designed to surcharge under normal operation. It is common engineering practice to allow street curbs and gutters to act as storage and conveyance of storm water, similar to overland flow, for a given rainfall intensity and duration in order to protect adjacent properties from flooding. When evaluating the adequacy of the exiting conveyance facilities serving existing developments, City streets were allowed to flood and provide flow attenuation and storage capacity, thus avoiding cost-prohibitive improvements. Floodwaters were permitted to accumulate in streets up to 7 inches above the gutter flow line for the 50-year design storm. For streets without established gutters, assumptions were made regarding allowable flooding based on actual conditions.

3.2.5 Gutter Flow

The purpose of modeling gutter flow in the model is to account for the attenuation and storage of storm water. Storage in streets/gutters was first simulated in the model by allowing ponding at drop inlets. Based on the terrain and elevations around the inlets, estimations of ponded areas were developed for each inlet. These areas were allowed to flood or pond up to a depth of seven inches, unless additional ponding area was available.

Areas with flooding or ponding greater than seven inches were analyzed on an individual basis. To avoid unnecessary pipeline improvements in these areas, gutters were then modeled as open channels to represent actual gutter flow from one drop inlet to the next. A representative cross section was used to determine flow, velocity, and depth in the gutters. This allowed storm water to travel down the gutter to the next inlet where capacity in the pipe was available, which typically occurs in storm drainage systems. If modeling the system in this manner did not correct the capacity problem, then a storm drain improvement was necessary.

3.2.6 Pump Stations

Pump stations should be sized to efficiently handle the calculated runoff from a storm with a 10-year return period unless utilized in conjunction with a detention basin. Pump stations utilized in conjunction with basins should be sized to be capable of draining 100 percent of the basin's storage capacity within five days.

3.3 RELEVANT ASSUMPTIONS

In general, the storm drainage system data used to develop the hydraulic model were provided by the City and the references listed in Chapter 1. When data was not available, supplemental information was requested from City staff, or reasonable planning assumptions were made based on the nature of the missing information. One relevant assumption included that the Federal Emergency Management Agency (FEMA) 100-year water surface elevations were used as the downstream control for all facilities where FEMA flood profiles were available. Furthermore, it was assumed that all system outfalls to the Pacific Ocean constituted free outfall conditions; therefore, tidal patterns were not considered to affect system outfalls.

3.4 PLANNING AND DESIGN CRITERIA SUMMARY

The City's storm drainage system was evaluated based on the analysis and design criteria described in this chapter. These criteria are summarized in Table 3.5.

Table 3.5 Planning and Design Criteria Summary

Design Storms		
Design Storm	**Facilities to be Evaluated**	**Maximum HGL Depth/Flooding Depth Criteria**
10-year, 24-hour	Storm Sewer Conveyance Facilities	0.5' below Inlet Grates, 1.0' below Manhole Covers
50-year, 24-hour	Combined Capacity of Streets, Basins, and Pipes	Maximum 7" Allowable Flooding Depth in Streets

Precipitation Depth – Duration – Frequency

Duration	10-Year		50-Year	
	(inches)	(inches/hour)	(inches)	inches/hour)
1-hour	0.85	0.85	1.14	1.14
2-hour	1.19	0.60	1.61	0.81
3-hour	1.43	0.48	1.94	0.65
6-hour	2.01	0.34	2.71	0.45
12-hour	2.67	0.22	3.61	0.30
24-hour	3.53	0.15	4.77	0.20

Soil Imperviousness

Land Use Category	Percent Impervious	Percent Pervious	Percent DCIA[(1)]
Residential Designations			
Mobile Homes	89	11	42
Multi-Family	47	53	24
Single Family Residential	34	66	18
Commercial Designations			
Auto Services	84	16	40
Commercial	79	21	38
Hotels	79	21	37
Mixed Use	84	16	40
Office	74	26	35
Utilities	17	83	11
Agricultural Designations			
Agriculture	4	96	5
Industrial Designations			
Industrial	85	15	40
Other Designations			
Beach	86	14	41
Church	42	58	21
Other Open Space	4	96	5
Other Public or Community Uses	36	64	19
Parks & Accessible Open Space	2	98	5
Schools	28	72	16
Vacant/Undeveloped	3	97	5
Unknown[(2)]	23	77	13

Notes:
1. DCIA = Directly Connected Impervious Area.
2. Unknown includes street right-of-ways and other land uses not classified in the City's existing land use plans.

Design Hydrographs

The Design Hydrographs were determined using the SWMM RUNOFF Block of H20MAP SWMM software for the 10-year and 50-year 24-hour storms with 5-minute time steps.

Lag Time

Lag time was calculated by the travel time component method:

Lag time = To + Tg + Tp + Tc

To = Overland flow travel time
Tg = Gutter flow travel time
Tp = Pipe flow travel time
Tc = Channel flow travel time

Overland Flow

Surface	Overland Manning's n	Distance Range (ft)
Pavement – smooth	0.02	50 – 200
Pavement – rough/cracked	0.05	50 – 200
Bare soil – newly graded areas	0.10	100 – 300
Range – heavily grazed	0.15	100 – 300
Turf – 1-2 in lawns/golf courses	0.20	100 – 300
Turf – 2-4 in parks/medians/pasture	0.30	200 – 500
Turf – 2-6 in natural grassland	0.40	200 – 500
Residential Landscaping	0.60	100 – 300
Few trees – natural grass undergrowth	0.50	300 – 600
Scattered trees – weed/shrub undergrowth	0.60	300 – 600
Numerous trees – dense undergrowth	0.80	300 – 600

STORM DRAINAGE SYSTEM FACILITIES AND HYDRAULIC MODEL

This chapter presents an overview of the City of Pacifica's (City) storm drainage facilities. The chapter also describes the development of the City's storm drainage hydrologic and hydraulic models. These models were used for identifying existing system deficiencies and for recommending capital improvements.

4.1 SYSTEM OVERVIEW

The City's existing storm drainage system collects and conveys surface water runoff from developed and undeveloped areas throughout the City and ultimately discharges the runoff into the Pacific Ocean. While developed areas utilize storm drains to manage storm water, much of the City's storm water flow utilizes natural drainage channels and gutters for storm water management. Pacifica's variable topography creates valleys and distinct drainage areas that determine the nature of storm water flow through the City. Each of the City's drainage areas is described in Section 4.2.

Figure 4.1 shows the existing storm drainage system, including storm drain diameters, pump stations, outfall locations, and open channels. Table 4.1 presents a summary by diameter of the known storm drains in the drainage system. In total, there are approximately 48 miles of storm drains. The City also contains approximately 45,953 feet (8.7 miles) of natural drainage channels that convey storm water through the City and to the Pacific Ocean.

4.2 EXISTING SYSTEM DRAINAGE AREAS

The City is currently divided into 12 hydraulically distinct subbasins, shown in Figure 4.2. Table 4.2 summarizes the total area for each subbasin and the level of development in each. Each subbasin has a system of conveyance facilities to collect and dispose runoff. Depending on the subbasin, storm water runoff is conveyed to the Pacific Ocean through either storm water pipelines, or local drainage channels (e.g., San Pedro Creek, Calera Creek, etc.). The City does not currently utilize any detention or retention basins with its storm drainage system.

For the sake of clarity, the existing subbasins were grouped into seven larger drainage areas based on their watersheds. A brief description of each drainage area and the existing drainage facilities in each is provided below.

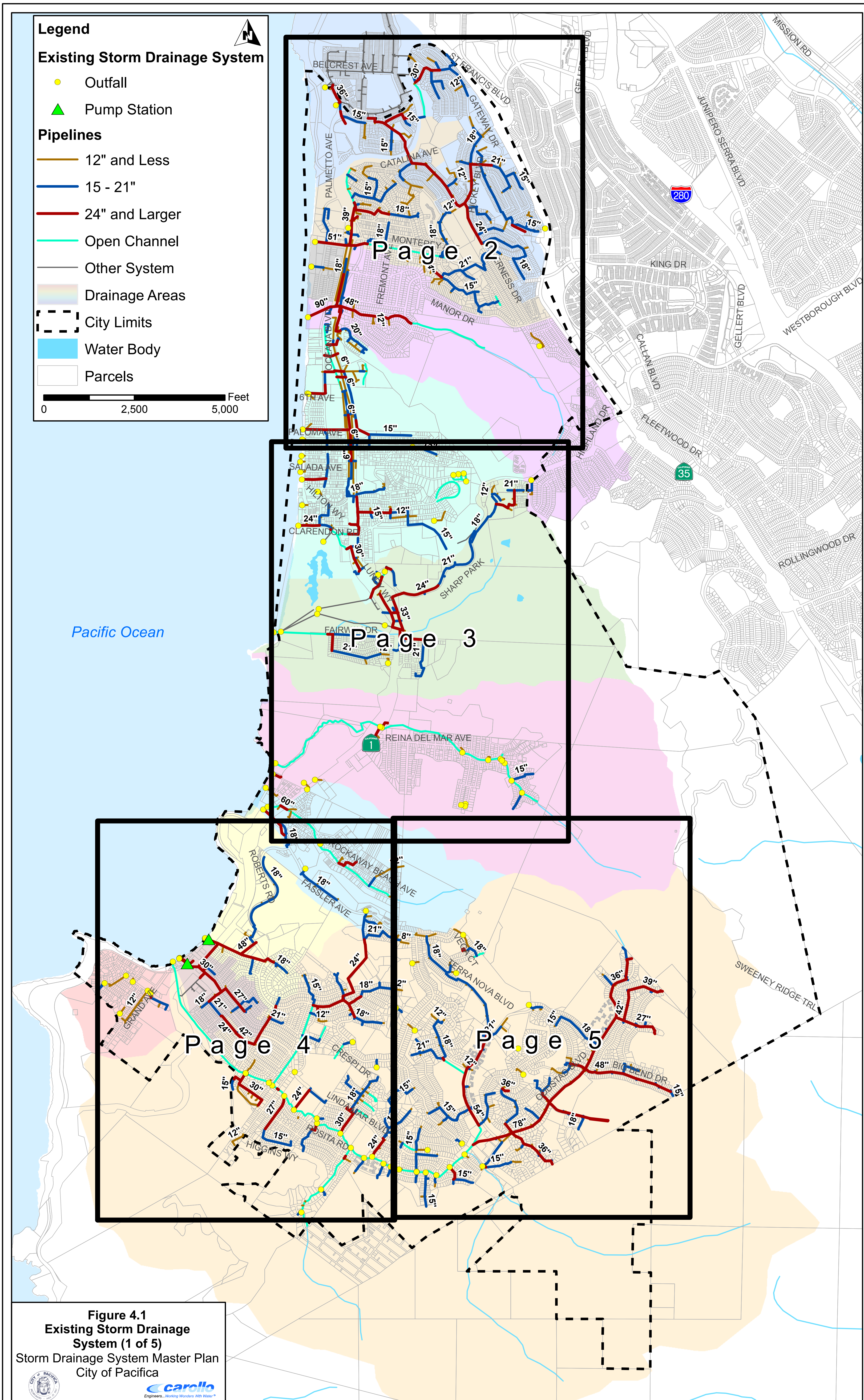
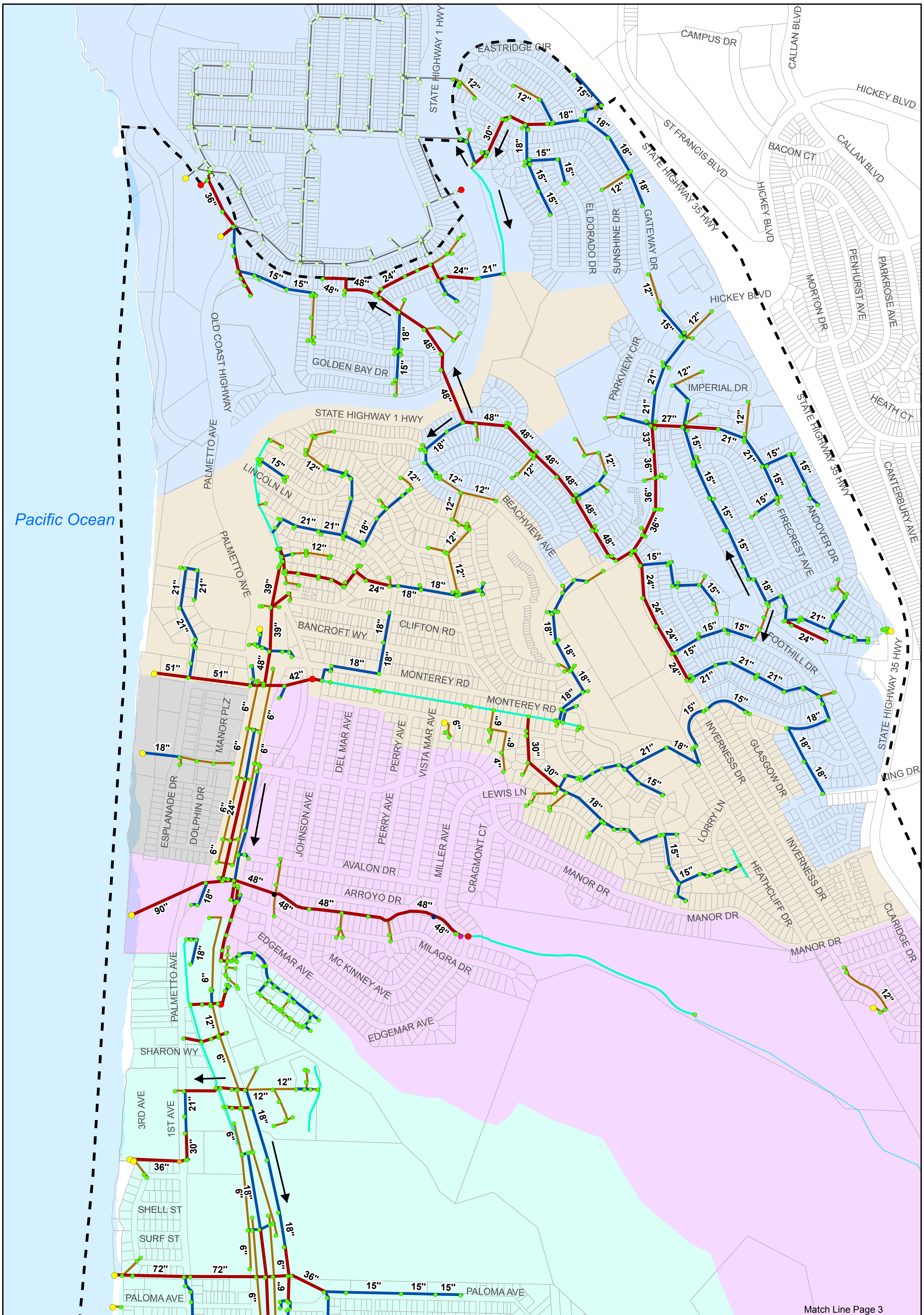


Figure 4.1
Existing Storm Drainage System (1 of 5)
Storm Drainage System Master Plan
City of Pacifica



Legend

Existing Storm Drainage System

- Outfall
- Pump Station
- Inlet
- Catch Basin/Manhole/Connector
- Diversion Structure
- Drain Structure
- Intake Structure
- Junction Box/Manhole
- Riser

Pipelines

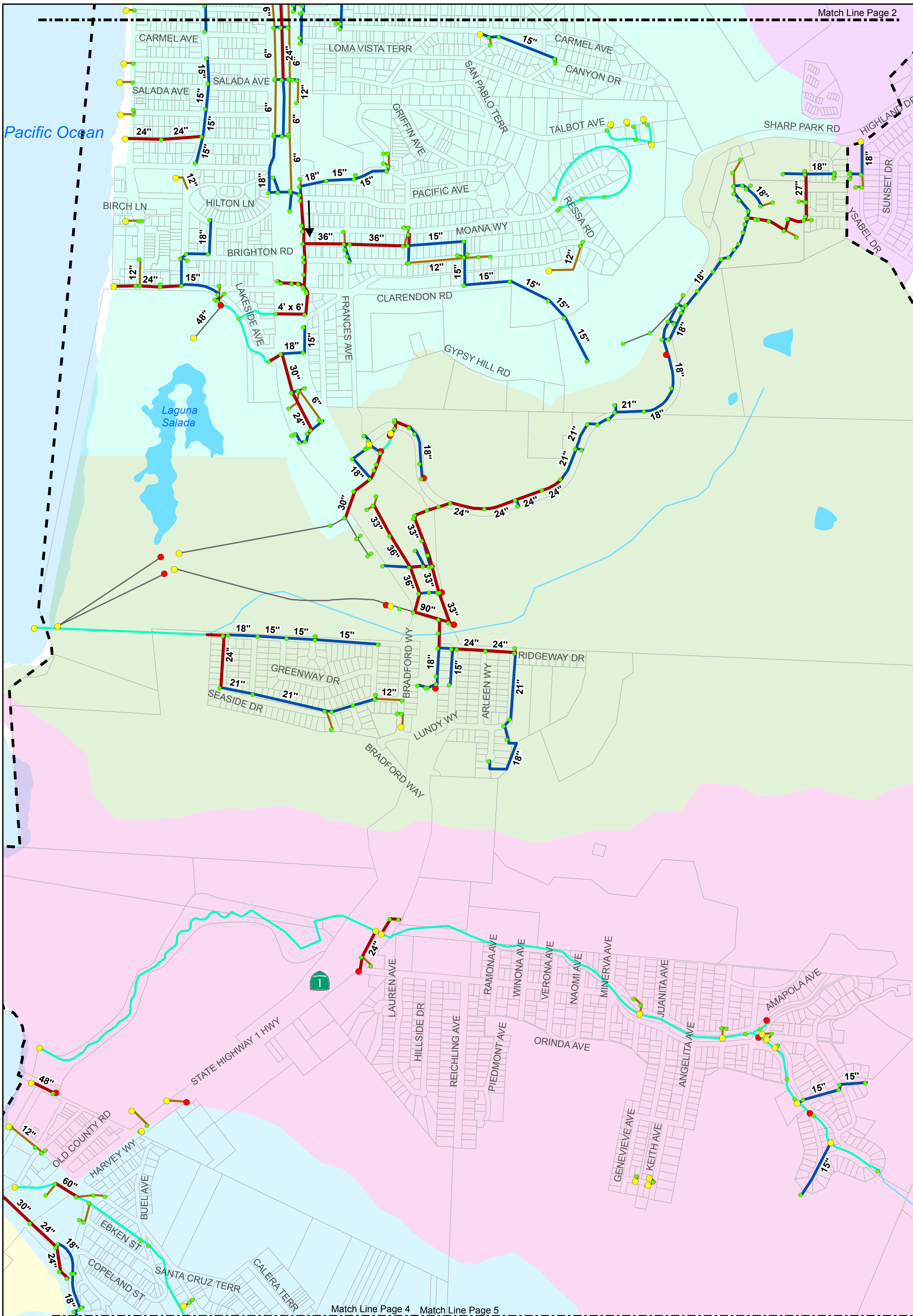
- 12" and Less
- 15 - 21"
- 24" and Larger
- Open Channel
- Privately Maintained

- Flow Direction
- City Limits
- Parcels
- Water Body
- Drainage Areas

0 750 1,500 Feet

Figure 4.1
Existing Storm Drainage System (2 of 5)
Storm Drainage System Master Plan
City of Pacifica

Carollo Engineers...Working Wonders With Water



Legend

Existing Storm Drainage System

- Outfall
- Pump Station
- Inlet
- Catch Basin/Manhole/Connector
- Diversion Structure
- Drain Structure
- Intake Structure
- Junction Box/Manhole
- Riser

Pipelines

- 12" and Less
- 15 - 21"
- 24" and Larger
- Open Channel
- Privately Maintained

- Flow Direction
- City Limits
- Parcels
- Water Body
- Drainage Areas

Feet: 0 — 750 — 1,500

Figure 4.1
Existing Storm Drainage System (3 of 5)
Storm Drainage System Master Plan
City of Pacifica

Legend

Existing Storm Drainage System

- Outfall
- Pump Station
- Inlet
- Catch Basin/Manhole/Connector
- Diversion Structure
- Drain Structure
- Intake Structure
- Junction Box/Manhole
- Riser

Pipelines

- 12" and Less
- 15 - 21"
- 24" and Larger
- Open Channel
- Privately Maintained

- Flow Direction
- City Limits
- Parcels
- Water Body
- Drainage Areas

Feet
0 750 1,500

Figure 4.1
Existing Storm Drainage System (4 of 5)
Storm Drainage System Master Plan
City of Pacifica

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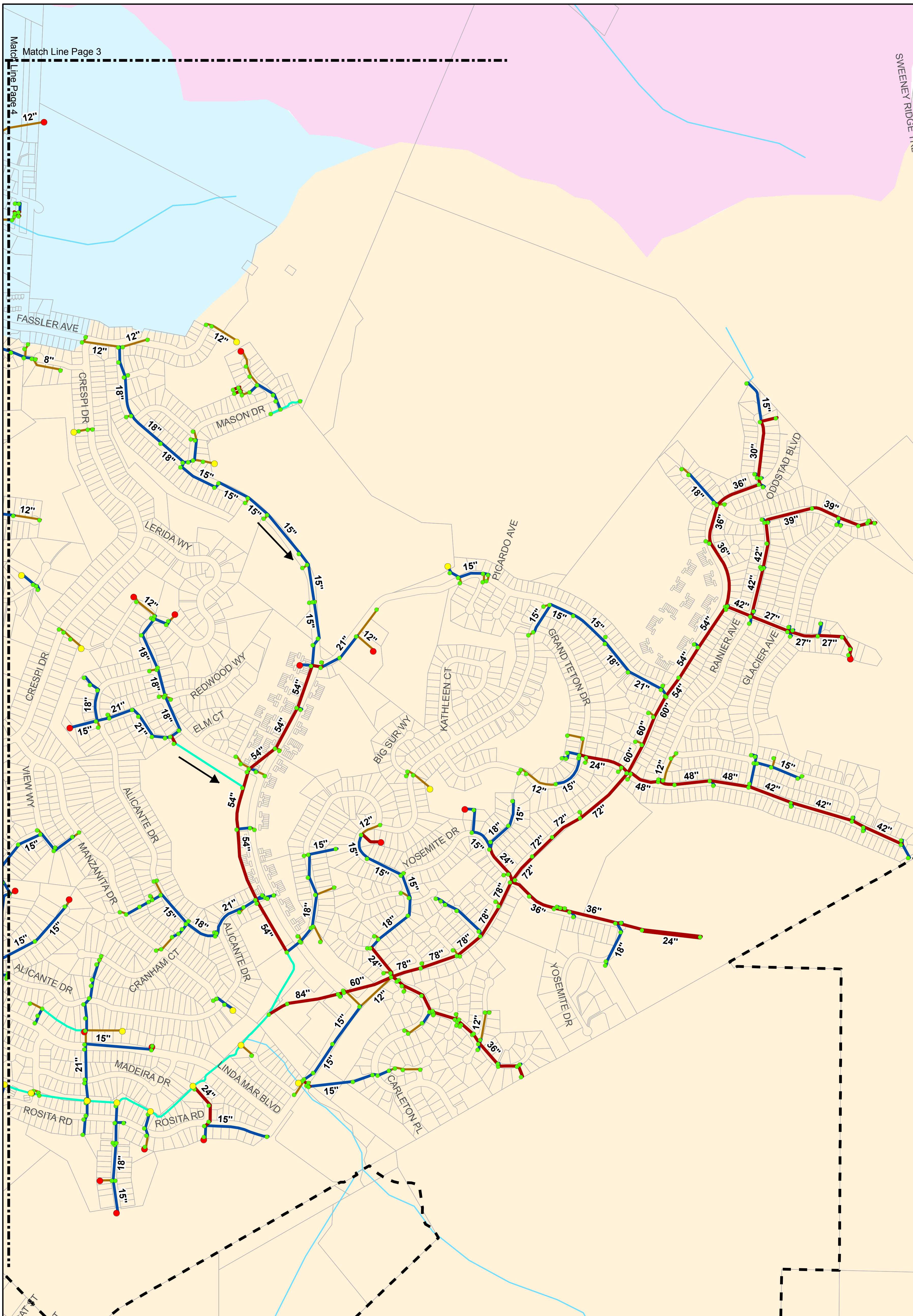

Legend

Existing Storm Drainage System

- Outfall
- Pump Station
- Inlet
- Catch Basin/Manhole/Connector
- Diversion Structure
- Drain Structure
- Intake Structure
- Junction Box/Manhole
- Riser

Pipelines

- 12" and Less
- 15 - 21"
- 24" and Larger
- Open Channel
- Privately Maintained

- Flow Direction
- City Limits
- Parcels
- Water Body
- Drainage Areas

Feet
0 750 1,500

Figure 4.1
Existing Storm Drainage System (5 of 5)
Storm Drainage System Master Plan
City of Pacifica

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Table 4.1 Storm Drainage System Pipeline Summary			
Diameter (inch)	**Length (feet)**	**Diameter (inch)**	**Length (feet)**
4	418	36	16,059
6	1,265	37	149
8	570	39	1,825
10	351	42	3,877
12	49,756	48	10,648
15	57,079	51	945
18	39,510	54	4,280
20	467	57	532
21	21,219	60	2,327
24	20,410	72	3,141
27	5,076	78	1,390
30	8,407	84	587
33	1,790	90	1,366
Total (feet)	**254,926**		
Total (miles)	**48.3**		

Notes:

1. System summary does not include pipeline infrastructure within Daly City or that which is managed by the California Department of Transportation.

4.2.1 North Pacifica

The North Pacifica drainage area encompasses the northern part of the City, including a portion of Daly City. Subbasins within the North Pacifica drainage area include East and West Fairmont, Monterey Road, West Edgemar-Pacific Manor, and East Edgemar-Pacifica Manor. Some of these subbasins are hydraulically connected through storm drainage pipeline infrastructure, but each has hydrologic characteristics that make them distinct from one another.

The storm water in this drainage area is managed by underground pipelines and several small open channels, two of which are primary drainage channels. One of these open channels is “Big Inch Creek” that flows through the neighborhood between Monterey Road and Nelson Avenue, and collects storm water from the Monterey Road subbasin.

The East Edgemar-Pacific Manor subbasin is served by the second prominent open channel in the North Pacifica drainage area, which stems from the valley area of the Milagra Ridge, part of the coastal mountain range that dissects the City. This channel flows

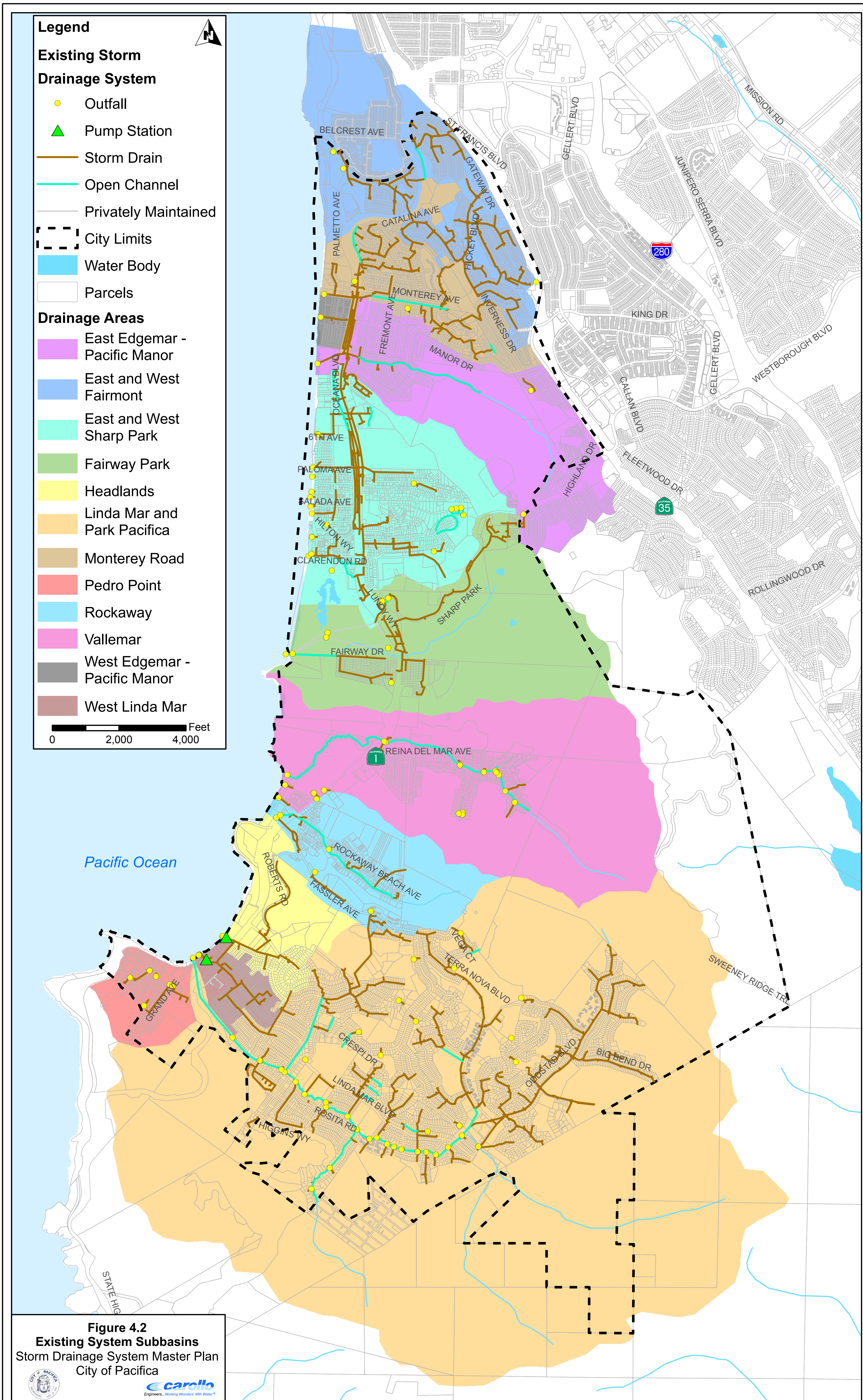

Figure 4.2
Existing System Subbasins
Storm Drainage System Master Plan
City of Pacifica

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Table 4.2 Subbasin Area and Level of Development					
		Developed		**Undeveloped**	
Drainage Area/ Subbasin	**Total Acres**	**Area (acres)**	**Percent of Total**	**Area (acres)**	**Percent of Total**
North Pacifica					
East and West Fairmont	642	274	43%	368	57%
Monterey Road	334	221	66%	112	34%
West Edgemar-Pacific Manor	30	20	67%	10	33%
East Edgemar-Pacific Manor	609	378	62%	231	38%
East and West Sharp Park	656	472	72%	184	28%
Fairway Park	803	709	88%	94	12%
Vallemar	1143	911	80%	231	20%
Rockaway	374	170	46%	203	54%
South Pacifica					
Headlands	240	109	45%	131	55%
West Linda Mar	91	66	73%	25	27%
Linda Mar and Park Pacifica	4748	2384	50%	2364	50%
Pedro Point	147	96	66%	51	34%

Notes:
1. Undeveloped area includes vacant, underutilized and greenbelt/panes/open space.

northwesterly between Milagra Drive and Arroyo Drive, and utilizes both pipe flow and a natural drainage channel to convey runoff. At the point where the residential development borders the open space area in the valley, the channel flow is split between continued open channel and a 48-inch pipeline. Flow that is not diverted from the natural drainage channel serves as the flow required to support the riparian habit. Collected storm water from the surrounding residential area is conveyed to the natural drainage channel, after which it is ultimately combined with the pipe flow and sent through a 90-inch pipeline to an ocean outfall.

The North Pacifica drainage area includes a combination of developed areas with dense pipeline infrastructure, and open space areas that rely more prominently on gutter and overland flow. All storm flows in this area are diverted to pipelines that flow underneath the highway and to various ocean outfalls. Storm drain pipelines range in size from 4-inches to 90-inches in diameter. Figure 4.2 and Table 4.2 illustrate the four subbasins that comprise the North Pacifica drainage area.

4.2.2 East and West Sharp Park

The East and West Sharp Park drainage area consists primarily of developed land with residential and commercial land uses, and a small portion of pervious hillside terrain. As such, much of the storm water conveyance system in this area is gutter flow over impervious surfaces and into inlets/catch basins, where it is combined into a pipeline conveyance system. Storm drainage flow through this area is westerly towards the ocean. Though small open channels exist, no open channel serves as a primary conveyance feature for this area.

The northern half of the Sharp Park Golf Course is included in this drainage area, and serves as the final outfall location for a large portion of the storm water runoff in East and West Sharp Park. Runoff is directed to a 48-inch outfall pipeline to Laguna Salada, a primary water feature at the golf course and substantial wetland area. However, the typically high water surface elevation of Laguna Salada, and silt deposition and plant growth around the outfall prevent adequate drainage of the southern portion of the drainage area. Inadequate drainage often leads to flooding of the residential and commercial development in the Clarendon Road and southernmost portion of Palmetto Avenue. When flooding events occur, the City uses a temporary pump near the Pacific Ocean outfall at the western end of Clarendon Road to remove standing water from the neighborhood. The Sharp Park Golf Course and the 48-inch outfall pipeline are currently managed by the City of San Francisco; any proposed improvements or storm water management efforts in this area may require coordination with the golf course management agency.

This drainage area also includes many independent ocean outfalls that serve separate, smaller neighborhood subbasins. A primary feature of the storm drainage collection system in this area is the complex drainage infrastructure that exists under Highway 1, which is managed by the California Department of Transportation (Caltrans). Though it is all interconnected, the various branches of the conveyance system divert storm flows to different ocean outfalls based on high and low elevation points in the area. Pipelines in this drainage area range in diameter from 6 inches to 60 inches.

4.2.3 Fairway Park

The Fairway Park drainage area is primarily comprised of pervious hillside terrain and manicured golf course turf. The area includes the communities of Fairway Park as well as a small portion of residential development on the ridgeline following Sharp Park Road, near Skyline Community College. Some of the storm water flows from this small ridgeline development are collected into the conveyance pipeline that underlies Sharp Park Road, while the remaining runoff flows into the Sharp Park valley and into several natural open channels.

Fairway Park is a small, hydraulically distinct neighborhood in Pacifica that is enveloped in the Sharp Park valley and adjacent to the Sharp Park golf course. An open channel runs north of the development in a westerly direction, which serves as primary runoff collection conduit for the open space areas upstream of the residential neighborhood. Storm water flow from the developed section of this drainage area is collected in pipelines ranging in diameter from 12 to 36 inches, where it is sent to a 90-inch pipeline and to an ocean outfall. Some of the runoff from this area contributes to the inflow into Laguna Salada (described in Section 4.2.2).

4.2.4 Vallemar

Vallemar is a hydraulically isolated community of Pacifica that is located along the floor of the Calera Valley. The Vallemar drainage area is comprised of a large portion of pervious hillside terrain, which contributes to the creation of several tributaries that feed Calera Creek. Calera Creek flows westerly through the residential development within this area, towards the ocean. There is minimal pipeline infrastructure for storm drainage in this area; storm drainage is facilitated primarily by gutter flow in the streets. A few 12-inch pipelines collect flow from the residential development and divert it into Calera Creek, which conveys all of the drainage area’s storm water flow to the ocean. Two 42-inch culverts exist in the upstream portion of Calera Creek to facilitate flow through the developed portion of the Vallemar neighborhood. Most of the land west of Highway 1 in this drainage area is open space that drains into Calera Creek, and ultimately to the ocean.

4.2.5 Rockaway

Rockaway is one of the oldest residential developments in Pacifica, and lies along the floor of the Rockaway Valley (elevations ranging from 270 feet above mean sea level [MSL] to sea level). The Rockaway drainage area is created by the ridgelines of Fassler Ridge and Cattle Hill, and is comprised of a high proportion of pervious hillside terrain compared to developed land. All of the storm water runoff through this area is diverted into a densely overgrown natural drainage channel that flows south of and alongside the primary thoroughfare (Rockaway Beach Avenue), in a westerly direction towards the ocean.

The community of Rockaway does not have a manmade gutter system to convey runoff. Rather, runoff typically utilizes overland flow to move from the hillside areas, through properties via on-site drainage measures, and into the drainage channel. The narrow design of the community facilitates quick recovery of impervious surface flow into the open channel. Cross sections of the drainage channel are extremely variable, and depend highly on the development design of the area (i.e. flow through residential backyard areas, under roadways, through commercial development, etc.). Collection system pipes in this area range in diameter from 8 to 30 inches, though the open channel does pass through a 60-inch pipeline under Highway 1.

4.2.6 South Pacifica

The South Pacifica drainage area encompasses the largest drainage area in the City, and is comprised of four smaller subbasins including the Headlands, West Linda Mar, Linda Mar and Park Pacifica, and Pedro Point. Included in this area is a large amount of residential development with many isolated branches of pipeline, most of which ultimately flow into San Pedro Creek. The topography of the area allows for utilization of gutter flow, which hydrologically connects the four subbasins in this drainage area during heavy storm events. The South Pacifica drainage basin is formed by a long stretch of the coastal mountain range, including Sweeney Ridge and Montara Mountain.

A large network of storm drainage pipelines run through the developed portion of this area, and range in diameter from 10 to 84 inches. All of the storm water flow collected by this infrastructure is diverted to San Pedro Creek (described in Section 4.2.6.1). The topography of the South Pacifica drainage area includes the variable hillside terrain near the coastal mountain range, and flat residential and commercial development towards the coastline. As a result, storm drainage issues differ based on drainage area subbasin, and subsequently have varying effects on storm water flows added to San Pedro Creek.

4.2.6.1 San Pedro Creek

San Pedro Creek is a perennial natural drainage channel that drains an 8-square mile watershed area in the South Pacifica drainage area, and provides riparian areas and winter flows that support migrating steelhead trout. The creek is formed by the combination of five main tributaries, including the north, middle, and south forks. The north fork was entirely converted to a culvert system in the 1970s. While the culverted north fork helps manage storm water flows into the creek, it also prevents natural infiltration and can subsequently cause downstream flows to reach unsustainable levels throughout the wet season. High flows through San Pedro Creek have historically caused significant erosion of creek habitat and flooding events that threaten residential and commercial development. In addition, the creek is intermittently affected by poor water quality. In particular, fecal and total coliform bacteria have been observed in a variety of sampling studies, and contributes to advisory warnings at Pacifica State Beach.[1]

San Pedro Creek serves as the primary means of storm water removal for most of the South Pacifica drainage area. As such, the creek will continue to act as an important drainage feature for all current and future development in the area. However, any future storm water control measures proposed for the watersheds in the South Pacifica drainage area must consider impacts to San Pedro Creek. Storage or retention best management practices (BMPs) and Low Impact Development (LID) measures will be recommended, as appropriate, to mitigate unhealthy flow rates during storm events. Providing temporary retention of storm water, rather than increasing flow capacity, will help protect riparian habitat and prevent downstream erosion of the creek bed.

[1] Source: San Pedro Creek Watershed Coalition. Retrieved August 15, 2011 from http://www.pedrocreek.org/index.html.

4.3 STORM DRAIN RETENTION/DETENTION BASINS

The City does not currently operate or maintain any storm drainage retention or detention basins.

4.4 STORM DRAIN PUMP STATIONS

There are currently two pump stations in the storm drainage system (Figure 4.1). Both pumps stations are located in the South Pacifica Drainage Area (specifically in the West Linda Mar neighborhood), and pump storm water from low-lying areas near the coastline. For both pump stations, limited information was available on the capacity, operating points, use pattern. Based on this limited information, the approximate capacities of the pump stations were estimated for use in the hydraulic model.

The smaller of the two pump stations ("Linda Mar") is located at the western edge of Linda Mar Blvd, west of Highway 1 and next to the beach. Linda Mar pump station contains three pumps: two with 50 horsepower (HP) motors and an estimated capacity of 13,500 gallons per minute (gpm), and one with a 40 HP motor and an estimated capacity of 11,200 gpm. According to the City, the approximate volume of the wet well for the Linda Mar pump station is 43,000 gallons. This pump station receives flow from the southern half of the West Linda Mar neighborhood and some surface runoff from the Linda Mar neighborhood.

The larger of the City's pump stations ("Anza") is located due west of Anza Drive, west of Highway 1 and next to the beach. This pump station also serves as a public restroom. Anza pump station contains three pumps: two with approximate maximum capacities of 31,000 gpm, and one with a 600 HP motor and an estimated capacity 140,000 gpm. According to the City, the approximate volume of the wet well for the Anza pump station is 62,000 gallons. This pump station receives storm water from the northern half of the West Linda Mar neighborhood and runoff from the Fassler Ridge hillside areas.

4.5 EXISTING DISCHARGE LOCATIONS

The City currently discharges storm runoff into the Pacific Ocean at approximately 22 locations throughout the City. Conveyance systems to the outfalls are comprised of a combination of pipelines and open channels. Several large open space areas on the coastline drain directly to the ocean and do not require conveyance infrastructure.

4.6 MODELING SOFTWARE

The storm drainage system was evaluated using H_2OMAP SWMM modeling software. H_2OMAP SWMM is a commercial version of EPA SWMM 5.0 software. The SWMM RUNOFF Block, which is included in H_2OMAP SWMM, was used to perform the hydrologic analysis.

H_2OMAP SWMM is a fully dynamic wastewater and storm water modeling and management software application. H_2OMAP SWMM can be used to model the entire land phase of the hydrologic cycle as applied to urban storm water and wastewater collection systems. The model can perform single event or long-term (continuous) rainfall-runoff simulations accounting for climate, soil, land use, and topographic conditions of the watershed. Once runoff quantity is simulated, and wastewater loads at receiving nodes are determined (for wastewater collection system modeling), the routing portion of H_2OMAP SWMM transports the flow through a conveyance system of pipes, channels, storage/treatment devices, pumps, and hydraulic regulators such as weirs and orifices. This can be done using either steady flow routing, kinematic wave routing, or dynamic wave routing. The model offers advanced Real-Time Control (RTC) scheme for the operational management of hydraulic structures.

4.7 HYDROLOGIC MODEL

Hydrologic analysis of the City's storm drainage system was performed using the SWMM Runoff Block, which is included in the H_2OMAP SWMM modeling software. The SWMM Runoff Block was designed to simulate the surface water runoff response of a drainage basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. The Runoff Block was used to simulate the quantity of storm water runoff that flows overland in each subbasin during a particular storm event.

In the SWMM Runoff Block, each model component represents a specific aspect of the rainfall-runoff processes occurring in a portion of the watershed. A component may represent the runoff occurring in a subbasin, the routing of flows down a drainage channel, or the routing of flows through a detention basin. The model operates by reading an input data file that contains the parameters describing each component of the drainage basin, along with information describing how the various components work together to form the drainage basin. The result of the modeling process was a tabulation of flow hydrographs at desired locations within the study area.

The Runoff Block output data was generated by the model based on the input parameters detailed below. Parameters describing the various components of the model are based on land use, soils, vegetation, drainage channels, and topography. For example, the land use in a subbasin will determine the percent of that subbasin that is impervious and the average condition of the drainage channels. These values, along with others describing additional components of the subbasin, are placed in a computer input data file that is read by the SWMM Runoff computer model and used as a basis for computation of the rainfall-runoff processes in the subbasin.

4.7.1 Design Hydrographs

Design hydrographs were determined using the SWMM Runoff Module of H_2OMAP SWMM, which is incorporated in the Pacifica storm water model. The 10-year and 50-year, 24 hour storms were used in the analysis. The hyetographs, which are graphical representations of the distribution of rainfall over time, were balanced so that 5, 10, 15, etc. minute intensities are nested symmetrically within the 24-hour storm. They were constructed (by the SWMM Runoff Module) from depth duration frequency (DDF) data provided in Chapter 3.

4.7.2 SWMM Hydrologic Unit (Subcatchment)

Subcatchments are hydrologic units of land whose topography and drainage system elements direct surface runoff to a single discharge point. The City was divided up into nearly 1,000 individual subcatchments and the appropriate outlet point was defined. The area and boundary of each subcatchment was determined with the use of development plans, available topographic data, and field observations to determine the drainage path. Table 4.3 summarizes the number of subcatchments by subbasin and the minimum, maximum, and average subcatchment area within each subbasin.

Table 4.3 Subcatchment Summary

Drainage Area/ Subbasin	Total Area (acres)	No. of Subcatchments	Subcatchment Area (acres)		
			Min	Max	Avg
North Pacifica					
East and West Fairmont	637.1	226	0.1	132.3	2.8
Monterey Road	322.9	109	0.2	34.1	3.0
West Edgemar-Pacific Manor	31.1	5	1.0	13.8	6.2
East Edgemar-Pacific Manor	601.7	18	0.7	418.4	33.4
East and West Sharp Park	606.9	72	0.1	126.8	8.4
Fairway Park	853.9	42	0.3	426.3	20.3
Vallemar	1,142.8	13	5.3	285.2	87.9
Rockaway	380.0	19	0.8	112.1	20.0
South Pacifica					
Headlands	238.6	22	0.4	74.1	10.8
West Linda Mar	78.4	36	0.02	7.9	2.2
Linda Mar and Park Pacifica	4,767.6	400	0.01	1,423.5	5.0
Pedro Point	140.5	7	1.8	65.7	20.1

4.7.3 Width of SWMM Hydrologic Unit (Subcatchment)

The width of each SWMM Hydrologic unit, or SWMM subbasin was used by the model to estimate the flow from the furthest point in the drainage area to the outlet. Determining this physical width of overland flow is a difficult process as it depends on storage and shape effects of the subbasin. Therefore, it is commonly used as a calibration parameter to account for the impact of the drainage system within each subbasin on flow travel time. However, due to inadequate data for calibrating the runoff from each subbasin, subbasin width was not considered as a calibration parameter in this analysis. Instead, the width was estimated first by determining the maximum length of overland flow and dividing the area by this length. This method is recommended in the SWMM User's Manual.

4.8 HYDRAULIC MODEL

The H_2OMAP SWMM hydraulic model was used to simulate the hydraulic conditions in the City's storm drainage system. The computer hydraulic model was used to analyze the storm drainage system, to identify deficiencies, and to propose system improvements.

4.8.1 Flow Routing

Flow routing within a conduit link in H_2OMAP SWMM is governed by the conservation of mass and momentum equations for gradually varied unsteady flow (i.e., the St. Venant equations). The H_2OMAP SWMM user has a choice on the level of sophistication used to solve these equations:

- Steady Flow
- Kinematic Wave Routing
- Dynamic Wave Routing

The City's hydraulic model used Dynamic wave routing to analyze the storm drainage system. Dynamic wave routing solves the complete St. Venant flow equations and therefore produces the most accurate results. These equations consist of the continuity and momentum equations for conduits and a flow continuity equation at nodes.

Dynamic wave routing can account for channel storage, backwater, entrance/exit losses, flow reversal, and pressurized flow. Because it couples the solution for both water levels at nodes and flow in conduits it can be applied to any general network layout, even those containing multiple downstream diversions and loops. It is the method of choice for systems subjected to significant backwater effects due to downstream flow restrictions or flow regulation via weirs and orifices. This generality comes at a price of having to use much smaller time steps, approximately a minute or less.

4.9 MODEL VERIFICATION

The reasonableness of the model results and the hydraulic grade line profiles were evaluated during the initial model runs. This was accomplished by comparing areas of flooding predicted by the model with observations offered by the City. Areas around the City that experience flooding were confirmed by the model results. Following the verification process, the model was used for the existing and future storm drainage system analysis.

CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

This chapter presents the results of the capacity evaluation of the storm drainage system and the proposed projects that correct capacity deficiencies and serve future users.

5.1 CAPACITY EVALUATION

Evaluation of the capacity of the City of Pacifica (City's) storm drainage system involved identifying areas in the system where street flooding exceeded the maximum criteria. Storm drains that lacked sufficient capacity to convey runoff generated from the design storm could produce backwater effects in the drainage system and potentially cause flooding. This chapter discusses the possible locations of existing and future flooding caused by these deficiencies. When an increase to capacity is required, it was assumed, unless otherwise noted, that storm drains would be replaced with a larger diameter pipeline.

5.1.1 Existing System

When evaluating the adequacy of the storm drainage facilities serving existing developments, City streets were allowed to flood and provide additional storage capacity (if available), thus reducing the number of storm drain improvements. When storm drains are located in City streets, the goal was to contain storm flows within the drainage pipelines, with minimal ponding in City streets during the 10-year design storm. The storm drainage criteria allowed City streets to flood up to seven inches above the gutter flow line in the 50-year design storm. If flooding exceeded seven inches and additional gutter capacity was not available, then an improvement was necessary to correct the problem. Drainage pipes within a street that cannot be supplemented by overland flow should be designed to have sufficient capacity to convey the 50-year design storm while maintaining a hydraulic grade line below the manhole rim elevations.

In general, the existing storm drainage system has sufficient capacity to convey runoff generated during the 10-year design storm. In some locations, the existing storm drains lack sufficient capacity to convey the 50-year design runoff while meeting the seven-inch flooding criterion. These areas are generally located in the low-lying areas of the City where storm water pipelines may be at or below mean sea level, which are susceptible to flooding.

5.1.2 Future System

The City's 2030 General Plan update recommends development alternatives that will add residential, commercial, recreational, and open space areas. On August 15, 2011, the Dyett & Bhatia Urban and Regional Planners (preparers of the City's 2030 General Plan Update) issued a memorandum to the City of Pacifica Planning Commission (Appendix B), which included City and resident preferences for the proposed residential commercial area alternatives based on survey data. The preferred commercial and residential alternatives described in the memorandum were used to determine relative future user responsibility for storm drainage system improvements.

In general, the future development areas (Figure 5.1) proposed for the City will have a relatively minor impact on storm water drainage facilities. However, two proposed commercial development areas may impact the City's existing storm drainage to a measureable degree: the proposed commercial development on Gypsy Hill and the proposed development of the Rockaway Beach/Quarry. These two areas will have the greatest impact on storm drainage facilities in comparison to other proposed developments because of the substantial increase in impervious area that will be constructed over existing pervious surfaces. Additional discussion on the affects of future development on the City's storm drainage system is provided in Section 5.2.2.5.1.

To replicate added flows from proposed new development within the City, relative percent impervious surface areas were increased to account for future buildings and structures that add impervious surface area. Many of the City's future development alternative sites are actually redevelopments of land uses with similar impervious qualities, and may not significantly increase storm water flows beyond what is existing. If the City continues to grow and develop beyond the 2030 General Plan boundaries, it is recommended that the pipeline diameters and pump station capacities proposed in this Master Plan be constructed to provide sufficient capacity for potential expansion.

5.2 STORM DRAINAGE SYSTEM IMPROVEMENTS

Figure 5.2 illustrates the proposed storm drainage system improvements required to correct existing deficiencies and to accommodate future growth as identified by the hydraulic analysis. One primary aspect of the City's storm drainage system improvements is the development and implementation of a storm drain maintenance and inspection program as a part of a long-term rehabilitation/replacement program. This maintenance program is described in detail in Chapter 6 of this Master Plan.

Table 5.1 shows details of each improvement, including the improvement figure number corresponding to Figure 5.2. For future storm drains, the proposed diameter is shown along with the length of pipe. Figure 5.2 and Table 5.1 should be used together to locate the proposed improvement on the map and to gain details of the improvement (length, diameter, street location, etc.).

5.2.1 Existing Versus Future Improvement

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to prevent flooding in excess of seven inches above the curb line) for existing users. If a project was proposed to correct an existing deficiency, then existing users were assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.

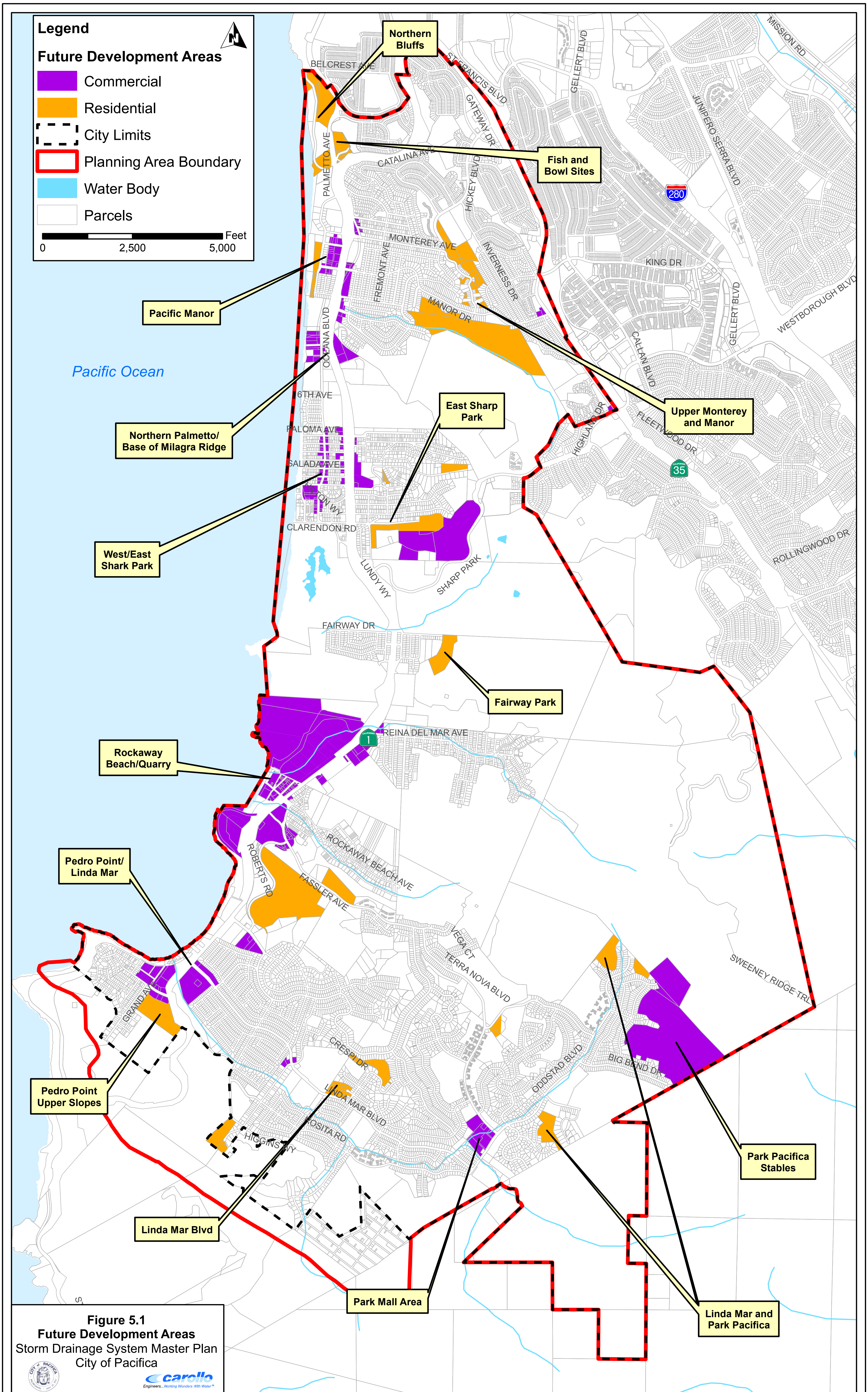


Figure 5.1
Future Development Areas
Storm Drainage System Master Plan
City of Pacifica

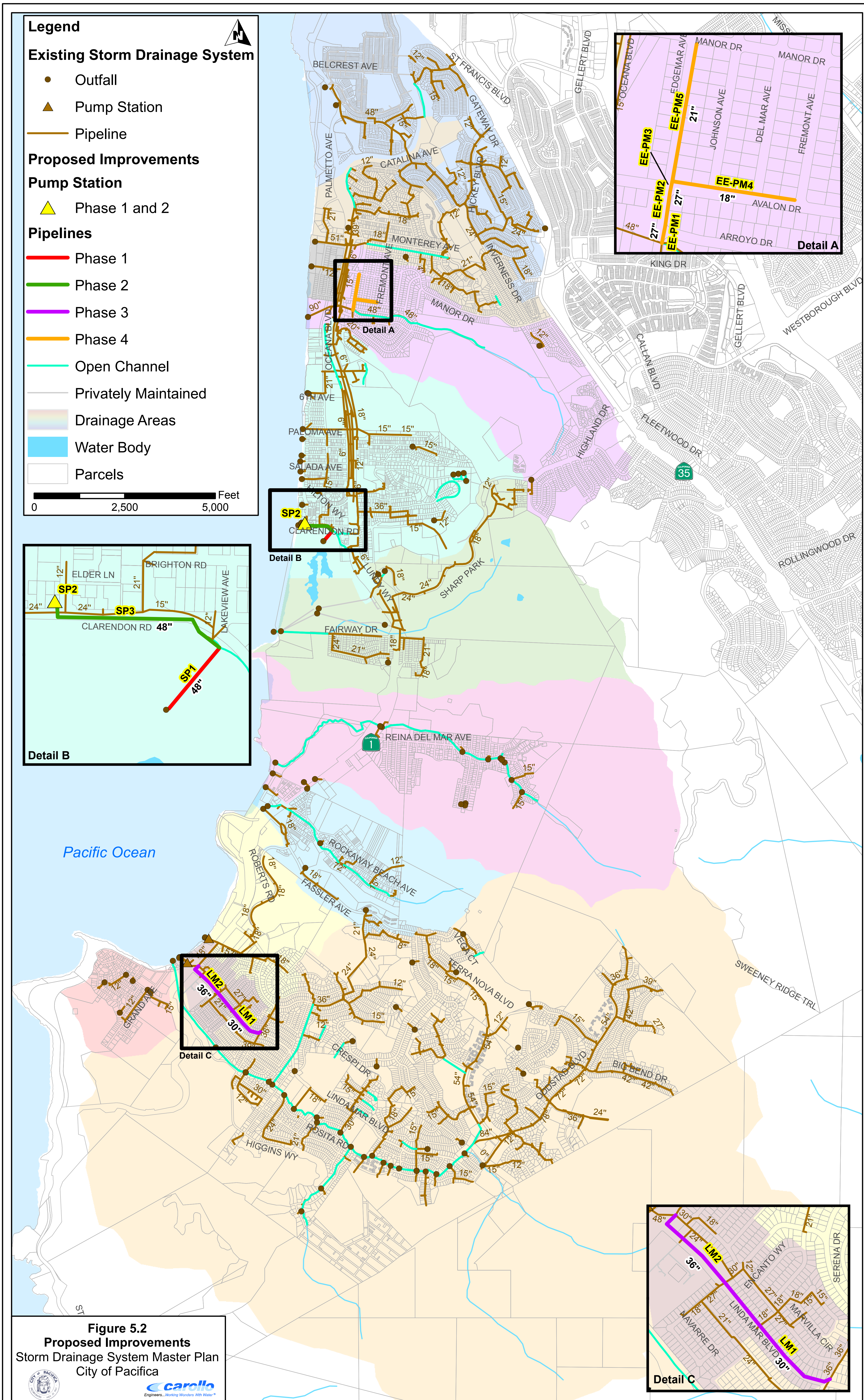


Figure 5.2
Proposed Improvements
Storm Drainage System Master Plan
City of Pacifica

Table 5.1 Proposed Storm Drainage System Improvements
Storm Drainage System Master Plan
City of Pacifica

Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Project Length/Size and Cost: Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Phasing: Phase 1 2012-2015	Phase 2 2016-2020	Phase 3 2021-2025	Phase 4 2026-2030	Phase 5 Post 2030
East Edgemar - Pacific Manor Subbasin (CIP-1)													
EE-PM1	Pipe	Edgemar Ave	Avalon Drive to just south of Arroyo Drive	A	12	27	Replace	90				Phase 4	
EE-PM2	Pipe	Edgemar Ave	Avalon Drive to just south of Arroyo Drive	A	12	27	Replace	175				Phase 4	
EE-PM3	Pipe	Edgemar Ave	Avalon Drive to just south of Arroyo Drive	A	12	27	Replace	60				Phase 4	
EE-PM4	Pipe	Avalon Drive	Fremont Avenue to Edgemar Avenue	A	-	18	New	625				Phase 4	
EE-PM5	Pipe	Edgemar Ave	Manor Drive to Avalon Drive	A	-	21	New	700				Phase 4	
East and West Sharp Park Subbasin (CIP-2)													
Alternative 1													
SP1	Cleaning	Laguna Salada Outfall	Lakeside Ave to Laguna Salada outfall	A	48	-	Clean	375	Phase 1				
Alternative 2													
SP2	Pump Station[1]	Clarendon Ave	65 MGD, Western End of Clarendon Ave	A	-	-	New	-	Phase 1				
SP3	Pipe	Clarendon Ave	Lakeside Ave to Western End of Clarendon Ave	A	-	48	New	900	Phase 1				
West Linda Mar Subbasin (CIP-3)													
LM1	Pipe	Linda Mar Blvd	Peralta Rd to Inlet on Linda Mar Blvd Due West of Marvilla Place	A	-	30	New	1,050			Phase 3		
LM2	Pipe	Linda Mar Blvd	Inlet on Linda Mar Blvd Due West of Marvilla Place to Highway 1	A	-	36	New	1,700		Phase 2			
Storm Drain Condition Assessment Program (CIP-4)													
-	Maintenance	CCTV	Storm Drain Condition Assessment Program, pipelines <= 15"	A	-	-	Clean/CCTV	108,800	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
-	Maintenance	CCTV	Storm Drain Condition Assessment Program, pipelines > 15"	A	-	-	Clean/CCTV	152,400	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5

Notes:
1. Pump station capacities refer to the total capacity unless noted otherwise.

Future growth may require the construction of new facilities to support this growth (i.e. new pipelines to serve vacant or undeveloped areas within the City service area). If a specific project is needed to serve growth exclusively, future users were assigned 100 percent of the future project's benefit and 100 percent of the costs.

The proposed long-term maintenance program (described in Chapter 6) will benefit primarily existing users, but will include future infrastructure once it is constructed. Where a project, such as the maintenance and inspection program, is recommended to serve existing and future growth, the future user benefit was determined based on the additional cost incurred as a result of future growth. More information on the breakdown in cost split between existing and future users, and whether a proposed improvement is intended to correct an existing deficiency, to serve a future user, or both, is provided in Chapter 7.

5.2.2 Proposed Existing System Improvements

The majority of the City's recommended improvements are a result of insufficient capacity of the existing storm drainage system to convey peak runoff without exceeding the planning criteria discussed in Chapter 3. Therefore, there are several locations where existing storm drains will need to be replaced by larger diameter storm drains, or new storm drainage infrastructure will need to be constructed to reduce peak flows through hydraulically-deficient storm drain pipes.

5.2.2.1 <u>East Edgemar - Pacific Manor (CIP-1)</u>

The hydraulic model indicated that there is an area within the East-Edgemar – Pacific Manor drainage area that experiences street flooding in excess of the maximum allowable criteria. The City has also identified this area to be a location where street flooding and occasional gutter overflow occurs. Recommended improvements to mitigate the existing deficiencies and reduce localized flooding include the following:

- Replace the existing 12-inch storm drain on Edgemar Ave from Avalon Drive to just south of Arroyo Drive with a 27-inch storm drain (EE-PM1, EE-PM2, and EE-PM3).
- Install an 18-inch storm drain along Avalon Drive, between Fremont Avenue and Edgemar Avenue, that connects to the existing storm drain on the corner of Edgemar Avenue and Avalon Drive (EE-PM4).
- Install a 21-inch storm drain along Edgemar Avenue, between Manor Drive and Avalon Drive, that connects to the existing storm drain on the corner of Edgemar Avenue and Avalon Drive (EE-PM5).

5.2.2.2 <u>East and West Sharp Park (CIP-2)</u>

According to the City, this drainage area includes one of the City's most significant and recurring flooding areas that regularly threatens businesses and residences. Flooding issues are caused by a combination of low-lying invert elevations and backwater effects/blockages from the existing outfall to Laguna Salada. Recommended improvements to this area will involve management of the interaction between the water level in Laguna Salada and the City's storm drainage infrastructure.

The water level in Laguna Salada is maintained by the presence of a levee, which separates the Shark Park Golf Course from the Pacific Ocean. Outflow from Laguna Salada is controlled via a pump station that is privately operated by the Sharp Park Golf Course. According to the City, environmental considerations periodically arise that prevent the Golf Course from pumping water from the lake, sometimes during storm events. When these situations occur, the low elevation of the ground surface and pipeline inverts in comparison to the lake surface elevation causes localized flooding in depressed areas of this neighborhood. In addition, silt deposits and aquatic growth in or around the 48-inch outfall to Laguna Salada likely inhibit drainage.

Two alternative improvement projects were developed for this area, which were based on two potential future management strategies of the stormwater discharged in this area of the City. Currently, the storm drainage outfall to Laguna Salada is maintained by the operator of the Sharp Park Golf Course (currently the City of San Francisco). Since the outfall facilities are not under the jurisdiction of Pacifica, the City cannot maintain or operate them. Alternative 1 stipulates that the operator of the Sharp Park Golf Course maintain responsibility of the outfall and establish conditions to prevent flooding in the area. This is a much less expensive alternative that establishes more desirable drainage conditions at the Golf Course, but maintains that the City will not have jurisdiction of key storm drainage infrastructure in this area. Alternative 2 creates an opportunity for the City to manage stormwater drainage in the area with the installation of a pump station and bypass of the existing outfall to Laguna Salada. This is a more expensive alternative, but provides the City with a long-term, self-sufficient management strategy of storm drainage.

5.2.2.2.1 *Alternative 1: Establish Non-Constrictive Gravity Outfall*

This alternative utilizes the existing 48-inch outfall into Laguna Salada, but requires establishing a condition of non-constrictive gravity outflow. Creation of a non-constrictive outflow at this location consists of maintaining clear outfall pipeline with minimal backwater effects or blockages. While cleaning of the 48-inch outfall is feasible, establishing non-constrictive outflow will additionally be dependent on maintaining a low enough water level in Laguna Salada. The water level in Laguna Salada should be managed by allowing overflow to the Pacific Ocean at an elevation that provides free outflow conditions at the outfall.

- Clear silt and debris from the 48-inch outfall to Laguna Salada on a regular basis. Maintain a clear outfall at all times to ensure adequate drainage (SP1).
- Establish level control of Laguna Salada. For example, remove a portion of the levee so that Laguna Salada can be maintained at a lower elevation. Since the Sharp Park Golf Course, Laguna Salada, and the levee are not within the City's planning

jurisdiction, a water level control method will not be included in this Master Plan or as a recommended CIP improvement.

5.2.2.2.2 *Alternative 2: Install Permanent Pump Station and Pipeline*

This alternative includes abandoning the existing 48-inch outfall to Laguna Salada, and installing a permanent pump station to remove storm water from low-lying residential and commercial areas. This alternative additionally recommends removal of the existing outfall at the end of Clarendon Road and recommends providing a free outfall (non-force main) onto the beach from the pump station, similar to the City's existing Linda Mar and Anza pump stations. The proposed pump station at Clarendon Road may also be built to provide public services, such as restrooms or washing stations.

- Install a wet well and pump station at the western-most end of Clarendon Road (SP2). The pump station should have a capacity of 55,000 gpm.
- Install a 48-inch pipeline along Lakeside Ave and Clarendon Road, adjacent to the Sharp Park Golf Course boundary. The pipeline will collect storm water flow from the open channels on Lakeside Ave and route it to the new wet well at the western end of Clarendon Road (SP3).

The recommendations for Alternative 2 incorporate the increased storm water flows as a result of the proposed future development on Gypsy Hill Road. Due to the nature of this development and subsequent removal of a significant amount of pervious land area, the development on Gypsy Hill has the potential to add a significant amount of storm water to the drainage system during storm events. Therefore, the pump station and 48-inch conveyance line were sized to handle these additional flows. To utilize smaller pumps than those listed above; it is recommended that the development on Gypsy Hill utilize onsite retention of peak storm flows, such as a storage basin. Distributing storm water flows from the Gypsy Hill development into the City's storm drainage system after the storm event will allow for the use of smaller pumps for this CIP. The City should consider implementing a low impact development method to help minimize peak flows from the development (described in more detail in Section 5.3). Additional discussion on the impact of future development on the storm drainage system is provided in Section 5.2.2.5.1.

5.2.2.3 <u>West Linda Mar (CIP-3)</u>

The hydraulic model indicated that there several areas within the West Linda Mar area that experiences street flooding in excess of the maximum allowable criteria, which occurs as a result of insufficient capacity. The City has also identified hot spots in this area where street flooding and occasional gutter overflow occurs.

Recently, the City converted a section of 42-inch storm drainage pipeline (starting at Montezuma Road and heading southwestward to San Pedro Creek) into a conduit for a sanitary sewer, removing a storm drainage outfall to San Pedro Creek. In addition, the City constructed a new 24-inch drainage pipeline connecting the 42-inch pipeline on the southeastern end of Montezuma Road, and connected it to an existing 21-inch pipeline on the northwestern end on Montezuma Road. As a result of this sanitary sewer system project, a substantial amount of storm water flow was directed from San Pedro Creek to the City's Linda Mar and Anza pump stations. The hydraulic model indicated that the recent construction results in a significantly hydraulically deficient storm drainage system in the West Linda Mar area.

The following recommendations will mitigate the existing deficiencies by creating additional underground storage and conveyance capacity. The recommended pipelines will cause runoff from the upstream storm drainage subbasins in the West Linda Mar area to flow to the City's Linda Mar and Anza pump stations. This CIP reduces hydromodification to San Pedro Creek because an outfall to San Pedro Creek is not required. Recommendations include:

- Install a 30-inch pipeline from the corner of Peralta Road and Linda Mar Blvd, to the inlet located due west of Marvilla Place on Linda Mar Blvd (LM1).
- Install a 36-inch pipeline from the inlet due west of Marvilla Place on Linda Mar Blvd, to the corner of Linda Mar Blvd and Highway 1. Continue the 36-inch pipeline along Highway 1 to the existing manhole at the northern corner of the Valero gas station (LM2).

The following pages contain CIP summary sheets for the previously described three improvement projects.

5.2.2.4 Condition Assessment and Rehabilitation/Replacement Program

One of the recommended capital improvements is the development of a long-term condition assessment, inspection, maintenance, and rehabilitation/replacement program. This proposed program is described in detail in Chapter 6 of this Master Plan.

5.2.2.5 Other Existing System Improvements

Other improvements consist of mitigation measures recommended for private properties or areas of infrastructure that are within the City limits, but that are not under the jurisdiction of the City. As such, while the following improvements will help resolve existing deficiencies in the storm drainage system, they do not represent improvements that the City is responsible for implementing. The following proposed improvements are for informational purposes only, and will not be included in the City's CIP (described in Chapter 7).

CAPITAL IMPROVEMENT PLAN PROJECT SHEET
STORM DRAINAGE SYSTEM MASTER PLAN
CITY OF PACIFICA

PROJECT CIP-1
East Edgemar-Pacific Manor
Improvements: EE-PM1 through EE-PM5

Project Benefit

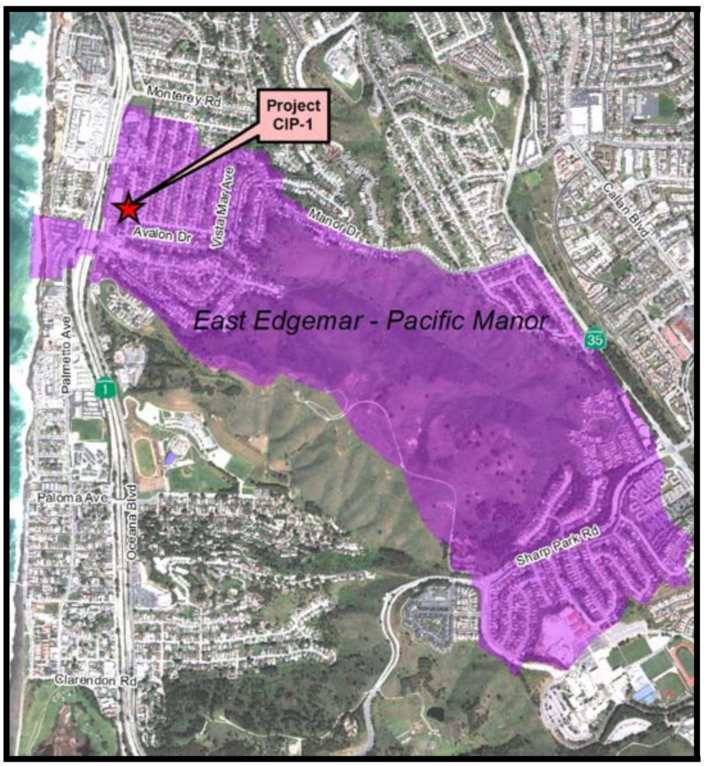
Existing Customers: 100%
New Development: 0%

Implementation Phase

___Phase 1 (2011-15)
___Phase 2 (2016-20)
___Phase 3 (2021-24)
_x_Phase 4 (2026-30)
___Phase 5 (Post 2030)

Project Location

- Avalon Drive, between Fremont Avenue and Edgemar Avenue
- Edgemar Avenue, between Manor Drive and Arroyo Drive



Project Component(s)

- Replace existing 12" pipelines with 27" pipelines.
- Install two new pipeline segments (18" and 21") and street inlets.

Project Cost Summary (2011 Dollars)

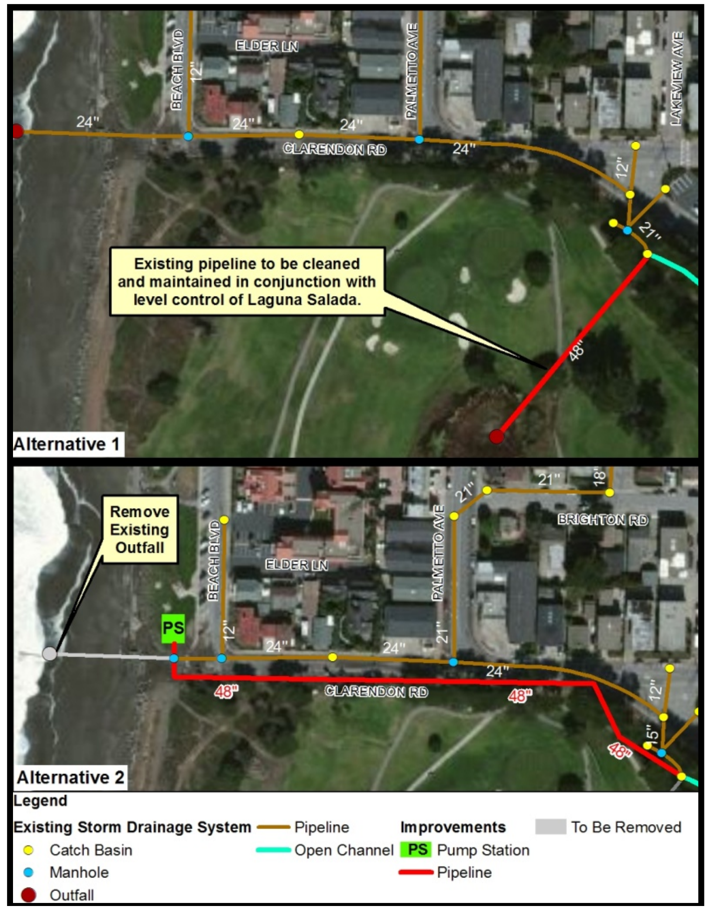
Baseline Construction		$348,000
Construction Contingency (25%)		$87,000
Total Construction Cost		$435,000
Engineering Construction Management Project Administration	(30%)	$131,000
Total Capital Improvement Cost		$566,000

Project Description

Project CIP-1 involves replacing 325 feet of existing 12-inch pipelines with 27-inch pipelines along Edgemar Avenue, between Avalon Drive and Arroyo Drive. In addition, CIP-1 includes construction of an 18-inch pipeline along Avalon Drive and 21-inch pipeline along Edgemar Avenue. The project will help reduce existing flooding that occurs during normal to heavy storm events on the corner or Edgemar Avenue and Avalon Drive by increasing underground storage and conveyance capacity in the subbasin.

CAPITAL IMPROVEMENT PLAN PROJECT SHEET
STORM DRAINAGE SYSTEM MASTER PLAN
CITY OF PACIFICA

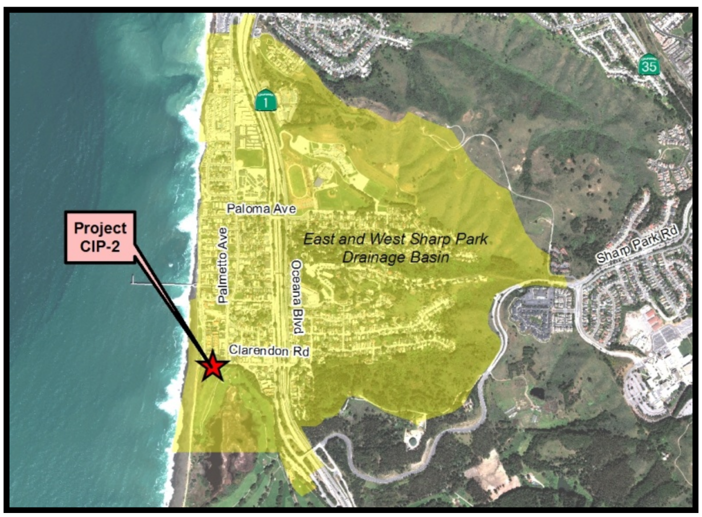
PROJECT CIP-2
East and West Sharp Park
Alternatives 1 and 2
Improvements: SP1 through SP3



Project Benefit
Existing Customers: 75%
New Development: 25%

Implementation Phase
_x_Phase 1 (2011-15)
___Phase 2 (2016-20)
___Phase 3 (2021-24)
___Phase 4 (2026-30)
___Phase 5 (Post 2030)

Project Location
- Lakeside Avenue to Clarendon Road
- Clarendon Road, between Lakeside Avenue and Beach Boulevard
- Sharp Park Golf Course



Project Component(s)
- **Alternative 1:** Provide non-constrictive outflow to Laguna Salada outfall. Establish level control of Laguna Salada.
- **Alternative 2:** Install new pump station, wet well, and pipeline.

Project Cost Summary (2011 Dollars)

		Alt 1	Alt 2
Pump Station		-	$3.00 mil
Pipeline		$2,000	$434,000
Baseline Construction(1)		$2,000	$3.43 mil
Construction Contingency (25%)		$0	$0.86 mil
Total Construction Cost		$2,000	$4.29 mil
Engineering Construction Management Project Administration	(30%)	$1,000	$1.29 mil
Total Capital Improvement Cost		$3,000	$5.58 mil

(1) Does not include modifications to golf course to allow Laguna Salada to overflow to ocean (i.e. levee removal).

Project Description
Project CIP-2 proposes two alternative solutions to mitigate existing system deficiencies. **Alternative 1** involves regular cleaning of the existing 48” outfall to Laguna Salada to provide non-constrictive outflow, and establishing level control of Laguna Salada to reduce backwater effects. **Alternative 2** involves construction of a permanent pump station and wet well at the western edge of Clarendon Road. Both of the proposed alternatives will reduce flooding in the surrounding low-lying residential and commercial area.

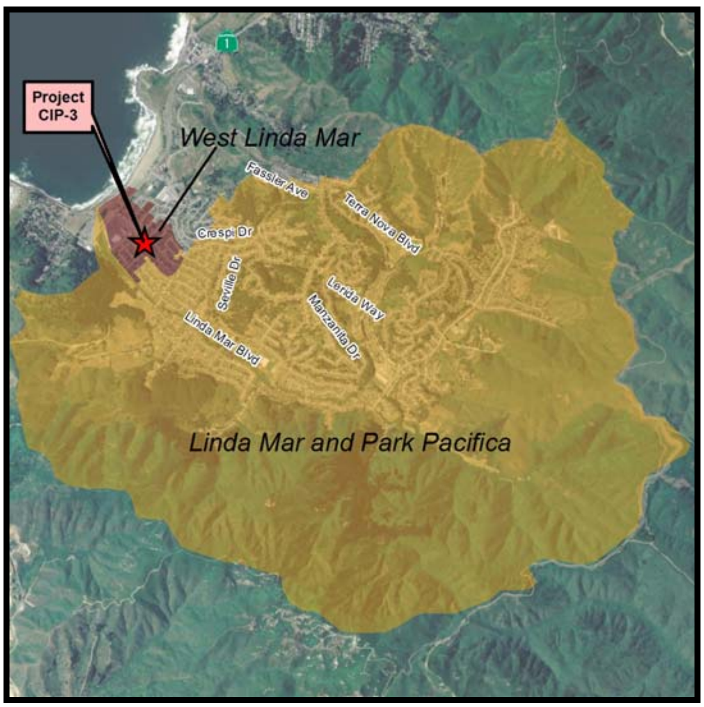
CAPITAL IMPROVEMENT PLAN PROJECT SHEET
STORM DRAINAGE SYSTEM MASTER PLAN
CITY OF PACIFICA

PROJECT CIP-3
West Linda Mar
Improvements: LM1 and LM2

Project Benefit
Existing Customers: 100%
New Development: 0%

Implementation Phase
___Phase 1 (2011-15) ___Phase 4 (2026-30)
_x_Phase 2 (2016-20) ___Phase 5 (Post 2030)
_x_Phase 3 (2021-24)

Project Location
- Linda Mar Boulevard, between Peralta Road and Highway 1
- Highway 1, to pump station wet well feed pipeline



Project Component(s)
- Install new segments of 30” and 36” pipeline
- Minimize hydromodification to San Pedro Creek

Project Cost Summary (2011 Dollars)

Baseline Construction		$932,000
Construction Contingency (25%)		$233,000
Total Construction Cost		$1.17 mil
Engineering Construction Management Project Administration	(30%)	$350,000
Total Capital Improvement Cost		$1.52 mil

Project Description
Project CIP-3 involves installing 2,750 feet of 30-inch and 36-inch pipelines along Linda Mar Avenue, between Peralta Road and Highway 1, ultimately connecting to the existing inflow pipeline to the Linda Mar wet well and pump station on Highway 1. Construction of this storm drainage infrastructure will increase subsurface storage and conveyance capacity. In addition, utilization of pipelines along Linda Mar Blvd instead of an outfall to San Pedro Creek reduces the occurrence of hydromodification due to stormwater flows.

5.2.2.5.1 *Fairway Park, Sharp Park Golf Course*

The hydraulic model indicated an existing capacity deficiency exists in the drainage pipelines that run through the Sharp Park Gold Course parking lot from just south of Lundy Way, in the Fairway Park drainage area. Sharp Park Golf Course is currently owned and operated by the City of San Francisco, and maintenance of the storm drainage system at the golf course is not within the City's jurisdiction. For informational purposes, a recommended improvement to mitigate this deficiency includes:

- Replace the existing 10-inch storm drain that connects the bubbler box in the Sharp Park Golf Course parking lot to the golf course outfall in Laguna Salada with a 21-inch storm drain.

5.2.3 Proposed Future System Improvements

As a part of the City's 2030 General Plan update, the City has prepared residential and commercial development alternatives for future planning and expansion. Currently, these development alternatives are in the public review and comment stage, wherein residents have had the opportunity to voice their opinions about the proposed alternatives. Dyett and Bhatia, the preparers of the General Plan Update, issued a survey to Pacifica residents to rank their preference the proposed development alternatives. Appendix B contains a memorandum that summarizes the results of this survey, and provides discussion of the recommended development alternatives to the City's Planning Commission.

Based on the recommendations provided in Appendix B, the following section summarizes the proposed future development land uses and their potential impacts on the City's storm drainage system. For a majority of the proposed commercial development sites, the nature of the proposed changes is actually a redevelopment of existing land uses. In these cases, impact on storm drainage infrastructure is minimized. Several locations, however, will introduce substantial impervious surfaces to areas with mostly pervious surfaces, resulting in substantial storm water runoff to the City's drainage system.

In general, there are several options to convey storm water runoff generated in future development or redevelopment areas, including direct discharge of runoff to drainage channels, discharge to existing or future pipeline infrastructure, and use of detention basins. Since the use of detention basins for storm water within the City is unlikely due to topography and available land, future developments were evaluated on their impact to pipeline infrastructure and natural waterways.

Figure 5.1 illustrates the proposed areas of residential and commercial development. Based on the percent imperviousness of existing land uses and the proposed development alternatives from the General Plan Update, the approximate increased runoff as a result of future development was estimated. Table 5.2 and Table 5.3 quantify the approximate increase in storm water runoff created as a result of commercial and residential developments, respectively, after the 24-hour 10- and 50-year design storms. These estimates were determined using the hydraulic model and a weighted area average of the percent imperviousness of the land use types proposed for the developments. These projected storm water flows may be used to facilitate planning of low impact development (LID) opportunities for new construction, to reduce impacts to the City's storm drainage infrastructure and minimize hydromodification.

In all cases of future development, the City should encourage or require implementation of LID controls to prevent hydromodification to natural waterways. This is especially prevalent in Pacifica, where natural drainage channels carry a significant amount of the City's storm water. LID controls are discussed further in Section 5.3.

Table 5.2 Preliminary Estimates of Runoff Created as a Result of Future Commercial Development

General Plan Update Commercial Development Title	Increased Runoff after 10-Year Design Storm		Increased Runoff after 50-Year Design Storm	
	(CCF)	(MG)	(CCF)	(MG)
Rockaway Beach/Quarry	720.6	0.54	933.2	0.70
West/East Sharp Park	36.1	0.03	46.8	0.04
Northern Palmetto/Base of Milagra Ridge	84.2	0.06	108.3	0.08
Pacific Manor	13.4	0.01	13.4	0.01
Pedro Point/Linda Mar	89.6	0.07	124.3	0.09
Park Mall Area	100.3	0.08	124.3	0.09
Park Pacifica Stables	0	0	0	0
Gypsy Hill	816.8	0.61	1,081.6	0.81

Notes:

1. Future percent imperviousness for development sites is based off of a weighted area average of future development land uses proposed in the City's 2030 General Plan Update, and the recommended developments from a September 2011 Dyett & Bhatia memorandum to the City of Pacifica Planning Commission (Appendix B).
2. Runoff volumes represent a 24-hour, 10- or 50-year design storm, as noted.
3. CCF=hundred cubic feet, MG=million gallons.

5.2.3.1 Rockaway Beach/Quarry

The recommended development at the Rockaway Beach/Quarry Area is characterized as "limited" development, including: a revitalization of the Rockaway Beach area; Quarry site development of hotel, retail, office, visitors, and open space uses; industrial and service commercial designation east of Highway 1; and hotel, visitor, commercial, and mixed-use designations near Fassler Avenue. Since much of this site is currently vacant or undeveloped and is comprised primarily of pervious surface area, the development will generate a new source of storm water runoff.

Table 5.3 Preliminary Estimates of Runoff Created as a Result of Future Residential Development

General Plan Update Residential Development Title	Increased Runoff after 10-Year Design Storm		Increased Runoff after 50-Year Design Storm	
	(CCF)	(MG)	(CCF)	(MG)
Bowl and Fish Sites	0	0	0	0
Northern Bluffs	0	0	0	0
Upper Monterey and Manor	677.8	0.51	867.6	0.65
East Sharp Park	32.1	0.02	42.8	0.03
Fairway Park	140.4	0.11	188.5	0.14
Pedro Point Upper Slopes	38.8	0.03	54.8	0.04
Linda Mar Blvd	41.4	0.03	52.1	0.04
Linda Mar and Park Pacifica Hillsides	81.6	0.06	111.0	0.08

Notes:

1. Future percent imperviousness for development sites is based off of a weighted area average of future development land uses proposed in the City's 2030 General Plan Update, and the recommended developments from a September 2011 Dyett & Bhatia memorandum to the City of Pacifica Planning Commission (Appendix B).
2. Runoff volumes represent a 24-hour, 10- or 50-year design storm, as noted.
3. CCF=hundred cubic feet, MG=million gallons.

However, an important planning feature of this development area is its proximity to the ocean and minimal impact to the City's existing storm drainage infrastructure. Currently, the primary means of storm water conveyance in this area is a natural drainage channel that originates in the Rockaway Valley, from Sweeney Ridge. Once this area is developed, onsite storm water may be managed by new underground pipelines or via surface (gutter) flow. In either case, storm water will likely be diverted to the western end of the drainage channel, near its outfall to the Pacific Ocean. If storm water flows are directed to the drainage channel, hydromodification will likely occur. However, since the development area is adjacent to the ocean, it may be possible for developers to avoid hydromodification by discharging storm water (via pipeline) directly to the ocean. From the nature of the proposed development at this site, the hydraulic model indicated that no CIPs were necessary as a result of this development.

5.2.3.2 West/East Sharp Park

Recommended development characteristics of this area include: mixed use redevelopment of Palmetto Avenue; redevelopment of old wastewater treatment plant site as open space; and office commercial designations and redevelopment. Compared to existing land uses of residential, commercial, and community and public areas, this development has the potential to increase storm water flows due to increased commercial and hotel development. However, because the sites proposed for development are already development, increased storm water runoff due to development is projected to be minimal.

Storm water runoff generated as a result of this development will be diverted to existing pipeline infrastructure along Palmetto Avenue that outflows directly to the Pacific Ocean. The development's proximity to the coastline minimizes capacity impacts to smaller infrastructure upstream. For areas in this neighborhood without pipeline infrastructure, primary conveyance methods are via surface and gutter flow, directed towards the Ocean.

The southern portion of the proposed commercial development on Palmetto Avenue is located near Clarendon Road, where the City experiences regular flooding events that threaten residences and business. CIP-2 proposes two improvement alternatives to mitigate existing deficiencies in this area. The proposed commercial development of the southern portion of Palmetto Avenue is within the same drainage area as Clarendon Road and would contribute to surface runoff handled by the proposed CIPs. Therefore, any development in this area should consider the use of LID control strategies to limit impacts to the storm drainage system, especially before the recommended CIP projects are implemented. If storm water flow from this site is directed to the City's storm drainage system, developers in this area will be responsible for a portion of the CIP-2 costs due to the added flow to the system.

5.2.3.3 Northern Palmetto/Base of Milagra Ridge

Proposed development in this area includes: maintenance of existing service commercial and industrial designations on northern Palmetto Avenue; new office and retail development; and long-term implementation of commercial recreational sites, like campgrounds or similar uses. The western portion of this development is developed, primarily for industrial use. Since percent imperviousness for industrial land uses is typically high, development of a portion of this area as campgrounds or commercial land will like reduce percent imperviousness. The eastern portion of this proposed development is currently undeveloped; therefore, any development will increase storm water runoff.

Storm water runoff in this area is provided primarily via surface runoff. Some pipeline infrastructure does exist, but it is located under Highway 1 and is maintained by the California Department of Transportation (Caltrans). Residential development on undeveloped portions in this area may require new pipeline infrastructure to divert runoff to the Caltrans drainage system. The hydraulic model indicated that no CIPs were necessary as a result of this development.

5.2.3.4 Pacific Manor

Recommended development in this area includes improvement of the existing land use designations and minor additions or upgrades to the shopping center. In addition, future development may include mixed use redevelopment of parts of the shopping center where possible.

Since all of the land area proposed for improvements or mixed use redevelopment are already developed with similar land uses, increased storm runoff as a result of development will be minimal. Storm water in this area is managed via surface (gutter) flow in combination with underground pipelines. In general, runoff is directed to catch basins and inlets, where it flows through City-operated pipelines outfalls at the Pacific Ocean. The hydraulic model indicated that no CIPs were necessary as a result of this development.

5.2.3.5 Pedro Point/Linda Mar

Proposed development in this area includes: new development of the Calson site with hotel, multi-family residential, and park designations; upgrades to the existing shopping centers; and high density housing, possibly in addition to mixed use redevelopment on Crespi Drive. Existing land uses at the development sites include commercial and undeveloped areas. While a majority of the proposed development will occur on land area that is already developed with similar uses, some development will add impervious surface area to currently undeveloped properties. As a result, surface water runoff will be increased. However, the proximity of the proposed development to the coast will limit the development's impact to the City's existing storm drainage infrastructure. In particular, the runoff from the newly developed land may be diverted directly to the ocean via a separate surface or pipeline drainage system, and may not require connection to the existing drainage system. The hydraulic model indicated that no CIPs were necessary as a result of this development.

5.2.3.6 Park Mall Area

The development in this area will be mixed use and is recommended to include: redevelopment of Park Mall and adjacent vacant site; and mixed use redevelopment of the Library including multi-family or senior housing. The existing land uses at this location include commercial, public and community, and undeveloped areas. Conversion of this development to a mixed use designation has the potential to increase storm water runoff from this area. However, a majority of this development site is already developed and has a high percentage of impervious surface areas, so runoff due to future redevelopment may not increased flows significantly. Because this development site is so close to San Pedro Creek, it is recommended that LID methods be implemented during and after development to minimize hydromodification to San Pedro Creek. The hydraulic model indicated that no CIPs were necessary as a result of this development.

5.2.3.7 Park Pacifica Stables

The development recommended for this area includes maintenance of the existing commercial recreation designation for the Park Pacifica Stables, with a potential for open space preservation of adjacent hillside parcels. Since the proposed development at this site is maintenance of existing uses, it is anticipated that future development will not increase storm water runoff from current conditions. In addition, the hydraulic model indicated that no CIPs were necessary as a result of this development.

5.2.3.8 Gypsy Hill

The development at this location is recommended to include: retail, residential, hotel, and hotel-related uses; and open space residential on adjacent parcels. This development area is currently undeveloped, and is situated on the crest of a hillside range and down a relatively steep slope. Because this development will add a significant amount of impervious surface area over pervious surfaces, storm water runoff will be increased.

Storm water flows from this site should be limited using LID design, where possible, to maximize on-site infiltration and minimize peak flows into the City's storm drainage infrastructure. CIP-2 addresses storm water received from the drainage area in which this development site is proposed. As such, any development on this site will add to the flows managed by CIP-2, causing the developers of this site to be responsible for a portion of the CIP costs.

5.2.3.9 Residential Development

The majority of the proposed future residential areas are open space residential land use designations. As such, storm water runoff from these areas is not expected to increase from existing conditions. However, three of the proposed future residential land use changes will increase storm water runoff once these sites are developed as the proposed land use. The proposed residential development sites that will increase surface water runoff to a significant extent are the Bowl and Fish sites, upper Monterey Road, and Linda Mar Blvd residential areas.

The proposed development at the Bowl and Fish residential sites is directly next to the Oceanside cliffs, and will likely utilize surface or pipeline runoff to discharge directly to the ocean, minimizing impacts to the City's storm drainage infrastructure.

The proposed high density residential development at upper Monterey Road will utilize a portion of the existing storm drainage infrastructure, and will do so in a way that may strain the existing system. Therefore, the City should require the developers of this site to include LID strategies that will retain peak flows onsite to reduce shock flows to the storm drainage system during storm events.

The proposed development of low and medium residential housing on Linda Mar Blvd will utilize surface (gutter) flow and a small segment of the City's existing drainage system.

Once runoff from this development enters the pipelines drainage system, it will be almost immediately discharged into San Pedro Creek. To reduce hydromodification to San Pedro Creek and minimize stress on the City's storm drainage infrastructure in handling peak flows, it is recommended that the City require implementation of LID methods for this development.

For all of its future development and redevelopment sites, the City should consider implementation of LID methods to promote onsite management of storm water runoff, minimize capacity impacts to the storm drainage infrastructure, and protect the environment from erosion and pollution caused by storm water.

5.3 LOW IMPACT DEVELOPMENT

LID is typically an effective and attractive approach to land development that controls storm water pollution and attempts to prevent changes to natural storm water flow conditions (hydromodification). Many LID options have an emphasis on cost-effective, lot-level strategies that replicate redevelopment hydrology and reduce impacts of development. In addition, implementing LID practices can help prevent polluted runoff from negatively impacting the water quality of receiving waters. Primary LID runoff control objectives include:

- prevent hydromodification wherever possible,
- minimize disturbances created by urbanized development,
- preserve and recreate natural landscape features,
- reduce effective impervious surface areas,
- increase hydrologic disconnects and provide maximize pervious areas,
- increase explicit drainage flow paths,
- enhance onsite storage and reduce ecosystem impacts due to peak shock flows, and
- facilitate detention and infiltration opportunities.

As growth and new development or redevelopment projects occur, the City should consider implementing LID projects to reduce capacity impacts to its storm drainage system. Doing so will ensure that the improvements proposed herein will satisfy capacity conditions through the 2030 planning period, as well as into the extended planning future. In addition, application of LID principles and practices can reduce the impact of built areas natural and sustainable movement of water within a watershed.

San Pedro Creek provides a primary example of the potential benefit of implementing LID practices. During and after heavy rainfall events, minor to significant erosion of the creek bed occurs that threatens the structural security of adjacent residences and businesses. In addition, historical water quality monitoring has shown unhealthy levels of coliform bacteria in the creek that make it unsafe for recreational use, and contributes to the sometimes poor water quality measured at Pacifica State Beach.[1] Implementation of LID projects in the San Pedro Creek watershed would help limit excessive peak flows and subsequent erosion of the creek. LID projects may additionally reduce pollution from nonpoint sources and help protect watershed riparian habitats. Future development in the Park Pacifica and Linda Mar communities that may potentially increase storm water flows to San Pedro Creek should incorporate LID projects and promote sustainable storm water management practices.

There is a significant amount of literature on LID strategies and practices. In particular, the U.S. Environmental Protection Agency (US EPA) has compiled a comprehensive compilation of design and guidance manuals, fact sheets and reports, and information resources and centers that describe all aspects of LID.[2] Actual LID projects chosen for implementation should consider the City's unique urban design, prevalence of natural waterways, watersheds conditions, storm water infrastructure, and appropriateness based on the City's development goals. The following are summaries of LID projects that the City could consider for inclusion in existing and future developments. In general, all LID projects are flexible and can be engineered to meet storm water management goals and requirements.

Bioretention Cells. Also known as rain gardens, bioretention cells are landscaping features that absorb and provide onsite treatment of storm water runoff. Runoff is diverted into shallow depressions in the landscape, which are designed to removal pollutants through natural filtration. Rainfall and runoff from impervious surfaces is allowed to drain into the bioretention cell and pond above the mulch and soil. Excess runoff that exceeds the capacity of the cell is diverted into the City's storm drainage collection system. These systems are generally applied to small sites and in urbanized settings where little pervious surfaces are available for natural infiltration to occur. The City should consider bioretention cells particularly for its commercial developments, where the terrain is typically flat and impervious surface areas are prevalent.

Cisterns/Rain Barrels. Cisterns and rain barrels collect and store rainwater collected from rooftops. These devices help reduce flooding and erosion caused by storm water runoff by retaining storm water onsite. Collected rainwater can then be utilized for garden or lawn irrigation, helping to conserve potable municipal water supply. These systems are applicable to most sites, and are most often recommended to control residential storm water runoff. For areas in the City where limited storm drainage infrastructure exists, such as the Rockaway neighborhood, cisterns may be a viable option to minimize reliance on overland flow or street flow for streets that have no gutters. Rain barrels also reduce the impact of high percent of directly connected impervious areas by providing storage and reducing offsite storm water flows.

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[1] Source: San Pedro Creek Watershed Coalition (2005). Water Quality. Retrieved from http://www.pedrocreek.org/.

Porous Pavements. Porous pavements, such as pervious concrete, utilize alternative materials (reduced sands or fines) that allow water to drain through it, rather than creating an impenetrable surface. When used in combination with an aggregate storage bed, pervious concrete will reduce storm water runoff volume, flow rate, and pollutants. Porous pavements can replace traditional impervious pavements for most pedestrian and vehicular applications except for high-volume/high-speed roadways. The City may consider porous pavements in new developments, or for redevelopment or retrofitting projects. Porous pavements are particularly applicable to parking lots, where it can be incorporated in large or small sections to provide additional infiltration capacity of a site with significant impervious areas.

Vegetative Swales. Also called a biofilter or bioswale, vegetative swales refer to open-channel management practices specifically used to treat and attenuate storm water runoff. Storm water runoff is allowed to flow along the channel, where it is filtered through a subsoil matrix (which can be tailored to treat runoff of various qualities), and/or underlying soils. Variations of grassed swales include grassed channels, dry swales, and wet swales. Each of these variations provides specific design features and methods of treatment, and all are improvements over the traditional drain ditch. Since the City relies significantly on natural channels to convey its storm water flows, vegetative swales may be an ideal LID feature that corresponds to existing storm water management methods in the City.

Each of LID methods described above are applicable to the City in a variety of circumstances, and they do not represent an exhaustive list of potential LID applications. Additional planning efforts should be undertaken to determine where LID projects may be implemented at existing and future development locations.

5.4 CAPITAL PROJECT PRIORITIZATION

When fully implemented, the capital projects will facilitate the collection, conveyance, storage, and discharge of peak storm flows to limit street flooding to the maximum allowed. Prioritizing the required capital improvements for the City's storm drainage system is an important aspect of the Master Plan. The improvement projects were prioritized based on a 10-year, 20-year, and long-term basis addressing storm drainage facilities necessary to mitigate existing deficiencies and meet the needs of proposed development. Special consideration was given to facilities where known system deficiencies already exist and are currently affecting residences and businesses.

All of the proposed CIP improvements are necessary to reduce flooding events and prevent damage to City infrastructure, residences, and businesses. The proposed phasing is provided to prioritize improvements by the risk that existing conditions create and on the

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[2] U.S. Environmental Protection Agency Low Impact Development resources can be found at http://www.epa.gov/owow/NPS/lid/.

likelihood of available funding for the CIP project. Improvement projects were grouped into the following timeframes:

- Phase 1: Years 2012 through 2015
- Phase 2: Years 2016 through 2020
- Phase 3: Years 2021 through 2025
- Phase 4: Years 2026 through 2030
- Phase 5: Post 2030

Phases 1 and 2 represent short-term improvement projects, Phases 3 and 4 represent medium-term improvement projects, and Phase 5 represents long-term improvement projects.

The projects shown in Figure 5.2 are color coded according to phase, which reflects their priority. Table 5.1 indicates the phasing timeframe for each capital project.

Proposed improvements within areas identified to have significant existing flooding issues were assigned a higher priority. Areas that experience regular flooding events that threaten residences and businesses received the highest priority. The proposed condition assessment and maintenance program was included through all capital improvement phases, since this program is anticipated to be an annual program carried out over the long-term. Changes in the City's planning assumptions could increase or decrease the priority of each improvement.

5.4.1 Phase 1 and Phase 2 Projects (2012-2015 and 2016-2020)

Phase 1 and Phase 2 projects include the alternative improvements for the East and West Sharp Park area. This area was identified as a priority for improvement implementation because of the recurring flooding issues that occur as a result of hydraulically deficient storm drains. Based on the chosen alternative and available funding, the City may choose to implement other capital improvements during these phases in addition to the East and West Sharp Park improvements.

In addition to these capital projects, the City should implement the condition assessment and inspection program, and storm drain rehabilitation and replacement projects as necessary.

5.4.2 Phase 3 Projects (2021-2025)

Phase 3 projects include the capital improvements to the West Linda Mar drainage area. These proposed improvements are required help to mitigate existing deficiencies caused by an existing system with insufficient capacity, and to supplement conveyance capacity that was removed with recent changes to the storm drainage infrastructure on Montezuma Drive. The hydraulic model indicates that the existing storm drainage pipeline facilities in this area are insufficiently sized and will cause flooding events to occur during the 10-year design storm above the seven-inch planning criteria. This improvement is a priority to prevent localized flooding.

5.4.3 Phase 4 Projects (2026-2030)

Phase 4 projects include the proposed improvements to the East Edgemar – Pacific Manor drainage area. These improvements will create a pipeline drainage system for a neighborhood that primarily relies on surface flow to convey storm water to natural waterways. The addition of pipelines in this neighborhood is necessary to create underground storage and conveyance capacity of storm flows and to mitigate existing deficiencies that cause localized flooding.

5.4.4 Phase 5 Projects (Post 2030)

Phase 5 projects include the long-term implementation of the proposed condition assessment, inspection, and maintenance program. This program is recommended for implementation over the course of a 10-year rotational period. The City should plan to incur costs associated with the condition assessment and maintenance program annually, into the post 2030 planning period. The proposed CIP-4 condition assessment and rehabilitation/replacement program is described in detail in Chapter 6 of this Master Plan.

CONDITION ASSESSMENT AND REHABILITATION/REPLACEMENT PROGRAM

This chapter provides a method for a condition assessment and long-term inspection program of the City of Pacifica's (City) existing storm drainage infrastructure, in support of a long-term rehabilitation/replacement (R/R) program for the City's storm drainage system.

6.1 EXISTING CONDITIONS

The existing condition of the City's storm drainage system varies significantly across the City because of the historic, mottled construction of its communities, starting in the early 1900s. As a result, the City's storm drainage infrastructure differs in capacity, configuration, and material, while some neighborhoods have no storm drainage infrastructure at all.

Pacifica's topography and limited development into its mountainous areas have been limiting factors on expansion of the storm drainage system. In fact, these limitations on expansion have probably facilitated the longevity of older infrastructure in conveying storm water flows. However, as the City continues to grow and storm water pipelines continue to age, it will be important for the City to have assessed the current state of its storm drainage system and establish a plan for improvements. With a condition assessment program, in conjunction with an R/R program (described in Section 6.4), the City will be able to make pre-emptive decisions regarding improvements to its storm drainage infrastructure.

Prioritization is an important aspect of any condition assessment program. Based on the approximate construction dates the City's storm drainage infrastructure, system inspection, and maintenance can be prioritized and scheduled over the course of the recommended planning period (described in Section 6.3.3).

6.2 EXISTING MAINTENANCE

This section provides a brief summary of the City's existing cleaning, inspection, and water quality practices.

6.2.1 Cleaning

City cleaning activities include street sweeping, cleaning catch basins, and removing materials from drainage channels. The City clears blockages of debris and trash when necessary, and therefore executes cleaning of the storm drainage system on an "as-needed" basis.

One "hot spot" that has regular blockage is the existing 48-inch outfall to Laguna Salada, just north of the Sharp Park Golf Course, which has significant sedimentation and plant growth that occurs at its outfall. The outfall to this marshy area is currently owned and maintained by the City of San Francisco. Therefore, the City does not have jurisdiction over cleaning of this pipeline, even though sediment and subsequent clogging of this outfall likely cause most of the flooding problems in this neighborhood. A specific improvement is recommended for this site, and is described in Chapter 5.

6.2.2 Inspection

The City conducts storm drain inspections on an "as-needed" basis (i.e. when a blockage or significant, abnormal flooding event occurs). Maintenance activities related to the storm drainage system, therefore, are almost exclusively corrective in nature.

The City does own a closed circuit television (CCTV) device that is used exclusively, year-round, to inspect the City's sanitary sewer system. The City may be able to use this device in the future to perform inspections on its storm drainage system.

6.2.3 Water Quality

The City does not maintain any water quality devices or monitoring programs related to its storm drainage system. However, effluent from San Pedro Creek (at the intersection of the creek and the Pacific Ocean) is monitored regularly by the San Mateo County Public Health Department. San Pedro Creek conveys a significant amount of the City's storm water from the Linda Mar and Park Pacifica neighborhoods. Though the drainage channel receives flows from other sources besides storm water, the City might be able to utilize the long-term results of the County's monitoring program to determine how storm water flow contributes to surface water quality in the creek, particularly after storm events.

6.3 FUTURE MAINTENANCE

The City should establish a long-term maintenance program that includes inspections, cleaning, and rehabilitation/replacement (R/R) of infrastructure, when appropriate. The maintenance program will be carried out on a rotating schedule over the course of an extended planning period (10 years), which is based on a preliminary condition assessment of the system and the City's available time and monetary resources. Primary goals of the maintenance program are to:

- prioritize inspections of existing City infrastructure based on age and condition;
- perform scheduled inspections on the system on an annual basis;
- use information obtained through the inspection program to identify required maintenance and R/R projects;
- develop a data recording system to keep track of inspections performed;
- issue an annual report that identifies the overall condition of the system, discusses the completion of inspection and maintenance goals, and provides recommendations based on collected information for future maintenance efforts.

6.3.1 Program Implementation

The proposed maintenance program will be overseen by the Director of Public Works, and carried out by Public Works staff. The maintenance program will include an annual commitment from the City of monetary and time resources, including the cooperation and involvement of a variety of staff members. City staff will be responsible for performing inspection, replacement, and rehabilitation projects when appropriate to help maintain the working status of the drainage system. A key component of the maintenance program, as with any long-term management plan, is documentation and analysis of work performed.

6.3.2 Schedule

The maintenance and inspection schedule is based on existing financial and maintenance goals of the City, identified system deficiencies, approximate age of infrastructure, and results of the system evaluation performed as a result of this Master Plan. Figure 6.1 and Table 6.1 indicate the recommended prioritization for the inspection of storm infrastructure facilities, over the course of 10 years. Once the City has completed inspection of its entire system, the inspection rotation will restart on the same schedule. It is anticipated that the City will begin inspections by 2012. Based on this schedule, the City should perform routine inspections, cleaning, and R/R projects as described in the sections below. Continuance of a long-term inspection schedule will help support the maintenance program, sustain a manageable R/R plan, and ensure a functioning storm drainage system.

6.3.3 Inspection Program

Thorough and regular inspections of the City's storm drainage infrastructure will provide detailed information of the system for preventative maintenance and future planning efforts. An inspection plan will also create an opportunity for the City to regularly perform condition assessments of its storm drainage system. The objectives of the inspection program are to:

- Support the City's R/R program;
- Refine a schedule for the inspection of the City's collection system based on observed conditions and age;
- Evaluate the need for cleaning;
- Assess the condition of the City storm drainage pipelines, inlets, and manholes.

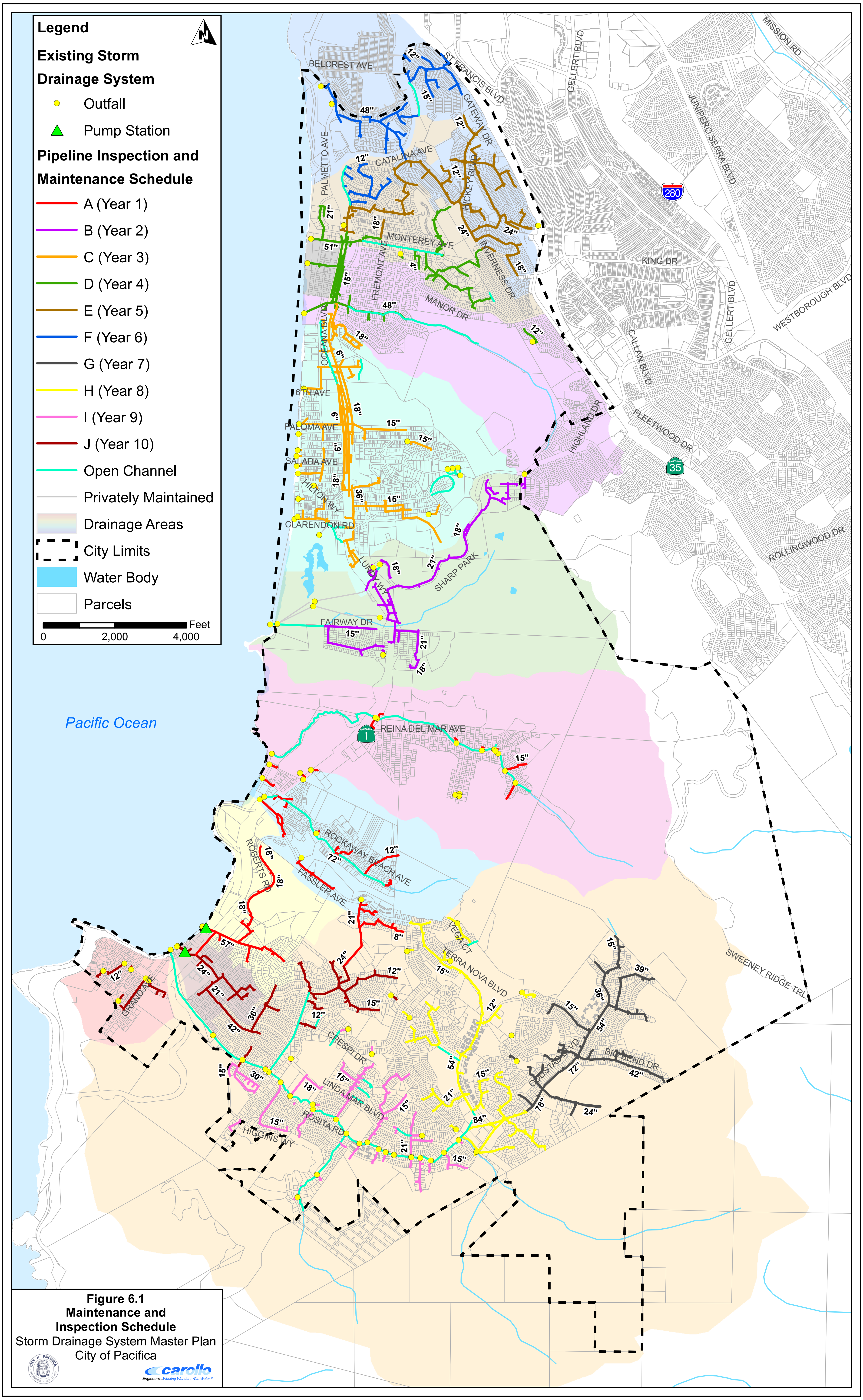

Figure 6.1
Maintenance and Inspection Schedule
Storm Drainage System Master Plan
City of Pacifica

Table 6.1 Maintenance and Inspection Schedule			
Rotation Year	**Map Area[1]**	**Description of Inspection Area[2]**	**Length of Pipeline to Inspect[3] (feet)**
1	A	The Headlands, Rockaway, and Vallemar areas	24,440
2	B	East and West Fairway Park, Gypsy Hill area	23,382
3	C	East and West Sharp Park	31,772
4	D	East and West Edgemar-Pacific Manor	22,034
5	E	Westview-Pacific Highlands	27,979
6	F	Fairmont areas	18,955
7	G	Eastern side of Park Pacifica	24,729
8	H	Western side of Park Pacifica	29,038
9	I	Southern portion of Linda Mar	26,461
10	J	Western side of Linda Mar, West Linda Mar, and Pedro Point	26,094
Total (feet)			**254,926**
Total (miles)			**48.3**

Notes:

1. Map area as indicated on Figure 6.1.
2. Descriptions utilize community names provided by the City, in the City's 2030 General Plan Update.
3. Does not include pipeline infrastructure that is managed by Caltrans, under the highway.

6.3.3.1 Methods

This section summarizes the pipeline and manhole inspection methods to be used by the City as a part of the maintenance program.

Inspection of Pipelines. The City will utilize both CCTV and visual methods to inspect storm drainage infrastructure. Cleaning or rehabilitation efforts should be considered if staff encounters blockages or structural damage of pipelines.

Condition Assessment. Whenever CCTV inspection is used, a condition assessment should be performed. This provides an opportunity for structural and maintenance defects to be identified, and evaluation of the previous R/R projects that have been implemented.

Inspection of Inlets and Manholes. Manholes and inlets should be visually inspected and cleared of debris, if necessary. Results of the inspection can be entered on a standardized inspection form as appropriate. City maintenance crews and on-call contractors should visually inspect all inlets and manholes they enter when work is being performed on the system.

6.3.3.2 Frequency

The proposed inspection schedule in Figure 6.1 and Table 6.1 correspond to average inspection of approximately 5 miles of pipeline per year. While regular inspections are to be performed annually, inspections can also be carried out on an ongoing basis as work or other maintenance tasks are being done in the City. Based on the results of the inspection program and R/R projects, the City may decide to alter the schedule to target areas most in need of inspection and maintenance. However, while the City may adjust the prioritization of infrastructure areas, the City's entire storm drainage system should still be inspected over the course of the 10-year planning period.

6.3.3.3 Data Management

Data collected during the implementation of the proposed storm drainage system inspection plan will be managed and analyzed in accordance with the information presented in this section.

Analysis and Categorization of Pipeline Inspection Data. Following completion of the CCTV inspection, a condition grade can be assigned to each pipeline segment using the PACP Quick Rating system to quantify the types of defects (both structural and maintenance) observed. PACP assigns defect severity grades (both structural and operations and maintenance [O&M]) for observed conditions in a pipe segment. Defect grades are described in Table 6.2.

Table 6.2 NASSCO PACP Defect Grades

Defect Grade	Defect Title	Descriptions
5	Immediate Action	Defects requiring immediate action
4	Poor	Severe defects that will become Grade 5 defects within the foreseeable future
3	Fair	Moderate defects that will continue to deteriorate
2	Good	Defects that have not begun to deteriorate
1	Excellent	Minor defects

The PACP Quick Rating system is a way of expressing the number of occurrences of the two highest severity grades in a pipe segment. A four character score is determined for the overall pipe segment condition, structural condition, and O&M condition as follows:

1. The first character is the highest severity grade occurring along the pipe segment.

2. The second character is the total number of occurrences of the highest severity grade. If the total number exceeds 9, then alphabetic characters are used as follows: 10 to 14 – A; 15 to 19 – B; 20 to 24 – C; etc.
3. The third character is the next highest severity grade occurring along the segment.
4. The fourth character is the total number of the second highest severity grade occurrences, derived as in item 2 above.

As an example, a pipeline segment whose two highest defects are 17 grade four defects and 7 grade 2 defects would be assigned a PACP Quick Rating of 4B27. If a pipe segment has only one defect grade, the first two characters are the grade and quantity of defects, and the last two characters are 00. A pipe segment with no defects would be assigned a Quick Rating of 0000.

Other rating systems are available, and may be used by the City at its discretion.

6.3.4 Cleaning Program

Cleaning of storm drainage pipelines is a task that can be performed as necessary before CCTV inspections and to clear debris that obstructs storm water flows through the system.

6.3.4.1 Methods

There are a number of different methods and pieces of equipment that are used for cleaning pipelines. Each method has a specific purpose and restrictions for use (e.g., pipe size, flow restrictions, solids removal). The following summarizes some of the typically used methods for pipeline cleaning:

Mechanical Cleaning. Mechanical cleaning involves pulling or forcing a mechanical mechanism through the sewer pipe to clean debris and sediment out of the pipe. Examples of mechanical cleaning are rodding and bucket machine. Rodding utilizes rotating blades that break up debris, with a bucket machine collects material and deposits it into a bucket.

Hydraulic Cleaning. Hydraulic cleaning equipment is a frequently used method applied for cleaning pipelines less than or equal to 18 inches in diameter. Examples include jetting, flushing, and balling. Jetting involves the targeted application of high pressure water, while flushing involves the introduction of heavy flows into the pipeline. Balling utilizes a threaded rubber ball that spines and scrubs the pipe interior as flow increases in the pipeline.

The City will utilize the cleaning methods and equipment that are available and most appropriate for a given segment of storm drainage pipeline.

6.3.4.2 Frequency

Cleaning will be performed on an as-needed basis, in conjunction with the inspection schedule provided in Figure 6.1 and Table 6.1. In general, pipelines with highest inspection priority may also indicate high priority cleaning areas. Older infrastructure and pipes requiring rehabilitation or replacement may indicate “hot spots,” where a greater-than-normal amount of debris may occur. As a part of its reporting program, the City should indicate where cleaning “hot spots” occur, and include regular cleanings of these areas and other parts of the system into the annual maintenance schedule.

The City’s system maintenance crews should record observations regarding the nature and extent of materials that are removed during pipeline cleaning. An example cleaning observation code is presented in Table 6.3. These observations, in addition to information obtained from the inspection program, will be used by the City to optimize the cleaning frequency.

6.3.5 Maintenance Costs

Future costs of recommended maintenance program include annual expenses incurred for CCTV inspections, cleaning, staff time, and reporting. Estimates for CCTV inspections and associated cleaning costs were developed based on typical costs for similar applications in the San Francisco Bay Area, California.

Typically, CCTV activities require cleaning of pipelines prior to inspection work. Cleaning costs were estimated to be $1.25 per linear foot for pipelines with diameters 15 inches or less, and $1.50 per linear foot for pipelines with diameters greater than 15 inches. These cleaning costs are based on typical costs for standard two-pass cleaning services. In addition, CCTV costs were estimated to be $1.25 per linear foot for all pipelines. Based on these cost estimates, Table 6.4 provides estimates for each of the proposed annual cleaning and maintenance areas of the City. Costs in Table 6.4 include 30 percent contingencies for engineering, construction, and administration-related expenses, which are described in more detail in Chapter 7.

Maintenance program costs are included in the recommended capital improvement program (CIP, described in Chapter 7) on an annual basis, from implementation Phases 1 through 5. R/R projects are not included in the maintenance program cost estimate because they will be recommended as a result of the maintenance program and performed on an as-needed basis.

6.4 REHABILITATION AND REPLACEMENT PROGRAM

The storm drainage R/R program consists of removing older storm drains that are susceptible to failure and replacing them with pipelines of appropriate condition and capacity. The R/R program encompasses a long-term commitment from the City to maintain its storm drainage infrastructure to serve existing and future users of the system. Establishing the R/R program alongside the long-term maintenance program will extend the useful life of existing storm drains and maintain the operation of the storm drainage system.

Table 6.3 Cleaning Observation Code

Material	Clear	Light	Moderate	Heavy
Debris	Code: **CL**	Code: **DL**	Code: **DM**	Code: **DH**
	No observable debris	Minor amount of debris	Less than 5 gallons of debris per line segment	More than 5 gallons of debris per line segment
		15 minutes or less to clean	15-30 minutes to clean	More then 30 minutes to clean
		1 pass	2-3 passes	More than 4 passes
				Operator concern for future stoppage
Grease	Code: **CL**	Code: **GL**	Code: **GM**	Code: **GH**
	No observable grease	Minor amount of grease	Small ‘chunks’	Big ‘chunks’ or ‘logs’
		15 minutes or less to clean	15-30 minutes to clean	More then 30 minutes to clean
		1 pass	2-3 passes	More than 4 passes
				Operator concern for future stoppage
Roots	Code: **CL**	Code: **RL**	Code: **RM**	Code: **RH**
	No observable roots	Minor amount of roots	Thin stringy roots	Thick roots
		15 minutes or less to clean	No ‘clumps’	Large ‘clumps’
		1 pass	15-30 minutes to clean	More then 30 minutes to clean
			2-3 passes	More than 4 passes
				Operator concern for future stoppage
Other	Code: **CL**	Code: **OL**	Code: **OM**	Code: **OH**
Pipe wall fragments, soil, dirt, rock	No observable materials	Specify material (if possible)	Specify material	Specify material
		Minor amounts of material	Less than 5 gallons of material per line segment	More than 5 gallons of material per line segment
				Operator concern for future stoppage

Notes:

1. This table was adapted from Best Practices Manual: Hydroflush Cleaning of Small Diameter Sewers, California Collection System Collaborative Benchmarking Group, February 2001.

Table 6.4 Maintenance and Inspection Program Annual Capital Costs				
Rotation Year	**Map Area[1]**	**Description of Inspection Area[2]**	**Length of Pipeline to Inspect[3] (feet)**	**Capital Cost**
1	A	The Headlands, Rockaway, and Vallemar areas	24,440	$89,700
2	B	East and West Fairway Park, Gypsy Hill area	23,382	$102,700
3	C	East and West Sharp Park	31,772	$93,700
4	D	East and West Edgemar-Pacific Manor	22,034	$92,900
5	E	Westview-Pacific Highlands	28,000	$87,600
6	F	Fairmont areas	18,955	$85,500
7	G	Eastern side of Park Pacifica	24,729	$101,400
8	H	Western side of Park Pacifica	29,059	$79,100
9	I	Southern portion of Linda Mar	26,461	$99,000
10	J	Western side of Linda Mar, West Linda Mar, and Pedro Point	26,094	$67,300
Total (feet)			**254,926**	**$898,900**
Total (miles)			**48.3**	

Notes:

1. Map area as indicated on Figure 6.1.
2. Descriptions utilize community names provided by the City, in the City's 2030 General Plan Update.
3. Does not include pipeline infrastructure that is managed by Caltrans, under the highway.

In general, rehabilitation/replacement projects will be initiated based on the results of the CCTV inspections and other regular maintenance events. As such, R/R projects will be performed on an as-needed basis. Once specific pipelines or channels have been identified as needing rehabilitation or replacement, they can be categorized as either minor or major rehabilitation/replacement projects.

6.4.1 Minor Rehabilitation

Storm drainage pipeline, inlet, and manhole defects requiring rehabilitation or reconstruction will be reported to the appropriate Director of Public Works. The Director will make the determination as to whether the rehabilitation/replacement can be done by in-house employees. If the work exceeds in-house capabilities, the work will be coordinated through the Engineering Division.

6.4.2 Major Rehabilitation/Replacement

Work that exceeds the capability of in-house forces will be added to the City's Capital Improvement Program through the Engineering Division. Major rehabilitation/replacement work will be prioritized and scheduled based on the severity of the defect and available funds.

6.4.3 Cost

The CIP described in Chapter 7 assumes that additional storm drainage infrastructure requiring R/R not identified in this Master Plan will be identified in the future. The City should utilize its annual inspection and maintenance reporting program to identify potential R/R projects and to determine the funding that will be required to complete them.

6.5 EQUIPMENT

As noted above, the City does own its own CCTV equipment, but it is currently used on a daily basis to inspect the sanitary sewer system. Therefore, the City may choose to utilize private contractors at times when the CCTV equipment is not available to perform storm drainage system cleaning and CCTV inspection work. If the cost is justified, the City could consider purchasing additional cleaning and/or inspection equipment specifically for storm drainage system maintenance. As discussed in Section 6.3.4, a variety of cleaning and inspection methods are available depending on level of treatment required. However, the City would ideally be able to utilize its existing vactor truck and CCTV equipment for storm drainage maintenance purposes.

6.6 REPORTING

This section describes a reporting approach to meet the annual reporting goals of the City. It is recommended that the City prepare annual reports regarding its cleaning and inspection programs, which will provide substantial support for the R/R program and future planning efforts for the storm drainage system.

6.6.1 Report Content

The City's annual report for the sewer cleaning and inspection program may include the following:

- Documentation of activities conducted under the pipeline cleaning program during the previous annual cycle, including:
  - Miles of pipe cleaned as part of the routine;
  - Miles of pipe treated by all methods used for controlling roots, if any;
  - A description of the success of the pipeline cleaning program at preventing blockages;

- Identification of “hot spots” that require more frequent cleaning.

- Documentation of inspection methods and findings of the condition assessment and inspection program conducted during the reporting year, including:
  - The estimated miles of pipeline and number of inlets and manholes inspected;
  - Description of the condition of the storm drainage pipelines, with emphasis on poor conditions that may adversely affect storm water flow;
  - Analysis of how the findings are being used to prioritize rehabilitation and replacement projects;
  - Estimated miles of pipelines to be inspected during the next reporting year.

6.6.2 Data Gathering and Analysis

The City will record and maintain all data and other information related to the cleaning and inspection program in the City’s hard copy and computer management system, as well as a GIS database when appropriate. Recorded data will then be used to extract the information needed to prepare an annual report.

6.6.3 Report Timing

The City will prepare the annual report for the cleaning and inspection program starting following the 2012 inspection year.

CAPITAL IMPROVEMENT PROGRAM

This chapter presents the recommended capital improvement program (CIP) for the City of Pacifica (City) storm drainage system, a summary of the capital costs, and a basic assessment of the possible financial impact on individual existing and future users. This chapter is organized to assist the City in making finance decisions, and to plan the storm drainage system improvements and maintenance tasks through the 2030 General Plan (General Plan) planning period. The CIP is based on the evaluation of the City's storm drainage system, planning area, and land use, as detailed in the recommended projects described in the previous chapters.

7.1 CAPITAL IMPROVEMENT PROJECT COSTS

The proposed system improvements, capacity upgrades, and long-term maintenance plan set the foundation for the City's storm drainage system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, P.C. (Carollo) experience on other projects. The costs are based on an Engineering News Record Construction Cost Index (ENR CCI) 20-city average of 9,035 (May 2011).

7.2 COST ESTIMATING ACCURACY

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variables such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

7.3 CONSTRUCTION UNIT COSTS

The construction costs are representative of storm drainage system facilities under normal construction conditions and schedules. Costs have been estimated for public works construction, either as new construction in existing developed areas or as new construction in undeveloped areas.

7.3.1 Pipeline Unit Costs

Storm drainage system pipeline improvements range in size from 18-inches to 48 inches in diameter. Pipe casings up to 48-inches in diameter are included for major crossings (e.g. creeks, canals, highways, railroad). Pipeline unit costs are shown in Table 7.1. The construction cost estimates are based upon these unit costs, which are for "typical" field conditions with construction in stable soil at a depth ranging between 10 to 15 feet. The unit costs below were compared to bid summaries of a recent recycled water pipeline project performed by the City, and were similar to the mid-range cost estimates considered.

Table 7.1 Pipeline Construction Unit Costs

	Pipeline Unit Cost ($/linear foot)	
Pipe Size (inches)	**Schedule A (Developed Areas)**	**Schedule B (Undeveloped Areas)**
15	166	116
18	181	127
21	211	148
24	241	169
27	271	190
30	302	211
33	332	232
36	362	253
42	422	296
48	482	338
54	543	380
60	603	422
66	663	464
72	724	507
Pipeline Casing for Major Crossings		
18/30	1,173	--
21/42	1,642	--
27/48	1,876	--
30/48	1,876	--
36/48	1,876	--

Notes:

1. ENR CCI 20 City average used for estimating (May 2011) = 9,035.

Construction of pipelines in undeveloped areas is anticipated to cost less than those constructed in currently developed areas. The Schedule B unit costs in Table 7.1 are discounted by 30 percent for pipelines that will be built in undeveloped areas. This discount is based on a review of bid tabulations that were constructed in developed and undeveloped areas. Pipelines built in undeveloped areas ranged from 30 to 50 percent less than pipelines built in developed areas.

7.3.2 Pump Station Unit Costs

Pump station improvements include the construction of facilities or increasing the capacity of exiting pump stations to convey storm runoff. Cost estimates for pump stations were developed based on projects of similar size in California and recent Carollo pump station projects of similar nature.

7.3.3 Cleaning and Maintenance Costs

Maintenance recommendations include annual closed-circuit television (CCTV) inspections of a portion of the City's drainage system infrastructure. Estimates for CCTV inspections and associated cleaning costs were developed based on typical costs for similar applications in the San Francisco Bay Area, California.

Typically, CCTV activities require cleaning of pipelines prior to inspection work. Cleaning costs were estimated to be $1.25 per linear foot for pipelines with diameters 15 inches or less, and $1.50 per linear foot for pipelines with diameters greater than 15 inches. These cleaning costs are based on typical costs for standard two-pass cleaning services. In addition, CCTV costs were estimated to be $1.25 per linear foot for all pipelines.

Based on the recommended 10-year rotational cleaning and inspection areas proposed in Chapter 6, specific annual cleaning and maintenance program costs can be estimated. However, since actual costs will depend on completion of maintenance activities, cleaning and inspection schedule, and funding availability, the actual costs for the maintenance program may vary. Therefore, the costs suggested for the maintenance and inspection program in Table 7.2 represent annual average costs, and are the same for every CIP year.

One alternative improvement for CIP-2 includes heavy-duty cleaning of a 48-inch outfall to Laguna Salada. Cleaning costs for this improvement was assumed to be $5 per linear foot based on typical costs for heavy-duty cleaning services.

7.4 PROJECT COSTS AND CONTINGENCIES

Project cost estimates are calculated based on a variety of elements, such as the project location, size, length, land acquisition needs, and other factors. Allowances for project contingencies consistent with an "Order of Magnitude" estimate are also included in the project costs prepared as a part of this study, as outlined in this section.

7.4.1 Baseline Construction Cost

This is the total estimated construction cost, in dollars, of the proposed improvement. Pipeline and pump station Baseline Construction Costs were developed using the following criteria:

- **Pipeline**: Calculated by multiplying the estimated length by the unit cost.
- **Pump Stations**: Estimated based on recent equivalent pump station projects of similar size and nature in California.

7.4.2 Estimated Construction Cost

Construction costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs, making it wise to incorporate allowances in preliminary estimates. To assist the City in making financial decisions for these future construction projects, construction contingency costs will be added to the planning budget as percentages of the Baseline Construction Cost, ultimately providing the Estimated Construction Cost.

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 25 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A 25 percent contingency to account for unknown site conditions such as poor soils, unforeseen conditions, environmental mitigations, and other unknowns is typical for master planning projects. The Estimated Construction Cost for the proposed storm drainage system improvement is the Baseline Construction Cost plus the 25 percent construction contingency.

7.4.3 Capital Improvement Cost

Other project construction contingency costs are divided into three subcategories, totaling 30 percent: 10 percent engineering, 10 percent construction phase professional services, and 10 percent project administration.

Engineering services associated with new facilities include preliminary investigations and reports, right-of-way acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. For this study, engineering costs are assumed to equal 10 percent of the Estimated Construction Cost.

Construction-phase professional services cover such items as construction management, engineering services, materials testing, and inspection during construction. The cost of these items varies, but for the purpose of this study, it is assumed that construction phase professional services expenses equal 10 percent of the Estimated Construction Cost.

Finally, project administration costs cover items as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, and interest during construction. The cost of these items varies, but for the purpose of this study, it is assumed that project administration costs equal 10 percent of the Estimated Construction Cost.

The Capital Improvement Cost is the total of the Estimated Construction Cost (including construction contingency) plus the other contingencies discussed in the previous paragraphs. As shown in the following sample calculation of the Capital Improvement Cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 62.5 percent of the Baseline Construction Cost. Note that contingencies were not applied to land acquisition costs. Calculation of the 62.5 percent is the overall mark-up on the Baseline Construction Cost to arrive at the capital improvement cost. It is not an additional contingency.

Example:

Baseline Construction Cost	$1,000,000
Construction Contingency (25%)	250,000
Estimated Construction Cost	$1,250,000
Engineering Cost (10%)	125,000
Construction Management (10%)	125,000
Project Administration (10%)	125,000
Capital Improvement Cost	$1,625,000

A summary of the capital project costs is presented in Table 7.2. This table identifies the recommended improvement projects, provides a brief description of the project, identifies facility size (e.g. pipe diameter and length), and the capital improvement cost. The table also shows the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

7.5 CAPITAL IMPROVEMENT IMPLEMENTATION

The CIPs are prioritized based on their urgency to mitigate existing deficiencies that currently cause flooding or capacity issues, other existing deficiencies, and for servicing anticipated development. The proposed implementation phases are separated into 5-year increments, except for the first phase, which runs from 2012 through 2015. Additionally, Phase 5 describes CIPs that will be carried out through the Post 2030 planning period, such as the long-term maintenance program. Each project is itemized by phase in Table 7.2. Proposed improvement implementation is described in more detail in Chapter 6.

Table 7.2 Capital Improvement Projects
Storm Drainage System Master Plan
City of Pacifica

					Project Length/Size and Cost					Capital Improvement Phasing						Reimbursement Category (Phases 1 through 4)[4]	
Figure No.	Type of Improvement	Description/ Street	Description / Limits	Pipeline Cost Schedule (A or B)	Ex. Size/ Diam. (in)	New Size/ Diam. (in)	Replace/ New	Length (ft)	Capital Improvement Cost[(1),(2)] ($)	Phase 1 2012-2015 ($)	Phase 2 2016-2020 ($)	Phase 3 2021-2025 ($)	Phase 4 2026-2030 ($)	Phase 5[(3)] Post 2030 ($)	Future Users Benefit (%)	Existing Users ($)	Future Users ($)
East Edgemar - Pacific Manor Subbasin (CIP-1)																	
EE-PM1	Pipe	Edgemar Ave	Avalon Drive to just south of Arroyo Drive	A	12	27	Replace	90	$ 39,000				$ 39,000		0%	$ 39,000	$ -
EE-PM2	Pipe	Edgemar Ave	Avalon Drive to just south of Arroyo Drive	A	12	27	Replace	175	$ 76,000				$ 76,000		0%	$ 76,000	$ -
EE-PM3	Pipe	Edgemar Ave	Avalon Drive to just south of Arroyo Drive	A	12	27	Replace	60	$ 26,000				$ 26,000		0%	$ 26,000	$ -
EE-PM4	Pipe	Avalon Drive	Fremont Avenue to Edgemar Avenue	A	-	18	New	625	$ 184,000				$ 184,000		0%	$ 184,000	$ -
EE-PM5	Pipe	Edgemar Ave	Manor Drive to Avalon Drive	A	-	21	New	700	$ 241,000				$ 241,000		0%	$ 241,000	$ -
East and West Sharp Park Subbasin (CIP-2)																	
Alternative 1																	
SP1	Cleaning	Laguna Salada outfall	Lakeside Ave to Laguna Salada outfall	A	48	-	Clean	375	$ 3,000	$ 3,000					25%	$ 2,250	$ 750
Alternative 2																	
SP2	Pump Station	Clarendon Ave	65 MGD, Western End of Clarendon Ave	A	-	-	New	-	$ 4,875,000	$ 4,875,000					25%	$ 3,656,250	$ 1,218,750
SP3	Pipe	Clarendon Ave	Lakeside Ave to Western End of Clarendon Ave	A	-	48	New	900	$ 705,000	$ 705,000					25%	$ 528,750	$ 176,250
West Linda Mar Subbasin (CIP-3)																	
LM1	Pipe	Linda Mar Blvd	Peralta Rd to Inlet on Linda Mar Blvd Due West of Marvilla Pl	A	-	30	New	1,050	$ 515,000			$ 515,000			0%	$ 515,000	$ -
LM2	Pipe	Linda Mar Blvd	Inlet on Linda Mar Blvd Due West of Marvilla Pl to Highway 1	A	-	36	New	1,700	$ 999,000		$ 999,000				0%	$ 999,000	$ -
Storm Drain Condition Assessment Program (CIP-4)[(5)]																	
-	Maintenance	CCTV	Storm Drain Condition Assessment Program, pipelines <= 15"	A	-	-	Clean/CCTV	108,800	$ 354,000	$ 141,600	$ 177,000	$ 177,000	$ 177,000	$ 35,400	0%	$ 672,600	$ -
-	Maintenance	CCTV	Storm Drain Condition Assessment Program, pipelines > 15"	A	-	-	Clean/CCTV	152,400	$ 545,000	$ 218,000	$ 272,500	$ 272,500	$ 272,500	$ 54,500	0%	$ 1,035,500	$ -
								CIP Total (Alternative 1)	**$ 2,982,000**	**$ 362,600**	**$ 1,448,500**	**$ 964,500**	**$ 1,015,500**	**$ 89,900**		**$ 3,790,350**	**$ 750**
								CIP Total (Alternative 2)	**$ 8,559,000**	**$ 5,939,600**	**$ 1,448,500**	**$ 964,500**	**$ 1,015,500**	**$ 89,900**		**$ 7,973,100**	**$ 1,395,000**

Notes:

1. Baseline Construction Cost plus 25% to account for unforeseen events and unknown conditions.
2. Estimated Construction Cost plus 30% to cover other costs including Engineering, Construction Management, and Project Administration.
3. Phase 5 costs represents the estimated average annual cost of the long-term condition assessment and inspection program.
4. Reimbursement categories for existing and future users including CIP costs are for Phases 1 through 4 only. Phase 5 costs represent the average annual cost of the cleaning and inspection program for the Post 2030 planning period. Therefore, the CIP totals listed until the reimbursement category column may be used to develop user rates through 2030. User rates developed for the Post 2030 period should take annual cleaning and inspection costs into consideration.
5. Condition assessment program CIP costs represent the estimated cost to perform inspections and cleanings of the City's entire storm drainage system once through (to be performed over the course of a 10-year rotational schedule).
6. Pump station capacities refer to the total capacity.
7. Costs are based on the Engingeering News Record Construction Cost Index 20-city average of 9035 (May 2011).

7.6 EXISTING VERSUS FUTURE USER COST SHARE

The improvements proposed in this Master Plan either benefit existing users or provide benefit to a combination of existing and future development. CIPs that partially benefit future users are indicated in Table 7.2. It was assumed that projects intended to correct existing deficiencies that provide no benefit to future users would be required regardless of future development. However, if an improvement will receive stormwater flow from a proposed development, a proportional share of the costs for the improvement was attributed to future development. A breakdown in existing and future user cost share of the proposed projects by implementation phase is provided in Table 7.3.

Table 7.3 Existing Versus Future User Cost Share

	Implementation Phase					
Reimbursement Category	**Phase 1 2012-15 (mil $)**	**Phase 2 2016-20 (mil $)**	**Phase 3 2021-25 (mil $)**	**Phase 4 2026-30 (mil $)**	**Phase 5 Post 2030 (mil $)**	**Total (mil $)**
Existing Users[2]						
Alternative 1	0.36	1.45	0.96	1.02	0.09	3.79
Alternative 2	4.54	1.45	0.96	1.02	0.09	7.97
Future Users[3]						
Alternative 1	0.001	0	0	0	0	0.001
Alternative 2	1.4	0	0	0	0	1.4
Total, mil $ (Alternative 1)	**0.36**	**1.45**	**0.96**	**1.02**	**0.09**	**3.79**
Total, mil $ (Alternative 2)	**5.94**	**1.45**	**0.96**	**1.02**	**0.09**	**9.37**

Notes:

1. All costs are in May 2011 dollars. ENR CCI 20 City average = 9035
2. Total CIP costs for Phases 1 through 4, through the 2030 General Plan planning period. Phase 5 represents average annual costs associated with the long-term maintenance and inspection program.
3. Projects are expected to be funded through user rates.
4. Projects are expected to be funded by developers.

APPENDIX A - SUMMARY OF LAND USE DESIGNATIONS (EXISTING CONDITIONS REPORT EXCERPT)

TABLE 2-6: GENERAL PLAN LAND USE DEFINITIONS

Land Use Designation	Description[2]
Residential	
Open Space Residential	Residential, agriculture, and recreation uses are allowed if consistent with objectives described in General Plan narrative. Average residential development densities are designated at more than five acres per unit.
Very Low Density Residential	Residential development averaging one-half to five acres per unit.
Low Density Residential	Residential development averaging 3 to 9 units per acre.
Medium Density Residential	Residential development at an average of 10 to 15 units per acre.
High Density Residential	Residential development at an average of 16 to 21 units per acre.
Commercial	
Agriculture	Lands under cultivation or intensively used for agricultural use.
Commercial	A variety of potential commercial uses, including visitor-serving commercial, retail commercial, office, heavy commercial and light industrial. The type of commercial use recommended for a site is stated in the Land Use Description.
Mixed Use	
Mixed Use[1]	A combination of residential and commercial uses, either arranged vertically within buildings or horizontally across sites.
Public or Institutional	
Public and Semi-Public	Public facilities, and public or private schools. In the case of public schools, the General Plan states that should the existing use be discontinued, the proposed use should be compatible with the adjacent neighborhood, and the existing play areas should be maintained as public recreation space.
Utilities	Water tanks, other public utilities.
Beach and Commuter Parking	Priority use is public parking. Underlying zoning will be consistent with adjacent land uses.
Parks and Open Space	
Parks	Publicly-owned areas, either now developed for recreation use or intended for future recreation development.
Greenbelts	Publicly- or privately-owned open areas not intended for development. May include land that is physically unsuitable to development due to geotechnical hazards or other environmental constraints; areas to remain undeveloped as a result of density transfers; areas covered by open space, recreational, or seismic easements; open areas providing a buffer between other areas; or open space required as mitigation for environmental impacts.
Prominent Ridgelines	A designation assigned to the most scenic ridges in order to protect their visual importance. The intent is to limit development on these ridges as much as possible.
Sandy Beach[1]	Beaches.
Other	
Special Area	An area, as described in the text, within which special physical or economic problems exist and for which more than one use would be acceptable, based on the land use designation in the Plan description and the findings of the Environmental Impact Report, site, plan, and other required evaluation of development.

Sources: City of Pacifica General Plan, City of Pacifica 2009, Dyett & Bhatia, 2009.

Notes:

[1] This category is not defined in the current General Plan, but is included in the General Plan map. Definition is inferred.

[2] Land use descriptions may be summarized from the original.

APPENDIX B - PACIFICA PLANNING COMMISSION MEMORANDUM (AUGUST 2011)

CITY OF PACIFICA
AGENDA MEMO

DATE: August 15, 2011

TO: Planning Commission

FROM: Leslie Gould and Peter Winch, Dyett & Bhatia Urban and Regional Planners

SUBJECT: **Agenda Item No. 1 Presentation** and discussion of the *Land Use Alternatives and Key Policy Issues* Report for the General Plan Update.

Background: The City of Pacifica is undertaking a comprehensive update of its General Plan, the guiding document for development and public improvements over a 20-year period. It is a plan that will provide guidance as people propose projects, and help the City make informed decisions. The plan will provide a vision and policies for land use, economic development, environmental protection, and infrastructure investment through 2030. The General Plan update process began with two community forums in the spring of 2009, and extensive research on existing conditions culminating in the *Existing Conditions and Key Issues* report in July 2010. We had a community meeting in January 2011 regarding alternatives, and the report is called *Land Use Alternatives and Key Policy Issues.* In this memo, we are making preliminary recommendations, based on community feedback, staff input, and new data sources.

Applicability: The Land Use Alternatives and Key Policy Issues Report is a stage in the process of updating the General Plan and Local Coastal Plan. It will inform land use designations and policies that will apply citywide.

Summary:

<u>Purpose of the Alternatives and Evaluation Phase</u>

In this phase, alternative land use scenarios are evaluated and approaches to key policy issues are considered, based on community priorities expressed in the preceding forums and on findings of the background research. The report was released to the public on July 15 (Report) presents land use scenarios that highlight issues related to commercial development, future residential development, and land conservation. It presents approaches to sustainable development, adaptation to sea level rise, open space preservation, and development of the parks and trails system.

A successful General Plan reflects the goals and values of the community. Public input is sought at key stages of the update process, ensuring that community members can take an active role in shaping the city's future. The land use alternatives and policy approaches discussed here were the subject of the third community forum (mentioned above), held at Pacifica's Ingrid B. Lacy Middle School on January 29, 2011.

The meeting featured presentations by the consulting team followed by small-group discussion periods. The feedback we received both on individual worksheets and from small-group discussion notes is summarized in each section of this report, with complete notes included in the report's Appendix.

Planning Context

Pacifica is a city of 40,000 located along six miles of coastline directly south of San Francisco. Pacifica grew quickly in the 1950s and '60s, but has grown very slowly since that time. Current projections are for the population to reach approximately 43,000 by the year 2030.

Figure 1-1 in the report shows existing land uses in the Planning Area. Nearly half (47 percent) of the Planning Area, or 3,600 acres, is protected open space, under the auspices of Golden Gate National Recreation Area, the City and County of San Francisco, San Mateo County, and the City of Pacifica. The Planning Area also has 1,200 acres of open spaces that is privately owned and potentially developable, as well as 360 acres of agricultural land. Altogether, two thirds of the Planning Area's land is not urbanized.

Pacifica's commercial land is distributed throughout the City at neighborhood shopping centers and in small commercial districts. Because it first grew as a series of separate communities, Pacifica lacks a clear city center. Retail businesses currently capture only half of the local spending power. More commercial development could be beneficial in terms of creating activity centers and increasing public revenue.

Growth Projections

Pacifica's population was estimated at 40,000 in 2009. Based on projections from 2007 by the Association of Bay Area Governments (ABAG), population growth is likely to be in the range of 1,000 to 1,500 people per decade, continuing a slow rate of growth that dates to the 1970s. For the General Plan update, we are projecting the need for 1,300 new housing units by 2030 to accommodate population growth. More immediately, the City must meet the need for 311 new housing units by 2014, with more than half of these units for very or extremely low-income households.

Job growth is expected to be greater than population growth. ABAG projects adding 1600 jobs by 2030, which is a 26% increase, compared to a 9% increase in residents.

Table 1-1 Projected Growth in Pacifica

Pacifica	*2005*	*2030*	*Increase*	*% Change*	*Annual Growth Rate*
Population	38,800	42,100	3,300	9%	0.3%
Households	14,190	15,480	1,290	9%	0.4%
Employed Residents	18,600	24,170	5,570	30%	1.1%
Jobs	6,190	7,790	1,600	26%	0.9%

Table 1-2 Housing Need in Pacifica, 1999-2014

Income Level	*Need*[1]	*Units Built or Approved*[2]	*Percent of Need Met*	*Remaining Need*
1999 - 2006 Period				
Very Low Income	120	10	8%	110
Lower Income	60	32	53%	28
Moderate Income	181	123	68%	58
Above Moderate Income	305	313	100%	0
Subtotal	*666*	*447*	*66%*	*196*
2007 - 2014 Period				
Extremely Low Income[3]	32	3	9%	29
Very Low Income	31	0	0%	31
Lower Income	45	1	2%	44
Moderate Income	53	42	79%	11
Above Moderate Income	114	152	100%	0
Subtotal	275	198	72%	115
Total Remaining Need				
Extremely Low Income[3]				29
Very Low Income				141
Lower Income				72
Moderate Income				69
Above Moderate Income				0
Total Remaining Need				**311**

Source: City of Pacifica, 2010.

Market Potential

Pacifica is a mainly residential community with a low commercial profile. The city has three times as many employed residents as local jobs. Its retail establishments capture just half of household, employee, and business expenditures. Market analysis conducted for the General Plan update concluded that while there will be limited demand for new grocery-anchored shopping centers or "destination retail" during the next 20 years, Pacifica has potential for unique local-serving retail, tourism-based retail, and boutique hotels, as well as for a luxury resort. New visitor-oriented development could add up to $1.5 million in transient occupancy tax and sales tax annually.

Development Capacity

An estimated 1,110 acres in the planning area are undeveloped (not including protected open space) and another 361 acres are in agricultural use. Underutilized urban land—aging shopping centers and commercial districts—comprises another 163 acres (see Figure 1-3 in the report). Not including land outside City limits, potential development sites could accommodate an estimated 1,457 housing units and 2.1 million square feet of commercial space, based on current development regulations (see Table 1-3). This is more than is projected to be needed to accommodate growth. However, much of the land has difficult access, competing demands for habitat protection, or fractured ownership. The Rockaway Quarry site, which accounts for 80 percent of the City's commercial development potential, requires a public vote for any development that includes residential uses.

Table 1-3 Summary of Development Capacity and Projected Demand (Current Zoning and General Plan Designations)

	Estimated Capacity		Projected Demand	
	Vacant or Underutilized Land (acres)	*Capacity of Vacant and Underutilized Sites*	*Projected Population and Job Growth by 2030*	*Projected Residential and Commercial Demand*
Residential Development	1,304	1,511 units	3,000 residents	1,300 units
Vacant Land Outside City	*287*	*54 units*	*NA*	*NA*
Residential Excluding Land Outside City	***1,016***	***1,457 units***	***3,000 residents***	***1,300 units***
Non-Residential Development	330	2,153,956 sq. ft.	1,600 jobs	640,000 sq. ft.
Quarry Site	*94*	*1,712,714 sq. ft.*	*NA*	*NA*
Non-Residential Excluding Quarry Site	***236***	***441,242 sq. ft.***	***1,600 jobs***	***435,000 to 640,000 sq. ft.***

Sources: California DOF, 2009; ABAG, 2006 and 2008; US Census, 2007; Dyett & Bhatia, 2010.

Key Policy Choices

Certain General Plan issues have revealed themselves to require more attention in Pacifica. These are the primary subjects of the Alternatives and Evaluation phase.

Future Residential Development and Protection of Biological Resources

Pacificans treasure the open spaces that define their city and prioritize open space preservation in the future. However, two of the draft policy statements receiving the least community consensus at the second forum called for "limited or no development" on sites critical for open space connections or habitat preservation. An appropriate approach to the balance of development and preservation is considered in Chapters 2, Residential and Future Residential Areas, and 5, Parks, Open Space, and Biological Resources, in the report.

The Quarry Site and Revitalization of Commercial Areas

Most participants at the first two community forums agreed with policies of shopping center revitalization, mixed-use redevelopment, and the creation of a stronger city center, but important locational questions remain. Critically, community members express mixed ideas about the future of the quarry site. These issues are considered in depth in Chapter 3 of the report.

The General Plan update will aim to help bring revitalization and economic development, and identify desired locations for civic uses, industrial uses, visitor-oriented uses, mixed-use districts. Three alternative scenarios are presented, described below.

Coastal Development

Pacifica regulates development near the coast to ensure safety from flooding and erosion. These risks are compounded by the potential for sea level rise over the long term. The new General Plan will need to consider strategies for adaptation to sea level rise. In chapter 4, the report presents strategies for managing new development in areas vulnerable to sea level rise; preserving undeveloped coastal land; and conducting "managed retreat" and shoreline restoration.

Summary of Land Use Alternatives, Community Preferences, and Recommendations

The January 29, 2011 community forum was structured as three presentations by the consulting team followed by two discussion periods. The first presentation was focused on land use alternatives for residential areas, the second on commercial areas, and the third session was devoted to coastal development policies and the future parks and open space system. Community members were asked to provide their feedback on individual worksheets, while the facilitators of each table group were asked to take notes on the discussions. The resulting community responses are incorporated into each section of the report, and are summarized below. The worksheets are included as Appendix A of the report, and complete responses are included in Appendix B. Table discussion notes are in Appendix C, and additional comments received are in Appendix D.

Existing and Future Residential Areas

The planning team proposed approaches to eight focus areas where changes to current General Plan designations should be considered (see map: Existing and Future Residential Areas). The designation proposed for discussion was intended to permit a density appropriate to site conditions. Community members were asked to mark on worksheets whether they agreed, disagreed, or did not have an opinion. In many cases, community members also added comments to the worksheets.

As shown in Table 1-4, the proposed approach to seven of the eight focus area received majority agreement from forum participants. The proposed approach to three focus areas received less than 60 percent support: Fairway Park, the Fish and Bowl sites, and Linda Mar Boulevard. Responses are discussed in more detail in Chapter 2 of the report.

Table 1-4 Level of Agreement With Proposed Approach to Residential Areas

Focus Area	*Approach*	*Agree*	*Disagree*	*No Opinion*
1 Fish and Bowl	Match Lower of GP/Zoning	53%	32%	15%

2 Northern Bluffs	OSR, TDR[1]	68%	30%	3%
3 Upper Monterey and Manor	Match Zoning	64%	27%	9%
4 East Sharp Park	Match Zoning	70%	18%	12%
5 Fairway Park	Match Higher of GP/Zoning	49%	46%	5%
6 Pedro Point Upper Slopes	Match GP	62%	34%	4%
7 Linda Mar Blvd	LDR, MDR[2]	59%	32%	9%
8 Linda Mar and Park Pacifica Hillsides	Match GP	73%	20%	7%

Source: Dyett & Bhatia, 2011.

[1] *Open Space Residential, Transfer Development Rights*
[2] *Low Density Residential, Medium Density Residential*

We recommend proceeding with the land use designations proposed, with one exception.

- Maintain Current Open Space Residential Designation for Property Above Fairway Park (Focus Area 5)

- The Fish and Bowl Property (Focus Area 1) has development entitlement matching the proposed Medium Density Residential designation.

Commercial Areas and Economic Development

Three alternative concepts were presented for the future revitalization and development of commercial areas. Commercial Areas maps for Alternatives A, B, and C were released to the public on July 15th, 2011. In the first alternative, a new city center is created at the Rockaway Quarry site, and new development is concentrated there. In the second alternative, the Quarry site receives some development, while the West Sharp Park neighborhood intensifies as the civic core of the city, and other sites also gain higher-density development. In the third alternative, the Quarry is almost entirely conserved as habitat and open space, while Pacific Manor, West and East Sharp Park, Rockaway Beach, and Linda Mar/Pedro Point each become a unique higher-density area.

The alternatives were compared overall, and then for each focus area (though for two of the eight focus areas, the alternatives all took the same approach). Participants were asked to rank their preferences overall and by focus area.

Table 1-5 shows that Alternative A: Strong Center at Quarry Site was the first choice of the greatest number of participants as an overall concept: 39 percent vs. 26 percent each for Alternatives B and C. Both Alternatives A and C were listed as third choice or given no rank by many participants, indicating that these alternatives had significant opposition.

Alternative A: Strong Center at Quarry Site, received the greatest number of first-choice preferences for all focus areas but one, Northern Palmetto/Base of Milagra Ridge, where Alternative B: Multi-Centered, West Sharp Park Emphasis, received slightly more support. In many cases, preferences were nearly even. Reponses to Alternatives A for most focus areas were divided between top and bottom choices, while Alternative B seemed to have fewer negatives. See Chapter 3 for a summary table and more detailed accounting of community response.

Table 1-5 Preferences for Proposed Alternatives for Commercial Areas

Alternative	*Approach*	*Preference*				
		1	*2*	*3*	*None*[a]	*Points (5,3,1,0)*[b]
Overall						
Alternative A	Strong City Center at Rockaway Quarry	**39%**	11%	**39%**	11%	102
Alternative B	West Sharp Park Emphasis	26%	**47%**	5%	21%	106
Alternative C	Conservation and Redevelopment	26%	18%	37%	18%	85
Focus Area						
1 Rockaway Beach / Quarry						
Alternative A	Full Development	**49%**	4%	36%	11%	204
Alternative B	Limited Development	23%	**44%**	11%	21%	181
Alternative C	Minimal Development	21%	21%	**41%**	16%	149
2 West / East Sharp Park						
Alternative A	Commercial, Mixed Use	**43%**	13%	33%	10%	200
Alternative B	Office, Civic Center	35%	**30%**	14%	20%	193
Alternative C	Mixed Use, Civic Center	17%	23%	**38%**	22%	134
3 Northern Palmetto / Base of Milagra Ridge						
Alternative A	Maintain	33%	17%	**42%**	8%	171
Alternative B	Retail, Office	**38%**	**32%**	14%	17%	197
Alternative C	Recreation, Industrial	23%	24%	35%	18%	146
4 Pacific Manor						
Alternative A	Improve Existing	**42%**	20%	30%	7%	208
Alternative B	Mixed Use	36%	**33%**	13%	17%	203
Alternative C	Commercial, Office	20%	23%	**41%**	16%	146
5 Pedro Point / Linda Mar						
Alternative A	Commercial, Residential	**35%**	19%	**33%**	13%	167
Alternative B	Hotel, Commercial, Mixed Use, Residential	33%	**37%**	11%	19%	181
Alternative C	Mixed Use, Hotel	25%	19%	32%	24%	136
6 Park Mall Area						
Alternative A/B/C	Mixed Use	**89%**	2%	0%	9%	253

7 Park Pacifica Stables						
Alternative A/B/C	Maintain	**95%**	0%	0%	5%	260
8 Gypsy Hill						
Alternative A	Hotel, Residential	**54%**	5%	25%	16%	189
Alternative B	High Density, Open Space Residential	5%	**34%**	**33%**	28%	98
Alternative C	Planned Development	20%	30%	28%	23%	131

Source: Dyett & Bhatia, 2011.

Notes:

a Where participants marked a preference for at least one alternative, any alternative that was not marked is considered to potentially indicate a negative response.
b This point system assigns 5 points to every first choice, 3 points to every second choice, 1 point to every third choice, and no points where an alternative was not ranked.

With the commercial areas, we recommend following an overall vision that recognizes the community's center in the West Sharp Park area; anticipates some development in the Quarry with habitat and open space preservation of a majority of the site; and facilitates redevelopment of aging shopping centers with a mix of uses. These recommendations are based on community preferences at the third community forum, comments received from community members, and an understanding of constraints. Our specific recommendations include:

1. Rockaway Beach/Quarry

- Quarry Site:
  - Open Space Likely to be Required on 1/2 to 2/3 of Site (or More)
  - Permitted Uses: Hotel and Retail, also Public Uses
  - Residential Use Requires Public Vote
- Rockaway Beach District:
  - Retain Current Zoning, Including Commercial Recreation Close to Ocean
- Lower Rockaway:
  - Visitor Commercial at Sea Bowl and Rock sites, Allowing Hotel, Restaurant
  - Multi-Family Housing Site on Fassler
- East Side of Highway 1:
  - Service Commercial, With Landscaped Frontage Required

  - Could Also be Retail Commercial

2. West/East Sharp Park
   - Palmetto Avenue:
     - Pedestrian-Oriented Mixed Use "Main Street"
     - Create Open Space on Ocean Side of Old Wastewater Treatment Plant
     - Hotel, Restaurant, Retail, Housing, Civic Uses May Be Developed on Rest of Site, as Suggested by Beach Blvd. Property Development Evaluation
   - Francisco and Oceana Avenues, Eureka Square:
     - Office and/or Commercial Along Highway 1
     - Possible Housing At East End of Eureka Square Site, Away From Freeway
3. Northern Palmetto/Base of Milagra Ridge
   - Northern Palmetto:
     - Complete Change of Use Community Preferred Retail is Not Realistic
     - Industrial Uses May Remain
     - Commercial Recreation (Campgrounds, Equestrian Uses, etc.) Appropriate Over Long Term Given Risk of Oceanfront Location
     - Add Landscaping to Both Existing Industrial and New Commercial Recreation Uses
   - Base of Milagra Ridge:
     - Retail or Office Frontage and Housing Upslope
4. Pacific Manor
   - Community Preferred Alternative that Would Improve Existing Shopping Center
   - Also Strong Support for Mixed Use Redevelopment; If There is Opportunity for Mixed Use it Should be Allowed
   - Residential Uses Should be at West End of Site, Oriented to Ocean and Shielded from Freeway
   - Retail Could be Added Fronting Palmetto Ave. / Highway 1

5. Pedro Point/Linda Mar
   - Linda Mar:
     - High-density Housing With or Without Retail on Crespi Drive
     - Housing Above Retail for Park-and-Ride site, Accommodating Parking for Transit
     - Small Additional Retail Frontage at Linda Mar Shopping Center
   - Pedro Point:
     - Retail, Possible Hotel at Pedro Point Shopping Center
     - Hotel, Park, and Residential on Calson site
     - Medium Density Residential on Neighborhood Edges
     - Hotel Oriented Toward Pacifica State Beach
     - Public Park in Portion of Site Nearest to Ocean, Shopping Center
6. Park Mall Area
   - Housing above Retail: Redevelopment of Park Mall Shopping Center and Adjacent Vacant Sites
   - Housing above Retail on the Library site, including Multi-Family or Senior Housing
7. Park Pacifica Stables
   - Commercial Recreation Designation Supporting Current Equestrian Use
8. Gypsy Hill
   - Visitor Commercial and Open Space Residential
   - Hotel, Inn, or Conference Center and Related Uses (including retail) on upper portion of Sharp Park Rd (currently zoned for commercial)
   - Open Space Residential on Adjacent Downslope Parcels
   - High-Quality, Site-Sensitive Design Required

Coastal Development Policies

Strategies for managing new development in areas vulnerable to sea level rise; preserving undeveloped coastal land; and conducting "managed retreat" were presented at the third community forum. Participants were asked to indicate on worksheets whether they agreed or disagreed with proposed approaches, and were given space to comment.

The majority of attendees reported that they agreed with the coastal development policies presented (see Table 1-6). Agreement was strongest (89 percent) concerning master plans for future development on public land. It was weakest (54 percent) for strict limits on future density. Responses are covered in more detail in Chapter 4 of the report.

Table 1-6 Level of Agreement With Proposed Approaches to Coastal Development

	Answers		
Question	*Agree*	*Disagree*	*No Opinion*[1]
1. New development within designated area requires study demonstrating safety from sea level rise	76%	14%	10%
2. Strict limits on future density, and do not upzone any new areas	54%	34%	11%
3. Rolling easement ensuring setback and public access	64%	20%	16%
4. Permanent open space protection with clustered development	57%	27%	16%
5. Master plans for public land	89%	1%	10%
6. Regulatory structure and incentives for shifting development away from coast	67%	26%	7%

Source: Dyett & Bhatia, 2011.

Notes:

1 includes items not marked.

We recommend proceeding with the proposals for #1, #5, and #6; developing them into sound policies. Regarding a requirement to demonstrate safety from sea level rise (#1), owners would need to show that the property will not be affected by sea level rise over the life of the building with no public intervention.

The idea of having strict limits (#2) on future density received less support. The key will be to coordinate the land use plan with the goals for protecting development along the coast. Future density may better determined by land use designations without the additional layer of coastal policies limiting future density. Future density may also be determined by the current trend in Low Impact Development (LID) and Transit Oriented Development (TOD); both of which are deemed necessary from various driving factors including stormwater regulations, infill development potential, and infrastructure and available resources.

Items #3 and #4 are recommended with 64% and 57%. They will need to be refined further to clarify if and when these policies will be used.

Parks, Open Space, and Biological Resources

Finally, the planning team presented a concept for future parks and open spaces, consisting of three main features: new neighborhood and pocket parks; priorities for future open space and habitat preservation; and enhancements to the trail system. See the Open Space and Trails map for details.

Meeting attendees were encouraged to provide open-ended comments regarding the open space presentation on the worksheets. These comments indicate a high level of support for new park space in neighborhoods with some concerns about City resources. A slight majority of community members seemed to support conserving more natural open space. There was strong support for improving the trail system, a subject which also generated considerable interest in specifics. These are covered in more detail in Chapter 5 of the report.

- With regard to neighborhood parks, we recommend that Pacifica should seek to create locally accessible park space at key opportunity sites, even small ones, and focus on quality and upkeep.
- Future open space may be conserved by acquisition, conservation easements, or as part of very low-density development with sensitive site planning and protection of key natural resources.
- The northern coastal bluffs, Milagra Canyon, and the west end of Cattle Hill are priorities.
- The concept of an enhanced, highly legible trail system should be pursued, with an eye toward regional connections and careful placement of access points.
- Use the open space and trails plan as the starting point for the General Plan Open Space concept.

Concerns about Process

Several community members wrote that the choices were too confusing, that the language was too technical, and/or that the map color schemes were confusing. One participant wrote that insufficient time was provided to digest complicated information. A small number of responses noted concern that the General Plan process must work closely with the Climate Action Plan Task Force, the Green Building Task Force, and with the Coastal Commission and other agencies to the extent possible.

Impact on Planning Commission:
Final decision by City Council.

Planning Commission Role in General Plan Update:
The Planning Commission plays an important role in each stage of the development of the General Plan and Local Coastal Plan Update. In September 2010, the *Existing Conditions* report was presented to the Planning Commission and City Council. Commission and Council comments were responded to in a subsequent addendum to that report.

Planning Commission response to the *Land Use Alternatives* will inform the identification of key policies and a preferred land use plan. There will be another public meeting of the Planning Commission to present draft outlines of the GP and LCP, and another to present the draft GP and LCP and Environmental Impact Report (EIR). The final Plans and EIR must be approved by the Planning Commission before being adopted by City Council.

Environmental Review: State Requirements:
The analysis of Land Use Alternatives and Key Policy Issues does not require environmental review. A full Environmental Impact Report will be prepared in conjunction with the General Plan and Local Coastal Plan Update.

COMMISSION ACTION REQUESTED
Make recommendations for the preferred plan to be selected by the City Council.
Comment on the designations discussed for the potential development sites, per the attached maps.

Attachments (Disseminated to Planning Commissioners on July 15, 2011)
Maps:
Existing General Plan
Existing Zoning
Existing and Future Residential Areas
Commercial Areas, Alternative A
Commercial Areas, Alternative B
Commercial Areas, Alternative C
Flooding and Coastal Erosion Hazards
Open Space and Trails

Report:
Land Use Alternatives and Key Policy Issues