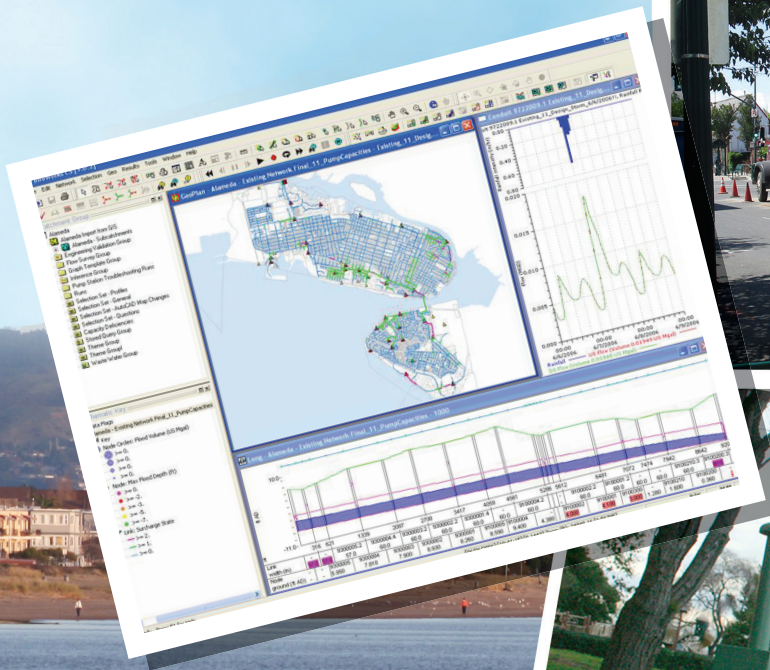
City of Alameda
Sewer Master Plan



RMC water and environment

FINAL REPORT

November 2015

November 30, 2015

Ms. Erin Smith
Acting Deputy Public Works Director
City of Alameda
950 West Mall Square, Room 110
Alameda, CA 94501-7575

Subject: Sewer Master Plan

Dear Ms. Smith:

RMC Water and Environment is pleased to submit this Final Report for the City of Alameda's Sewer Master Plan. The report presents the results of a comprehensive analysis of the City's sanitary sewer system to support the City's ongoing efforts to upgrade its sewer infrastructure and comply with its Consent Decree with the U.S. EPA and State and Regional Water Boards.

The study included the development of a "pipe rating model" to prioritize sewers for rehabilitation and replacement based on their likelihood and potential consequence of failure, focusing primarily on their physical condition as documented by the results of closed-circuit television inspections conducted over the past several years. The study also included a detailed capacity assessment of the sanitary sewer system based on land use plans for future development and redevelopment and an updated hydraulic model of the sewer system.

The information presented in the report provides a firm basis for establishing project priorities and budgets for the City's 20-year Capital Improvement Program and will help inform City decisions on providing additional hydraulic capacity where needed. The report also supports the City's compliance with the Sewer System Management Plan requirements of the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems.

We appreciate the opportunity to have worked with the City on this challenging project and thank City staff for their assistance and guidance throughout the study.

Sincerely,

Gisa M. Ju, P.E.
Project Manager

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Complex Challenges | Innovative Solutions

City of Alameda
Sewer Master Plan
Final Report

Prepared by:

RMC water and environment

November 2015

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Acknowledgements

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List of Abbreviations

ADWF	Average Dry Weather Flow
AMIP	Asset Management Implementation Plan
AO	Findings of Violation and Order for Compliance (Administrative Order)
APN	Assessor Parcel Number
Baykeeper	San Francisco Baykeeper
BWF	Base Wastewater Flow
CCTV	Closed-Circuit Television
CDO	Cease and Desist Order
CIP	Capital Improvement Program or Capital Improvement Plan
CIPP	Cured-in-Place Pipe
City	City of Alameda
CMMS	Computerized Maintenance Management System
d/D	Ratio of flow depth to pipe diameter
DWF	Dry Weather Flow
EBMUD	East Bay Municipal Utility District
ENR CCI	Engineering News Record Construction Cost Index
EPA	U.S. Environmental Protection Agency
FMLR	Flow Modeling and Limits Report
fps	Feet per second
FY	Fiscal Year
GIS	Geographic Information System
gpd	Gallons per day
GWDR	General Waste Discharge Requirements for Sanitary Sewer Systems
GWI	Groundwater Infiltration
HDPE	High Density Polyethylene (Pipe)
HOA	Homeowner Association
I/I	Infiltration and Inflow
MIP	(Alameda Point) Master Infrastructure Plan
MFR	Multi-Family Residential
mgd	Million Gallons per Day
MH	Manhole
MWWTP	EBMUD Main Wastewater Treatment Plant

NAS	(Alameda) Naval Air Station
NASSCO	National Association of Sewer Service Companies
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
PACP	Pipeline Assessment and Certification Program
PDWF	Peak Dry Weather Flow
PS	Pump Station
PSL	Private Sewer Lateral
PVC	Polyvinyl Chloride (Pipe)
PWWF	Peak Wet Weather Flow
RCP	Reinforced Concrete Pipe
RDI/I	Rainfall Dependent Infiltration and Inflow
RMC	RMC Water and Environment
R/R	Rehabilitation/Replacement
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SECAP	System Evaluation and Capacity Assurance Plan
SFR	Single Family Residential
SO	Stipulated Order for Preliminary Relief
SQR	Structural Quick Rating
SSES	Sewer System Evaluation Survey
SSMP	Sewer System Management Plan
SSO	Sanitary Sewer Overflow
SWRCB	State Water Resources Control Board
VCP	Vitrified Clay Pipe
WWF	Wet Weather Facility or Wet Weather Flow
WWPF	Wet Weather Peaking Factor

Executive Summary

Executive Summary

This report presents the results and recommendations of the Sewer Master Plan for the City of Alameda (City). The report was prepared by RMC Water and Environment (RMC) under an agreement with the City dated August 26, 2014. The Master Plan evaluates the capacity and condition of the City's sanitary sewer system and establishes the basis for the City's 20-year sewer system Capital Improvement Program (CIP).

ES-1 Existing Sewer System and Service Area

The City's sewer system serves a population of about 76,000 within the Alameda city limits. The system includes approximately 140 miles of City-owned sanitary sewers and 42 sewage pump stations, including 14 miles of pipes and 9 pump stations located in Alameda Point, the former Alameda Naval Air Station site. In addition, there are over 10 miles of pipelines and 7 pump stations located in Alameda that are part of the East Bay Municipal Utility District (EBMUD) wastewater system, which serves as the "backbone" of Alameda's sewer network. All wastewater is conveyed to EBMUD's South Interceptor in Oakland via inverted siphon pipelines underneath the Oakland Estuary, from where the flow is conveyed north to EBMUD's Main Wastewater Treatment Plant located near the eastern terminus of the San Francisco-Oakland Bay Bridge. During periods of wet weather when the capacity of the interceptor is exceeded, flows in the South Interceptor may be diverted to EBMUD's Oakport and San Antonio Creek Wet Weather Facilities (WWFs) in Oakland for storage and/or discharge. **Figure ES-1** shows the existing Alameda sewer system.

Over 75 percent of Alameda's sewer system consists of 8-inch and smaller diameter pipe, and over 90 percent is 12 inches and smaller. The oldest portions of the system date to the early 1900s; however, over 30 percent of the system has been rehabilitated or replaced in the past 30 years. Most older sewers are constructed of clay pipe materials, with plastic materials used for newer sewer construction and rehabilitation.

The sewer system also includes approximately 19,000 private sewer laterals. The property owner is responsible for maintenance and repair of the entire service lateral to the connection to the City's sewer main. However, the City takes responsibility for replacement of the lower portion of the lateral (within the public right-of-way) when the public sewer main to which it is connected is rehabilitated or replaced, or if the lower lateral fails, whichever occurs first. The sewer system also includes a number of private sewer systems, primarily on Harbor Bay Isle and in new developments on the western side of the main Alameda island; these private systems are the responsibility of individual Homeowner Associations.

ES-2 Background and Master Plan Objectives

Prior to this Master Plan, the City's last comprehensive evaluation of the sanitary sewer system was conducted as part of the region-wide wet weather infiltration/inflow (I/I) studies conducted in the 1980s by EBMUD and its seven tributary agencies ("Satellites"), including Alameda. The findings of those studies resulted in a long-term program of sewer system improvements, which included sewer rehabilitation and construction of relief sewers in the Satellite collection systems, and improvements to EBMUD's system to handle wet weather flows. The EBMUD improvements included construction of three WWFs, which provided storage and primary-level treatment and disinfection for wastewater discharged during wet weather periods. The programs developed based on the 1980s studies were accepted by State and federal regulators as an appropriate solution to the region's wet weather issues, and were approved as part of Cease and Desist Orders and National Pollutant Discharge Elimination System (NDPES) Permits issued to EBMUD and the Satellites at the time.

Since the 1980s, the City has constructed needed relief sewers and rehabilitated or replaced over 30 percent of the sewers in its system. In the late 1980s, in order to further reduce I/I, the City was also the first of the Satellites to also adopt an upper lateral compliance program to provide for repair or replacement of private sewer laterals at time of property sale or transfer or major remodel. This program has resulted in the rehabilitation or replacement of over 6,000 private laterals city-wide since that time (the City has since joined the EBMUD Regional Private Sewer Lateral program).

Starting in 2007, however, a series of regulatory decisions resulted in the remand of EBMUD's permit for its WWFs, and Stipulated Orders for Preliminary Relief (SOs) were subsequently issued by the U.S. Environmental Protection Agency (EPA) to both EBMUD and the Satellites requiring asset management programs and plans to reduce wet weather flows. Recognizing the need to address the capital demands of its aging sewer system, in 2010 the City adopted a program of increases to its sewer service charge to fund needed improvements. In September 2014, EBMUD and the Satellites entered into a Consent Decree (CD) with EPA, the State Water Resources Control Board (SWRCB), and San Francisco Bay Regional Water Quality Control Board (RWQCB) intended to eliminate discharges from the WWFs over an approximate 20-year period. For Alameda, the CD-required "Work" includes specified annual amounts of sewer rehabilitation, inspection, and cleaning; as well as continued implementation of private sewer lateral compliance and inflow elimination programs; and pump station renovation.

Since 2004, the City has also had to comply with other regulatory requirements, including the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems adopted by the SWRCB in 2006. These regulations include the requirement to prepare and adopt a Sewer System Management Plan (SSMP). The SSMP must include programs for addressing the operation and maintenance of the system and assessing and upgrading its capacity and condition.

Therefore, based on these requirements, as well as the City's commitment to providing a high level of service to its customers, the primary objectives of the Sewer Master Plan are to:

- Confirm that the system has adequate capacity to handle peak wet weather flows, as required for the System Evaluation and Capacity Assurance Plan element of the SSMP
- Satisfy the Rehabilitation and Replacement Plan requirements of the SSMP and CD
- Establish a firm basis for project priorities and budgets in the City's 20-year Capital Improvement Program

ES-3 Basis of Planning

This Sewer Master Plan utilizes the information that the City has collected through its maintenance, inspection, and monitoring activities to perform an assessment of system condition and capacity; and utilizes the results of those assessment to identify and prioritize sewer system capital improvement needs. The basic tool used to develop the CIP was a "Pipe Rating Model," which assigns a risk score to each gravity pipe in the system and provides a means of helping to prioritize pipes for rehabilitation and replacement.

The risk of asset failure is calculated by quantifying the likelihood of failure (LOF) and consequence of failure (COF) for each sewer asset. LOF is the probability of asset failure, which can be a result of a structural failure, capacity deficiency, or maintenance issue that causes a blockage or overflow. COF is defined as the impact on level of service resulting from asset failure. The risk of failure is defined as:

$$\text{Risk} = \text{LOF} \times \text{COF}$$

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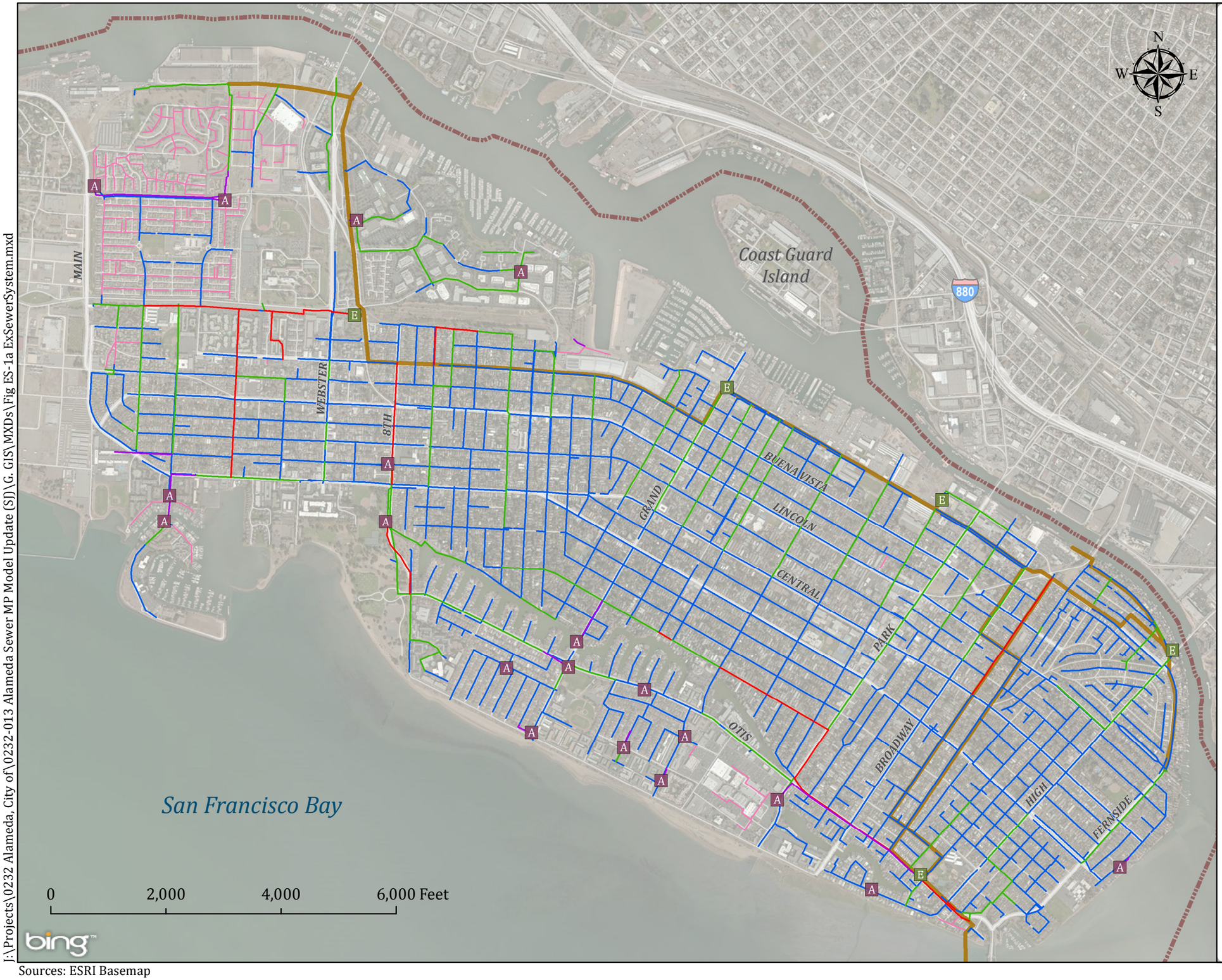


Legend

Gravity Sewers
- ≤ 8"
- 10" - 15"
- > 15"

Private Sewers

Force Mains

EBMUD Interceptor

A Alameda Pump Stations

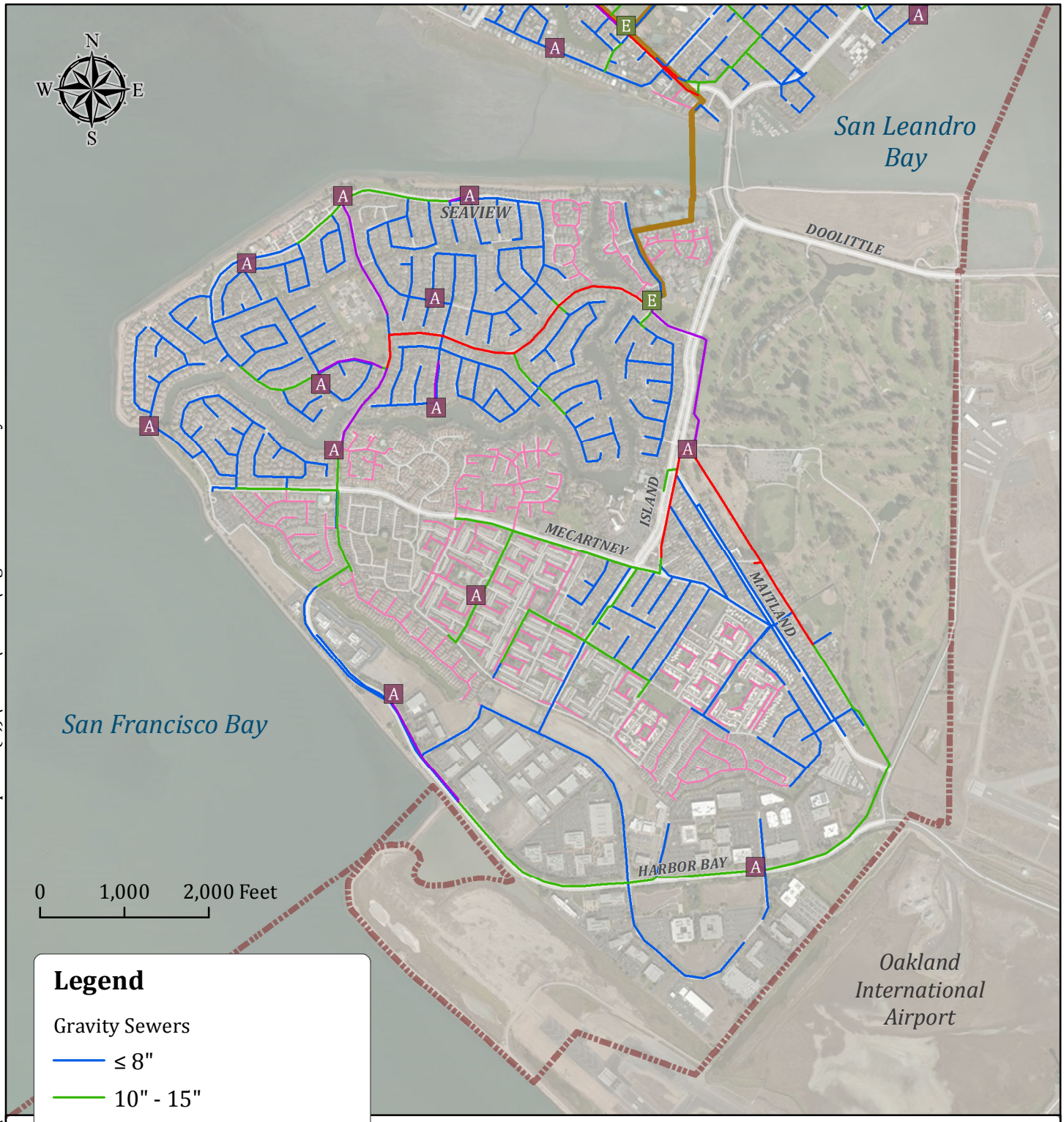
E EBMUD Pump Stations

Alameda City Limit

City of Alameda
Sewer Master Plan

Figure ES-1a
Existing Sewer System
(Alameda Island)

Sources: ESRI Basemap



City of Alameda
Sewer Master Plan

Figure ES-1b
Existing Sewer System
(Harbor Bay Isle)

water and environment

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Sources: ESRI Basemap

The following four LOF indicators were used in the Pipe Rating Model:

- Structural Condition
- Operation & Maintenance (O&M) Condition
- Capacity Deficiency
- I/I Contribution (relative impact on flows to EBMUD interceptor and discharges from EBMUD's WWFs)

The following three COF indicators were used in the Pipe Rating Model:

- Flow Volume (Economic Impact)
- Community (Social) Impact.
- Environmental Impact

A scoring system was developed to quantify each of these factors based on relevant parameters (e.g., number and type of defects observed from sewer inspection; extent of sewer surcharge predicted by hydraulic modeling; location with respect to busy streets, commercial areas, storm drain inlets and and water bodies; etc.), and assign relative weights to each factor. The risk scores were then calculated for each pipe and used to establish initial priorities for rehabilitation and replacement, which were modified based on other factors such as pavement condition, maintenance issues, and location.

ES-4 Capacity Assessment

The capacity of Alameda's sewer system was assessed through use of a hydraulic model. The model was originally developed as part of the City's *Sanitary Sewer System Hydraulic Analysis* study completed in 2010 and was updated for this study. The modeled system consists of the majority of the existing sewer system (except for Alameda Point), including the EBMUD pipelines on Alameda. (A model of the future Alameda Point sewer system was developed separately, as discussed later in this section.) Flow loads to the model were developed from assessor parcel data, other sources of information (e.g., school enrollment), and estimates of additional flows from potential future developments based on information provided by the City's planning staff. Data from flow monitoring programs conducted by the City and by EBMUD during the 2009/10 and 2010/11 wet weather seasons were used to estimate the amount of I/I for various areas of the system and to confirm, through model calibration, that the hydraulic model reasonably simulates the actual performance of the system during both dry and wet weather conditions.

The capacity of the system was assessed with respect to a design storm condition, defined as a design rainfall event falling under saturated soil conditions with the timing of the storm such that the peak I/I flows occur at about the same time as the peak diurnal base wastewater flow in most areas. The design rainfall is a 7-hour historical storm (known as the "EBMUD design event"), which was defined for the 1980s I/I studies and has been used since that time by the Satellites and EBMUD for wet weather evaluations. The storm has an approximate *rainfall* return period of 5 years, but based on the assumed timing of the storm under design event conditions, it is generally thought to create a return period of peak wastewater *flow* that is greater (less frequent) than the return period of the rainfall event.

The hydraulic model was run with the design event to identify areas of the sewer system that would not have adequate capacity to convey the peak wet weather flows generated by that event. Capacity was considered inadequate whenever the model predicted that the peak flows would result in surcharge (flow above the crown of sewer pipes) to within five to six feet of manhole rims.

The modeling indicated that overall, the Alameda system has adequate capacity to convey peak wet weather flows. Only two potential capacity deficiencies were identified, both located within and/or downstream of

the Harbor Bay Business Park area. Proposed sewer capacity improvements (pipe upsizing along Harbor Bay Parkway and Beach Road) were developed for these areas.

The modeling also provided updated estimates of peak wet weather flows to the modeled system pump stations, which were compared to the existing and planned station firm capacities (firm capacity is the capacity of the pump station with the largest pump out of service). A number of the system pump stations have already been planned for capacity upgrades as part of the City's Pump Station Renovation program. The results indicated that all of the pump stations (except those with only a single pump) have adequate existing or planned firm capacity to handle estimated peak wet weather flows. However, all of the pump stations with only one pump have high level gravity bypass pipes that can prevent overflows if the pump is out of service or pump capacity is exceeded.

Note that climate change and predicted sea level rise may result in increased rainfall and higher groundwater levels in the system in the future. However, as the City continues to rehabilitate and replace sanitary sewers, and property owners replace their private service laterals, these changes are not expected to result in any further capacity issues in the Alameda sewer system.

ES-4.1 Alameda Point

The sewer system serving Alameda Point is hydraulically separate from the system serving the rest of the City. The flows from Alameda Point discharge to EBMUD's Pump Station R, located on the north side of the site, from where they are pumped directly to the inlet of the Alameda siphons.

As part of the preparation of the City's *Master Infrastructure Plan (MIP)* for Alameda Point, a hydraulic model of the future trunk sewer system was developed by RMC in order to estimate system flows and confirm the sizing of the backbone sewer infrastructure proposed in the MIP. The flow estimates were based on the ultimate development of approximately 1,400 residential units and 5.5 million square feet of commercial floor space. The sewer improvements would be constructed in phases, with completely new sewer infrastructure constructed initially in the "Development Area" of the site, and incremental rehabilitation and replacement of the infrastructure in the "Reuse Area". Based on the model analysis, the proposed backbone sewer network as developed in the MIP was found to be adequate to convey the wastewater flows anticipated to be generated in Alameda Point.

ES-5 Condition Assessment

Closed-circuit television (CCTV) inspection of sewer pipelines is the primary method used by the City to assess the physical condition of its system. Since 2009, the City has inspected about 85 percent of the pipes in the system. Each defect observed during CCTV inspection is assigned a code indicating its type and severity, which allows a grade to be assigned to the defects and to the overall pipe segments. The defect grades were used to compute Structural Condition LOF scores (on a scale of 1 to 10) for all of the inspected pipes (for pipes that have not yet been inspected or could not be inspected due to access issues or obstructions, their age was used as a surrogate for structural condition). Pipes that have low Structural Condition LOF scores are primarily those sewers that have been rehabilitated or replaced over the past 30 years and newer sewers constructed with plastic materials since the 1970s. Almost 15 percent of the pipes have a score of 10, indicating that their structural condition is poor or is likely to be poor due to age, and are in need of near-term rehabilitation or replacement.

ES-6 Recommended Capital Improvement Program

The City's sewer system Capital Improvement Program (CIP) includes three primary components: sewer rehabilitation and replacement; capacity improvements; and pump station renovation, as presented below.

ES-6.1 Sewer Rehabilitation and Replacement

The Pipe Rating Model was used as the primary tool for initial prioritization of sewers for rehabilitation and replacement. Risk scores were calculated for each pipe based on the LOF and COF factors described previously. For purposes of grouping pipes into potential sewer rehabilitation projects, other factors including pavement condition, pipe material, location (proximity), and City staff input were also considered.

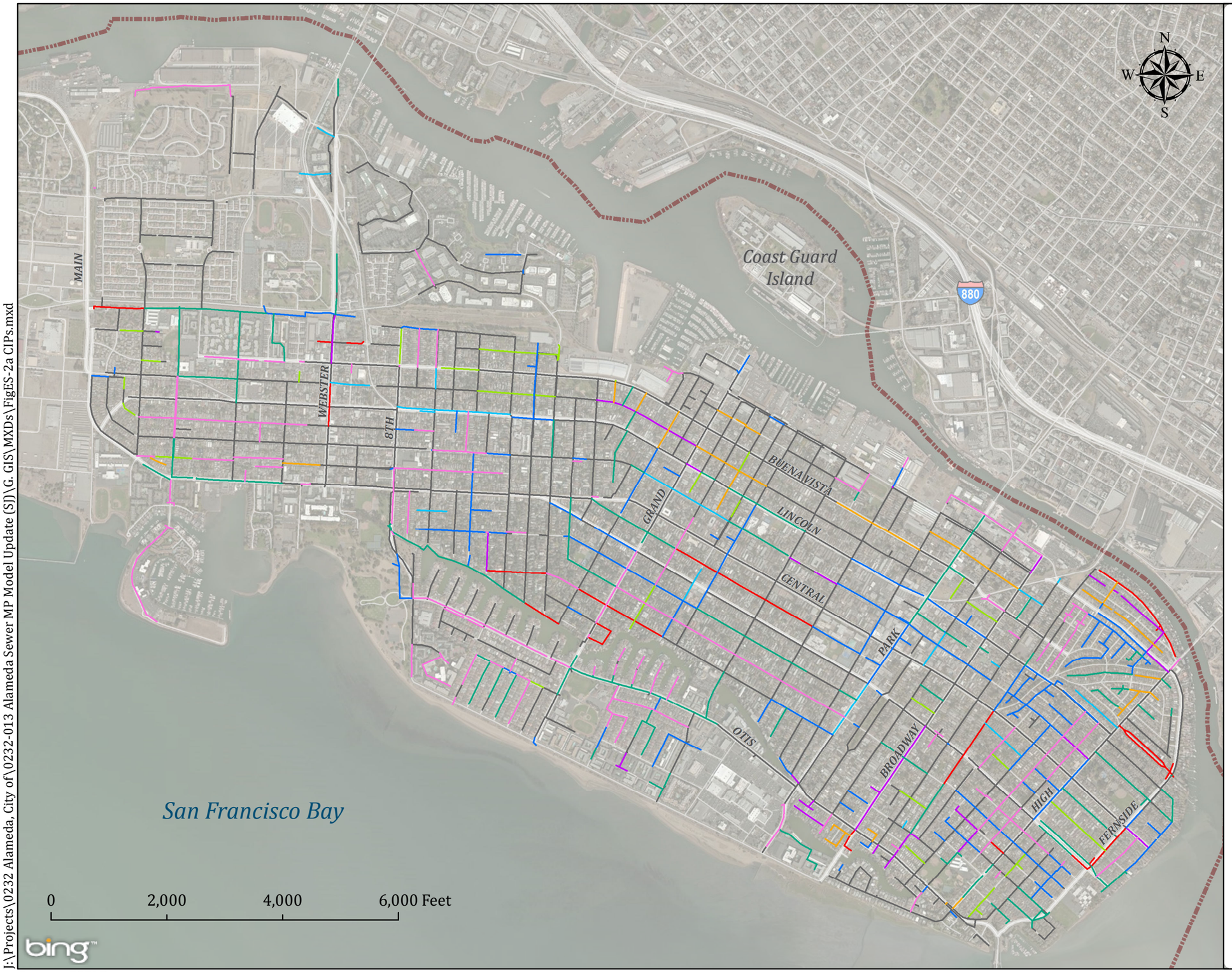
The City's approach to sewer rehabilitation involves complete replacement of the sewer main and associated manholes and lower laterals. Replacement is typically accomplished by pipe bursting or by open-cut remove-and-replace construction. The sewers are replaced with pipes of plastic material, which minimizes the potential for I/I. The cost of sewer replacement varies based on pipe size, depth, and soil and groundwater conditions.

The sewer rehabilitation CIP was developed based on the following three primary criteria:

- Meet the minimum annual sewer rehabilitation footage requirements of the Consent Decree.
- Maintain consistency with the City's annual capital improvement budget based on the financial plan and sewer service charge schedule that has been adopted by the City Council.
- Prioritize mini-basins for rehabilitation based on risk scores as calculated by the Pipe Rating Model and other factors such as pipe material, pavement condition, and proximity.

The City's current annual capital budget available for sewer rehabilitation projects is approximately $5,450,000 (the budget provides for a 3 percent annual increase over the next four years). This budget would be adequate to meet Consent Decree footage requirements (2.6 miles per year on a cumulative basis) at an average sewer rehabilitation cost of $397/ft (assuming open-cut pipe replacement). Because some projects will have lower cost and some higher, the challenge is to find the most appropriate balance of cost and footage while adhering to the Pipe Rating Model risk scores to the extent possible and incorporating other factors as noted above.

Figure ES-2 and **Table ES-1** present the recommended 20-year sewer rehabilitation CIP developed by RMC and City staff by application of the three guiding criteria described above. Based on this program, by the end of 20 years the City will have rehabilitated or replaced over 75 percent of its gravity sewer system. The City may elect to modify the CIP schedule as needed to accommodate budget constraints and changes in project priorities as additional inspection data and other information are collected over time. Such information may include the need for coordination with street paving or other infrastructure or utility projects; need to address new or recurring maintenance problems in the system; or specific data provided by EBMUD as to priority areas for focusing I/I reduction efforts.



Legend

Project Year

- 1
- 2
- 3
- 4
- 5
- 6-10
- 11-15
- 16-20
- Not Scheduled
- Alameda City Limit

City of Alameda
Sewer Master Plan

Figure ES-2a
Recommended
Sewer Rehabilitation CIP
(Alameda Island)

RMC water and environment

Sources: ESRI Basemap

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City of Alameda
Sewer Master Plan

Figure ES-2b
Recommended
Sewer Rehabilitation CIP
(Harbor Bay Isle)

water and environment

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Sources: ESRI Basemap

Table ES-1: Recommended 20-year Sewer Rehabilitation CIP

Project Year	Fiscal Year	Length of Pipe (miles)	Estimated Capital Cost ($ Million)[a]
1	FY 15/16	3.33	6.97
2	FY 16/17	2.78	5.41
3	FY 17/18	2.73	5.29
4	FY 18/19	2.80	5.40
5	FY 19/20	2.89	5.41
6	FY 20/21	2.84	5.54
7	FY 21/22	2.95	5.52
8	FY 22/23	2.71	5.37
9	FY 23/24	2.81	5.38
10	FY 24/25	2.41	5.47
11	FY 25/26	2.52	5.56
12	FY 26/27	2.47	5.48
13	FY 27/28	2.72	5.50
14	FY 28/29	2.61	5.54
15	FY 29/30	2.70	5.43
16	FY 20/31	2.72	5.39
17	FY 31/32	2.51	5.37
18	FY 32/33	2.90	5.48
19	FY 33/34	2.56	5.49
20	FY 34/35	2.60	5.51
Total 20-year CIP		**54.6**	**105.0**

a. Estimates represent current (FY2015/16) costs.

ES-6.2 Sewer Capacity Improvements

As noted previously, the model indicates the potential need for additional sewer capacity in sections of Harbor Bay Parkway and Beach Road. The proposed projects are listed in **Table ES-2**. Project C1 would be required to address a predicted existing capacity deficiency; Project C2 would only be required in the future when additional development in the Harbor Bay Business Park occurs. However, it is recommended that the City monitor these locations before constructing improvements to confirm the capacity issues under peak wet weather flows.

Table ES-2: Proposed Sewer Capacity Improvement Projects

Project ID[a]	Project Name	Description	Estimated Capital Cost ($)[b]
C1	Harbor Bay Parkway Sewer Capacity Improvement	Replace approx. 1,535 lf of 10" pipe with 15" pipe on Harbor Bay Pkwy. between Loop Road and Harbor Bay Pkwy. I PS	798,000
C2	Harbor Bay Parkway/Beach Road Sewer Capacity Improvement	Replace approx. 3,800 lf of 12" & 15" pipe with 15" & 18" pipe on Harbor Bay Pkwy. and Beach Rd. downstream of Harbor Bay Pkwy. I PS to Seminary Ave.	1,993,000

a. Projects C1 and C2 were identified as Projects C-3 and C-4, respectively, in the 2010 *Sewer System Hydraulic Model Analysis* report.
b. Costs calculated based on open-cut pipe replacement. Construction using trenchless techniques such as pipe bursting may be feasible and less costly. Estimates represent current (FY2015/16 costs).

ES-6.3 Pump Station Renovation Program

The City's 2012 *Pump Station Renovation Plan* developed a program for pump station improvements to be implemented in approximately five phases. Pump stations were grouped according to priority for improvements. The current program, which has been modified since the original Pump Station Renovation Plan, includes six pump station groups, proposed for construction through FY 2019/20. (Note: the first group of pump station improvements has already been completed). **Table ES-3** summarizes the remaining pump station improvement groups, target schedule, and estimated costs. The pump station improvements vary by station but may include new pumps, conversion to submersible pumps, relocation, or re-building. Standardization of pumps and equipment has also been a major objective of the pump station renovations.

Table ES-3: Pump Station Renovation CIP

Pump Station Group	Estimated Capital Cost ($)[a]	Est. Construction Schedule
Group 2	2,350,400	FY 15/16
Group 3	1,016,800	FY 16/17
Group 4	5,250,000	FY 16/17 to 18/19
Group 5	3,060,000	FY 18/19 to 19/20
Group 6	2,483,500	FY 20/21
Total	**14,160,700**	

a. Estimates represent current (FY2015/16) costs.

ES-7 Implementation Recommendations

The following recommendations for implementing the Sewer Master Plan and overall sewer improvement program are listed below:

- **Force Main Condition Assessment.** The City has about 6 miles of force mains ranging in size from 4 to 16 inches and in length from approximately 25 to over 7,000 feet, constructed of various types of pipe materials. The condition of the force mains is largely unknown. A recent failure in the Park/Otis force main has focused attention on the need for a more systematic program for assessment of the condition of the force mains. It is therefore recommended that the City develop and implement a force main condition assessment program. The force mains should be prioritized and assessment methods tailored to each pipe based on age, material, size (or flow), location, and length, and whether or not the associated pump station has a high level gravity pipeline bypass. Based on the results of the assessments, potential improvements to address identified force main condition deficiencies should be incorporated into the sewer system CIP.
- **GIS Updates.** The City should continue to maintain and update its geographic information system (GIS) and sewer mapping to reflect new or updated information obtained from sewer inspections, sewer improvement projects, and ongoing maintenance activities.
- **Sewer Rehabilitation Plan Updates and Funding.** The sewer rehabilitation plan presented in this Master Plan is intended to provide a roadmap for the City's efforts over the coming years. To meet the sewer rehabilitation requirements of the Consent Decree, it is recommended that the 3 percent annual increase in sewer rates be extended beyond FY 19/20 in 5-year increments for the duration of the Consent Decree. It is expected that the sewer rehabilitation plan will be continually refined based on new information and changing conditions and priorities. The plan should be incorporated into the City's GIS and computerized maintenance management system (CMMS) so that the information is readily available and easily updated.
- **Master Plan Updates.** This Master Plan has been prepared to facilitate both use of the information in capital improvement project planning and design, as well as to allow the City to update the Plan in the future as the need arises. The Master Plan should be updated whenever there are major changes in planning assumptions or priorities, or at a minimum every eight to ten years.