Chapter Four
Condition Assessment

Chapter 4 Condition Assessment

This chapter provides a brief summary of the overall physical condition of the Alameda sewer system based on closed-circuit television (CCTV) inspection results, and presents the methodology used to determine Structural Condition Likelihood of Failure (LOF) scores for the Pipe Rating Model. The condition assessment focuses on the structural condition of the sewer pipes. The City also conducts manhole inspections and addresses any acute problems as they are found. However, since manholes are replaced or rehabilitated along with sewer mains as part of sewer rehabilitation and replacement projects, manhole condition was not specifically used as a parameter in the asset risk assessment and prioritization of sewer rehabilitation projects.

4.1 CCTV Inspection Program

CCTV inspection is the basic method used by the City to gather the data required to assess sewer condition. The City's CCTV inspection program was initiated in 2009, and seven phases of the program were conducted over the past seven years by contractor, with the majority of the work completed in 2014-15. The City also purchased its own CCTV inspection camera and data collection software and equipment in 2011, and conducted some inspections in 2011 and 2012, but primarily uses the equipment for maintenance troubleshooting and other activities rather than formal condition assessment. The inspections (both by contractor and City) include digital capture of CCTV data, video, and still images using Granite XP sewer inspection data management software.

4.2 Condition Grading and LOF Scores

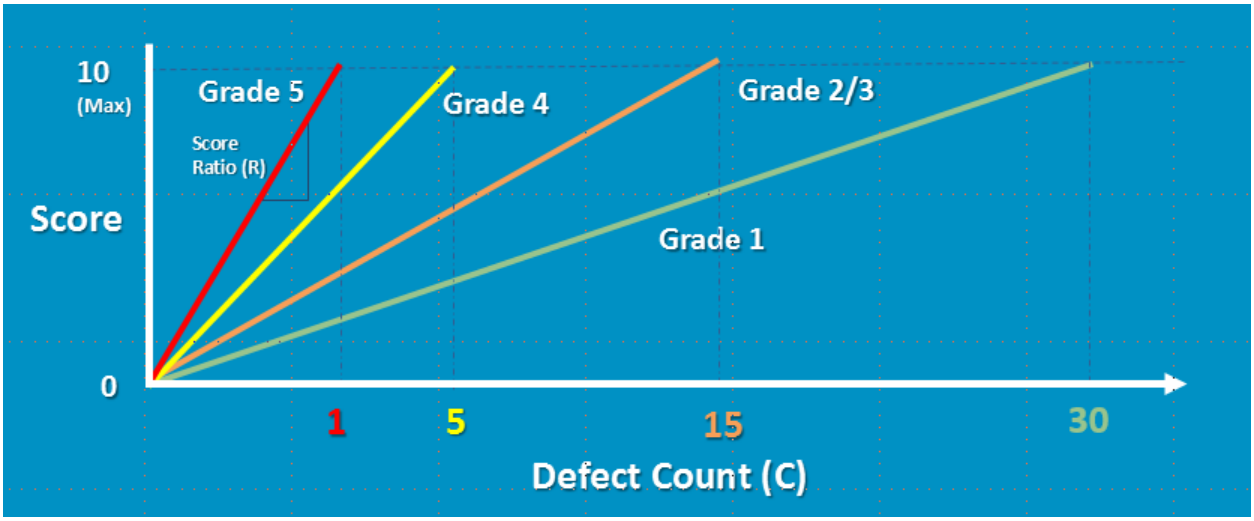
The City uses the Pipeline Assessment and Certification Program (PACP) system developed by the National Association of Sewer Service Companies (NASSCO), which has become the standard of the industry for sewer condition assessment. PACP utilizes standard observation codes to describe different types of structural and maintenance-related defects and construction features, with defect grades assigned to each defect based on its type and severity.

Under the PACP standard, all structural defects are assigned a Structural Grade of 1 to 5, with Grade 5 representing severe defects and Grade 1 representing minor defects. (Maintenance defects are assigned similar O&M grades.) The grades for individual defects observed on a manhole-to-manhole pipe segment can be combined in various ways to determine an overall structural condition rating for the pipe. The PACP manual suggests several approaches for this purpose, including summing the grades of all defects or averaging the grades. While such approaches may be useful for screening pipes in terms of overall condition, they may not be particularly useful for prioritizing pipe replacement. What is most important in such decisions is the presence of major defects and the number of such defects. For example, a single Grade 5 defect in a pipe may require immediate action, while five Grade 1 defects would not, even though they both have a PACP overall segment grade score of 5.

For the purposes of evaluating the Likelihood of Failure (LOF) resulting from structural defects, a scoring system that consolidates the PACP grades was developed for this study. The scoring system provides a single 'structural grade score' based on the CCTV data which ranges from 0 to 10 and accounts for multiple defect ratings and the number of defects. Although a high maximum structural grade is a good indicator of the need for a near-term pipe rehabilitation or repair, the number and severity of other defects in the pipe should also be considered. Therefore, the calculation of the structural grade score gives higher score values for more severe defects but still considers the number of less severe structural defects. Using this approach, all pipes with at least one Grade 5 structural defect are given the maximum structural grade score of 10, but lesser grade defects can also contribute to the structural grade score depending on the number and grade of these defects. **Figure 4-1** illustrates the computation of structural grade scores. The Structural Condition

LOF score is then determined based on the range in which the structural grade score falls, as shown in Table 2-1.

Figure 4-1: Computation of Structural Grade Scores



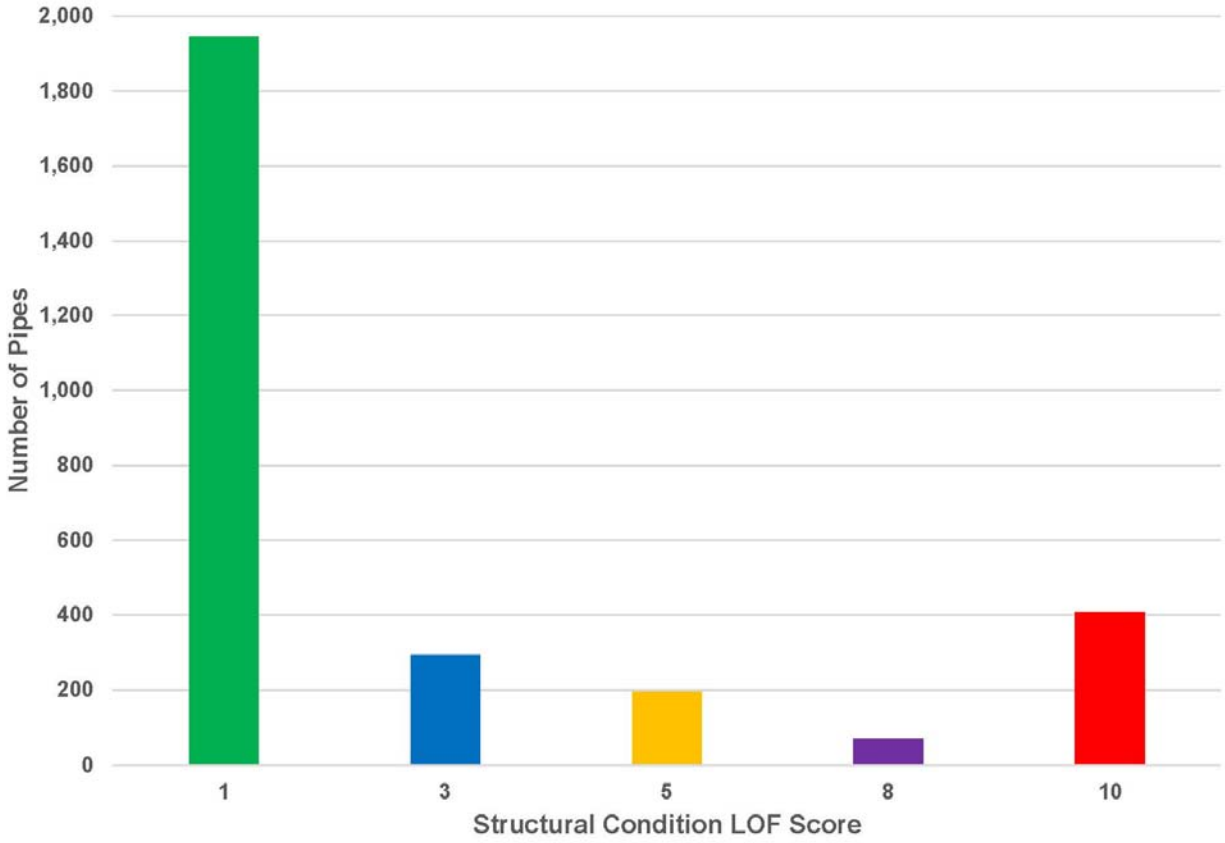
- Grade score = Score Ratio (R) x Defect Count (C)
- Total Structural Grade Score = $(R_5 \times C_5) + (R_4 \times C_4) + (R_{2/3} \times C_{2/3}) + (R_1 \times C_1)$
- Maximum score = 10

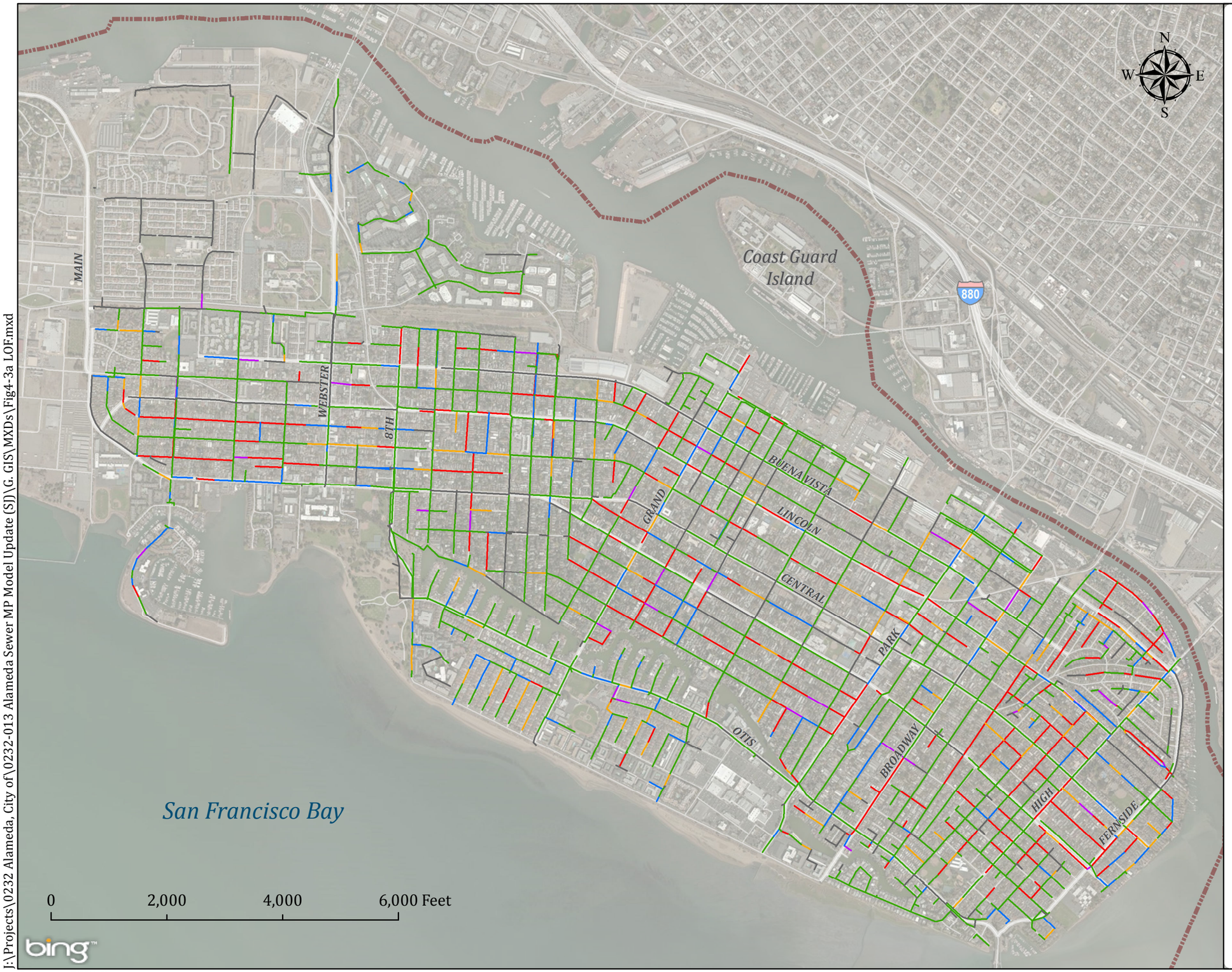
In addition to structural condition, a pipe may be assigned an O&M grade score if the CCTV data shows significant O&M defects such as grease, debris, or root intrusion. The O&M grade score is based on a similar calculation approach as the structural grade score except the Grade 4 and 5 defects are combined and the score ratios are lower. As with the Structural Condition LOF, the O&M Condition LOF score is then determined based on the range in which the O&M grade score falls, as shown in Table 2-1.

4.3 Condition Assessment Results

Figure 4-2 is a chart showing the overall distribution of the Structural Condition LOF scores for the system, and **Figure 4-3** provides a map showing the Structural Condition LOF score each inspected sewer pipe. Note that the Structural Condition LOF scores for pipes that have not yet been inspected (approximately 450 pipes or about 15 percent of the sewers in the system) were estimated based on the age of the pipe (these scores are not shown on the map but are included in the graph in Figure 4-2). As shown in the graph, over 75 percent of the pipes in Alameda's sewer system have low Structural Condition LOF scores (1 or 3), indicating that they are in good condition. These are primarily the sewers that have been rehabilitated or replaced over the past 30 years and newer sewers (e.g., 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.

Figure 4-2: Distribution of Structural Condition LOF Scores





Legend

Likelihood of Failure (LOF) Scores

- 10
- 8
- 5
- 3
- 1
- Not Inspected
- Alameda City Limit

City of Alameda
Sewer Master Plan

Figure 4-3a
Structural Condition
LOF Scores of
Inspected Sewers
(Alameda Island)

RMC water and environment

Sources: ESRI Basemap

J:\Projects\0232 Alameda, City of\0232-013 Alameda Sewer MP Model Update (SJ)\G. GIS\MXDs\Fig4-3a LOF.mxd

Legend

Likelihood of Failure (LOF) Scores

- 10
- 8
- 5
- 3
- 1
- Not Inspected
- Alameda City Limit

City of Alameda
Sewer Master Plan

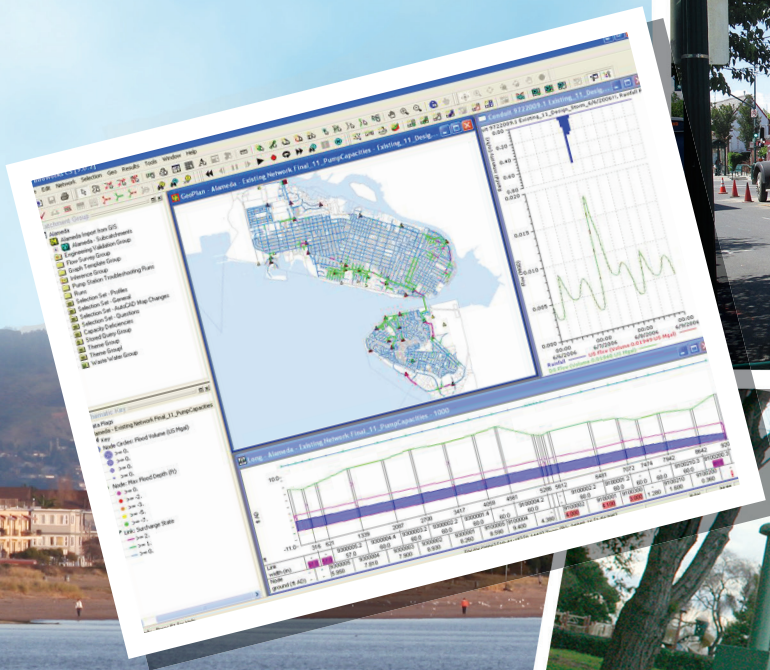
Figure 4-3b
Structural Condition
LOF Scores of
Inspected Sewers
(Harbor Bay Isle)

water and environment

J:\Projects\0232 Alameda, City of\0232-013 Alameda Sewer MP Model Update (SJ)\G. GIS\MXDs\Fig4-3b LOF.mxd

Sources: ESRI Basemap

Chapter Five
Recommended Capital Improvement Program



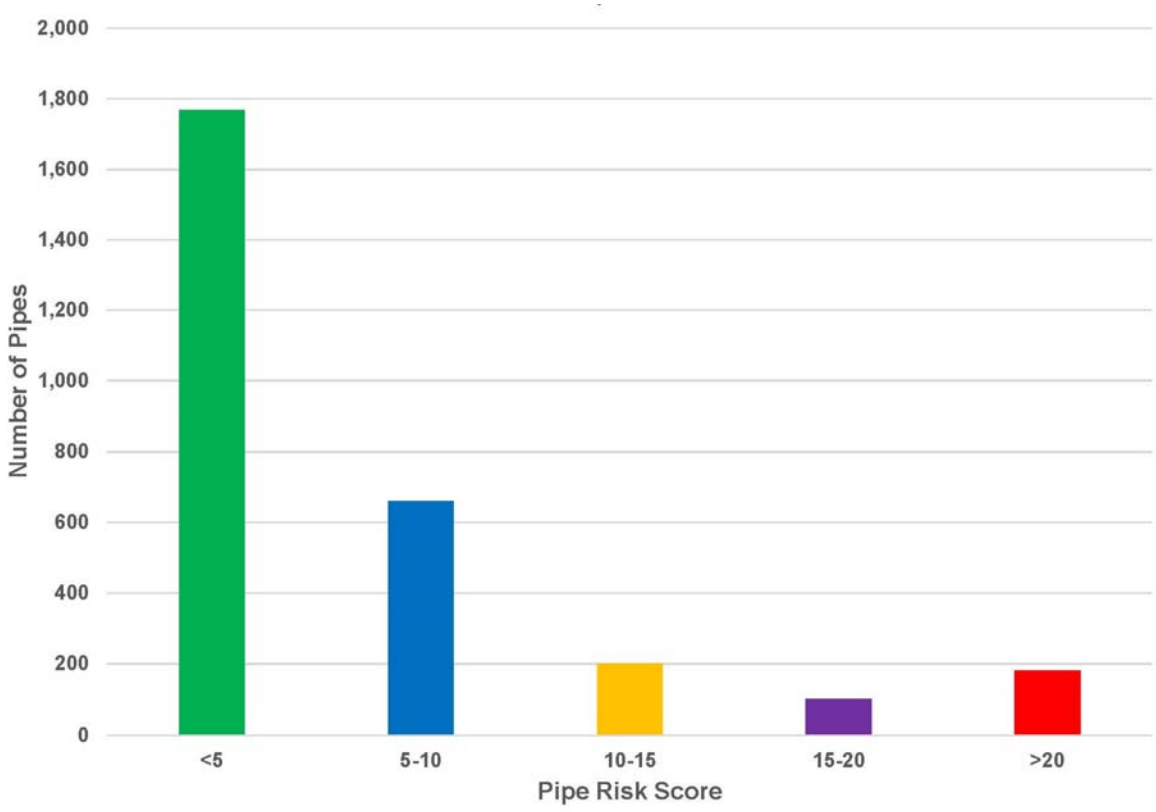
Chapter 5 Recommended Capital Improvement Program

The previous chapters of this report presented the results of the capacity and condition assessments of the Alameda sewer system and the methodology used in the City's Pipe Rating Model to assess the relative risk of sewer failure in order to provide information to help prioritize pipes for rehabilitation and replacement. This chapter presents the Pipe Rating Model results, describes the approach for using those results and other information to define and prioritize rehabilitation projects and schedules, and presents the recommended 20-year Capital Improvement Program (CIP) including estimated costs and schedule for improvements.

5.1 Pipe Rating Model Results

The Pipe Rating Model was used to calculate the total risk score for each City-owned gravity sewer pipe in the Alameda sewer system. The risk scores represent the product of the Likelihood of Failure (LOF) and Consequence of Failure (COF) for each sewer pipe, considering its structural condition, capacity requirements, size, location, and other risk factors, as described in Chapter 2. **Figure 5-1** is a chart showing the overall distribution of the risk scores for the system, and **Figure 5-2** provides a map showing the risk score of each sewer pipe. A detailed tabulation of sewer inventory data and the LOF, COF, and total risk scores for each gravity sewer mainline pipe in the system is included in **Appendix B.**

Figure 5-1: Distribution of Sewer Pipe Risk Scores



It should be noted that some pipes that have previously been rehabilitated or are of relatively recent construction (as evidenced by plastic pipe materials) do have structural defects noted in the CCTV inspection data which results in an elevated Structural Condition LOF score, indicating that they may be in need of spot repairs or in some cases more extensive rehabilitation. Many of these defects are sags, which are primarily maintenance-related issues but have not been found to result in any problems to date. The City will evaluate these pipes on a case-by-case basis to determine what, if any, action is needed; and some may be added to the rehabilitation projects if the need for corrective action is indicated.

5.2 Sewer Rehabilitation Costs

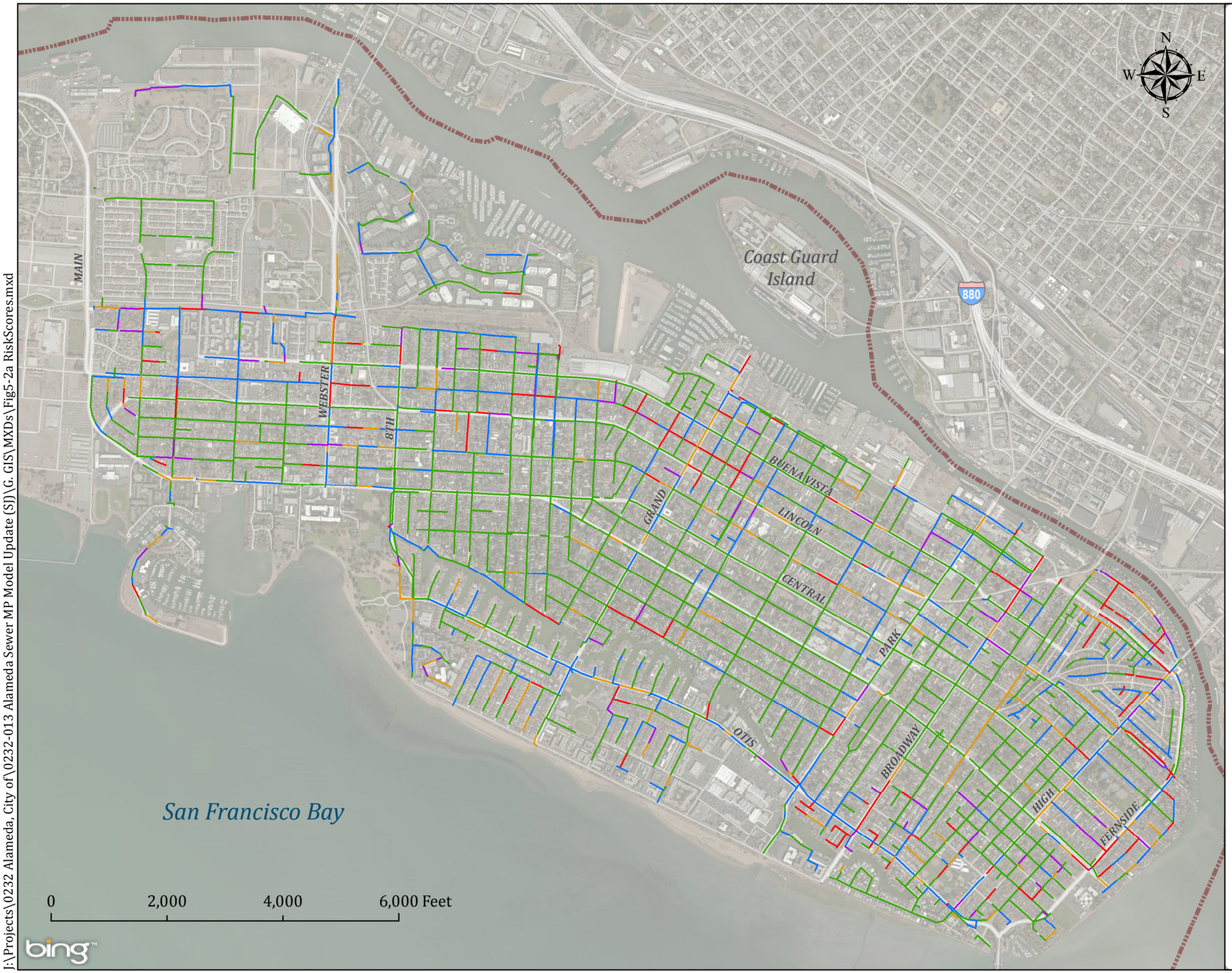
The City's approach to sewer rehabilitation involves complete replacement of the sewer main and associated manholes and lower laterals. Replacement is typically done by open-cut remove-and-replace construction, but pipe bursting may be used if appropriate, and pipes are generally replaced with either HDPE or PVC pipe.

To develop average unit costs for sewer rehabilitation for use in estimating the costs of sewer projects for the CIP, recent construction bids from City sewer projects and similar projects constructed by nearby cities were reviewed. All of these projects involved primarily open-cut replacement or pipe bursting of primarily smaller diameter sewers with replacement of associated manholes and lower laterals.

Based on this review, two sets of unit costs were developed for Alameda: costs for construction in areas with relatively stable soil conditions, and costs for construction in areas with more unstable soils (e.g. fill material) and higher groundwater levels, characteristic of areas on the perimeter of the main Alameda Island and much of Harbor Bay Isle. Construction in these poor soil areas may require more substantial trench shoring (e.g., sheet piles for deeper excavations) and more extensive dewatering.

The basic unit construction costs assume open-cut sewer main replacement, and include replacement of manholes and lower laterals and installation of cleanouts at the property line. The unit costs include associated construction costs (mobilization/demobilization, traffic control, bypass pumping, post-construction video and testing, etc.). Total estimated construction costs include an 8 percent minimum allowance for contingencies, plus a 15 percent allowance for design engineering and construction management (based on experience from City's recent projects). Unit costs for construction in poor soil conditions were developed by applying a higher contingency allowance to the basic unit construction costs, ranging from 20 percent for 8-inch sewers to 70 percent for larger (21- to 30-inch) pipes, which are typically deeper. Based on these factors, the net capital costs for construction in poor soils would be 10 to 50 percent higher than construction in stable soils, depending on pipe diameter. The unit costs are shown in **Table 5-1.** Note that costs for deeper construction and/or pipes in poor soils areas could potentially be reduced by use of trenchless methods, which would be evaluated during project design.

The cost estimates presented in this report are planning or conceptual level estimates, and are considered to have an estimated accuracy range of -30 to +50 percent. This level of accuracy corresponds to an "order of magnitude" or "Class 5" cost estimate as defined by the American Association of Cost Estimators. These estimates are suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed into the design and construction phases. All estimates presented in this report are assumed to represent current (FY2015/16) construction costs for the San Francisco Bay Area.



Legend

Risk Scores:

- >20
- 15-20
- 10-15
- 5-10
- <5
- Alameda City Limit

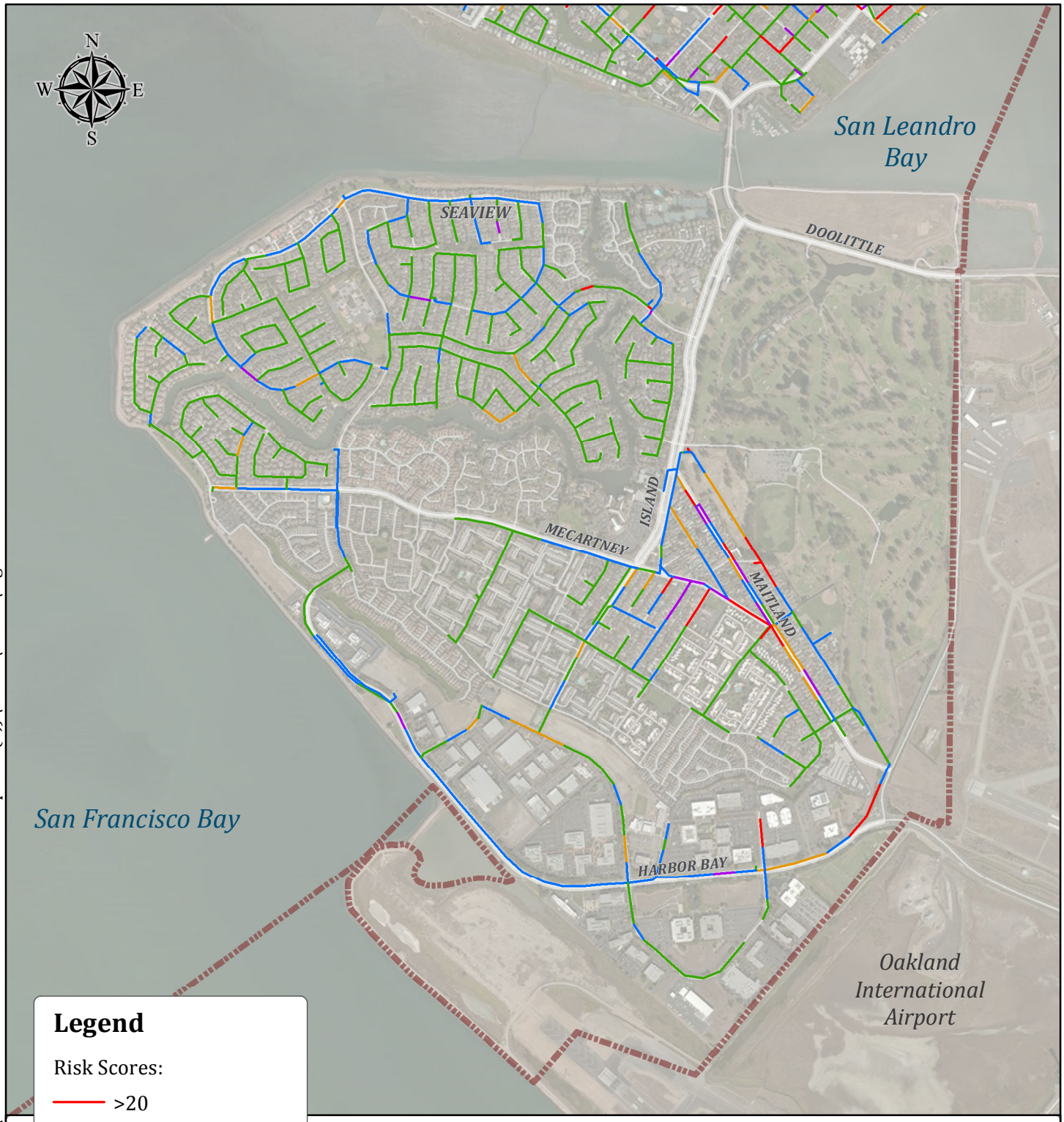
City of Alameda
Sewer Master Plan

Figure 5-2a
Sewer Pipe Risk Scores
(Alameda Island)

RMC water and environment

J:\Projects\0232 Alameda, City of\0232-013 Alameda Sewer MP Model Update (SJ)\G. GIS\MXDs\Fig5-2a RiskScores.mxd

Sources: ESRI Basemap



Legend

Risk Scores:

- >20
- 15-20
- 10-15
- 5-10
- <5
- Alameda City Limit

0 1,000 2,000 Feet

City of Alameda
Sewer Master Plan

Figure 5-2b
Sewer Pipe Risk Scores
(Harbor Bay Isle)

water and environment

J:\Projects\0232 Alameda, City of\0232-013 Alameda Sewer MP Model Update (SJ)\G. GIS\MXDs\Fig5-2b RiskScores.mxd

Sources: ESRI Basemap

Table 5-1: Sewer Replacement Unit Costs

Pipe Size (in.)	Basic Unit Construction Cost ($/ft)[a]	Total Capital Cost ($/ft) Stable Soils[b]	Total Capital Cost ($/ft) Poor Soils[c]
8	280	344	378
10	295	363	472
12	312	384	499
15	325	400	520
18	337	415	539
21	307	378	568
24	346	426	640
27	384	472	710
30	422	519	781

a. Assumes open-cut pipe replacement, including replacement of manholes and lower laterals.
b. Includes 8 percent allowance for contingencies plus 15 percent of basic unit construction for engineering design and construction management.
c. Includes 20 to 70 percent allowance for contingencies (based on pipe size) plus 15 percent of basic unit construction cost for engineering design and construction management.

5.3 Sewer System Capital Improvement Program

The sewer system capital improvement program (CIP) includes three components: sewer rehabilitation, sewer capacity improvements, and pump station renovation.

5.3.1 Sewer Rehabilitation Projects

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 sewers for rehabilitation based on risk scores as calculated by the Pipe Rating Model and other factors such as pipe material, pavement condition, and proximity.

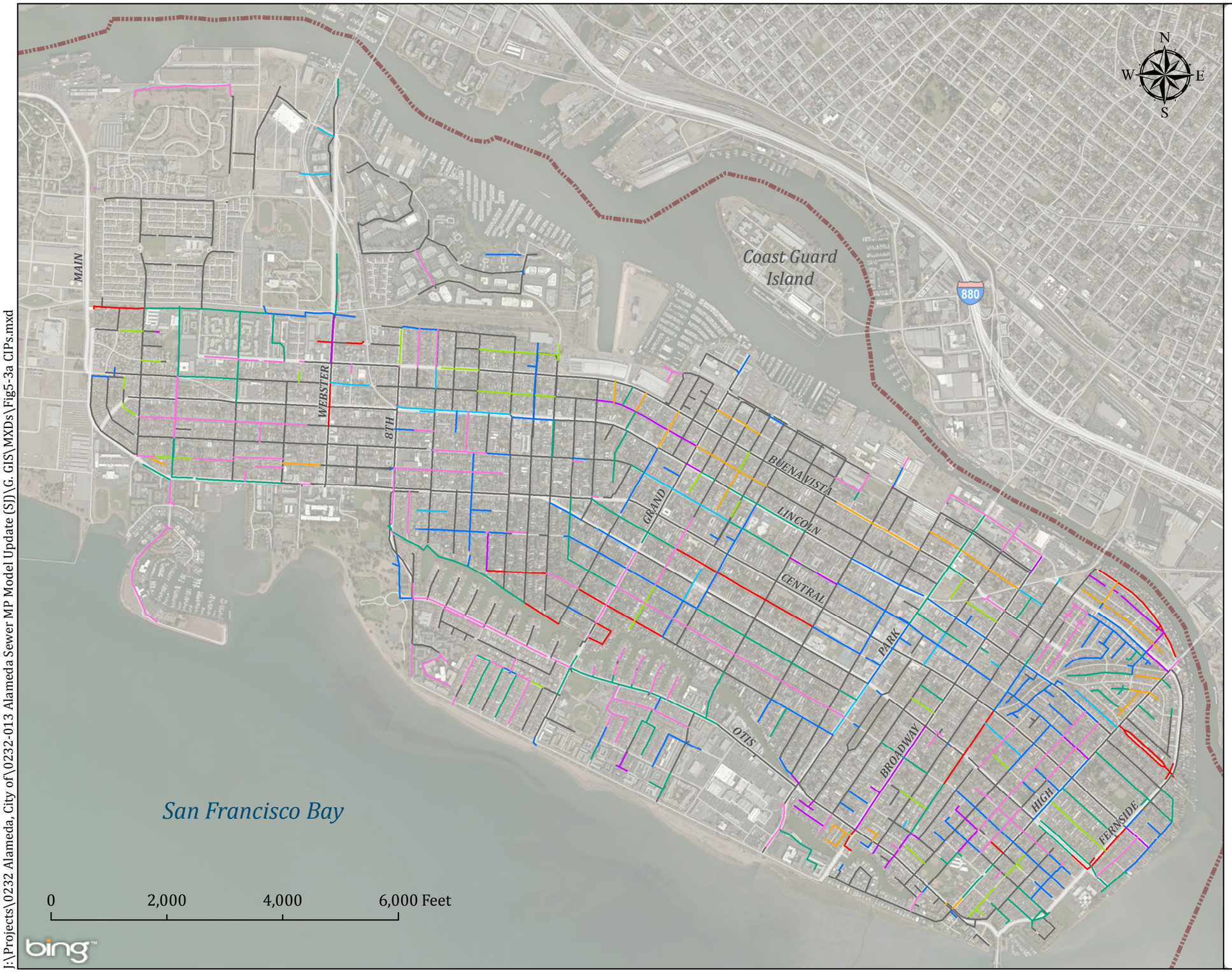
The City's FY15/16 annual capital budget available for sewer rehabilitation projects is approximately $5,450,000 (the budget provides for a 3 percent annual increase over the following four years). This budget would be adequate to meet Consent Decree footage requirements (2.6 miles per year on a cumulative basis) at a current average sewer rehabilitation cost of $397/ft assuming that the 3 percent annual increase in sewer rates is extended in five-year increments for the duration of the Consent Decree. Because some projects will have lower cost and some higher, the challenge is to find the most appropriate balance of cost and footage while still adhering to overall rankings indicated by the Pipe Rating Model risk scores to the extent possible and incorporating other factors as noted above.

Table 5-2 presents the recommended 20-year sewer rehabilitation CIP developed by RMC and City staff by application of the three guiding criteria described above, and **Figure 5-3** shows the location of the proposed projects. 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 coordination with street paving or other infrastructure or utility projects; new or recurring maintenance problems in the system; or incorporate specific information provided by EBMUD as to priority areas for focusing I/I reduction efforts.

Table 5-2: Proposed 20-Year Sewer System 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.



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 5-3a
Recommended
Sewer Rehabilitation CIP
(Alameda Island)

RMC water and environment

Sources: ESRI Basemap

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City of Alameda
Sewer Master Plan

Figure 5-3b
Recommended
Sewer Rehabilitation CIP
(Harbor Bay Isle)

water and environment

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Sources: ESRI Basemap

5.3.2 Capacity Improvements

As noted in Chapter 3, the model indicates that the 10-inch sewer in Harbor Bay Parkway upstream of the Harbor Bay Parkway I Pump Station is predicted to be capacity deficient under existing design storm PWWF conditions; and the 12- and 15-inch sewer downstream of the pump station would be deficient in the future. Two capacity improvement projects are recommended to address these potential deficiencies, as listed in **Table 5-3**. However, it is recommended that the City monitor these locations before constructing improvements to confirm the capacity issues under peak wet weather flows.

Table 5-3: Proposed Sewer Capacity Improvement Projects

Project ID[a]	Project Name	U/S MHID	D/S MHID	Description	Estimated Capital Cost ($)[b]
C1	Harbor Bay Parkway Sewer Capacity Improvement	10110117	10110109	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	10110108	10013219	Replace approx. 2,900 lf of 12" pipe with 15" pipe and 900 lf of 15" pipe with 18" pipe on Harbor Bay Pkwy. and Beach Rd. downstream of Harbor Bay Pkwy. I PS to Seminary Ave.	1,993,000

c. Projects C1 and C2 were identified as Projects C-3 and C-4, respectively, in the 2010 *Sewer System Hydraulic Model Analysis* report.
d. Costs calculated based on open-cut pipe replacement in poor soil conditions per unit costs shown in Table 5-1. Construction using trenchless techniques such as pipe bursting may be feasible and less costly. Estimates represent current (FY2015/16) costs.

5.3.3 Pump Station Renovation

The City has conducted extensive assessments of its sewer pump stations as part of separate studies. Information on estimated peak wet weather flows from hydraulic modeling have been considered in developing recommendations for pump station improvements, as well as other considerations including safety, reliability, structural condition, and ease of operation and maintenance. 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, which included Aughinbaugh, BFI, Channing, Eighth/Portola, and Pond/Otis pump stations, has already been completed). **Table 5-4** presents 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 5-4: Pump Station Renovation CIP

Group	Pump Station/Item	Estimated Capital Cost ($)	Est. Construction Schedule
2	Adelphian	346,200	
	Verdemar	265,700	
	Harbor Bay Parkway II	408,100	
	Willow/Whitehall	634,600	
	Haile	169.700	
	Bay Fairway	219,500	
	Contingency	306,500	
	Subtotal	**2,350,400**	**FY 15/16**
3	Seaview I	124,700	
	Seaview 2	134,500	
	Eastshore Myers	128,387	
	Bayview	151,287	
	Sand Beach	146,200	
	Encinal Boat Ramp	122,800	
	Triumph/Independence	153,100	
	Lift Station 6	27,800	
	Grand	27,800	
	Subtotal	**1,016,800**	**FY 16/17**
4	Harbor Bay Parkway I	850,000	
	Cola Ballena	850,000	
	Marina Village	1,000,000	
	Catalina	850,000	
	Grand/Otis	850,000	
	Park/Otis	850,000	
	Subtotal	**5,250,000**	**FY 16/17 to 18/19**
5	Sheffield-Cumberland	500,000	
	Eighth/Taylor	540,000	
	Tideway	670,000	
	Eighth/Portola	800,000	
	Willow	400,000	
	Dublin	150,000	
	Subtotal	**3,060,000**	**FY 18/19 to 19/20**
6	Eastshore Myers	300,000	
	Triumph/Independence	437,000	
	Bayview	368,000	
	Sand Beach	333,500	
	Bay Fairway Hall	310,000	
	Seaview I	390,000	
	Seaview 2	345,000	
	Subtotal	**2,483,500**	**FY 20/21**
	TOTAL	**14,160,700**	

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

5.4 Implementation Recommendations

5.4.1 Force Main Condition Assessment

The City owns and maintains approximately 6 miles of force mains ranging in size from 4 to 16 inches in diameter, and in length from approximately 25 to over 7,000 feet. These force mains are located throughout the main island, Harbor Bay Isle, and Alameda Point. The City has conducted an inspection program to investigate the condition of its gravity sewers (other than those in Alameda Point), but as yet does not have a formal program for condition assessment of its force mains. In July 2015, the City experienced a structural failure in one of its force mains, a 30- to 40-year-old 8-inch transite (asbestos cement) pipe from the Park/Otis Pump Station (a diversion to the parallel gravity trunk sewer in Otis Drive will be implemented as a permanent solution, which will allow abandonment of most of the force main length).

It is therefore recommended that the City develop and implement a force main condition assessment program to address the condition of its sewer force mains. The force mains should be prioritized for assessment based on age, material, size (or flow), location, and length, and whether or not the associated pump stations also have high level bypass gravity pipelines. Initially, the assessment could focus on the longest force mains (e.g., the seven that are over 1,000 feet in length) and the 15 force mains associated with pump stations that do not have gravity bypass lines.

Methods of inspection should be tailored to the pipe material, size and length, location and access, and other factors, but could include CCTV inspection (if possible), external corrosion investigations, or various pipe wall thickness and pipe leakage assessment methods. Based on the results of the assessments, potential improvements to address any identified force main condition deficiencies should be developed and incorporated into the sewer system CIP.

5.4.2 GIS Updates

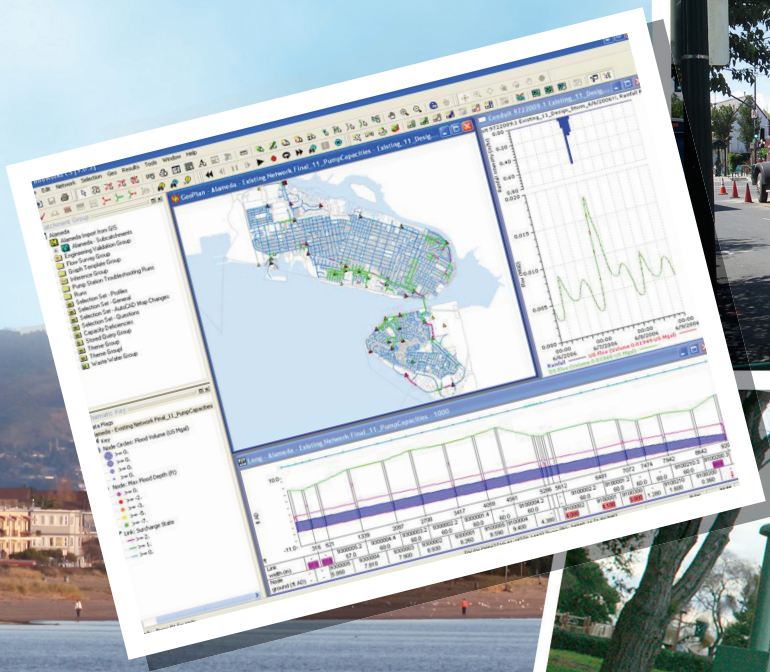
The City has made significant improvements in its geographic information system (GIS) and sewer mapping over the past few years. As new information is collected through sewer inspections, surveys associated with sewer design projects, and on-going maintenance activities, the GIS should be updated in order to keep the sewer inventory and maps current. This is particularly important, as the GIS serves as the basic inventory database for the City's computerized maintenance management system (CMMS) and hydraulic model. The City should also establish consistent standards for manhole numbering and graphic representation of new pipes that are constructed as part of new developments and sewer rehabilitation and replacement projects.

5.4.3 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 sewer rehabilitation and replacement 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 City intends to incorporate the sewer rehabilitation schedules into its GIS and CMMS so that the information is readily available and easily updated.

5.4.4 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.



RMC
water and environment

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