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## Abbreviations

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<th>Definition</th>
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<tbody>
<tr>
<td>CAC</td>
<td>Citizens Advisory Committee</td>
</tr>
<tr>
<td>City</td>
<td>City and County of San Francisco</td>
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<tr>
<td>CSD</td>
<td>Combined Sewer Discharge</td>
</tr>
<tr>
<td>CSO</td>
<td>Combined Sewer Overflow</td>
</tr>
<tr>
<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
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<tr>
<td>EDCs</td>
<td>Endocrine Disrupting Compounds</td>
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<tr>
<td>GHGs</td>
<td>Greenhouse Gases</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<tr>
<td>MG</td>
<td>Million Gallons</td>
</tr>
<tr>
<td>mgd</td>
<td>Million Gallons per Day</td>
</tr>
<tr>
<td>MLLW</td>
<td>Mean Lower Low Water</td>
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<tr>
<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
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<tr>
<td>NPF</td>
<td>North Point Wet-Weather Facility</td>
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<tr>
<td>NPO</td>
<td>North Point Bay Outfalls</td>
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<tr>
<td>OSP</td>
<td>Oceanside Water Pollution Control Plant</td>
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<tr>
<td>PCBs</td>
<td>Polychlorinated Biphenyls</td>
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<tr>
<td>PDO</td>
<td>Pacific Decadal Oscillation</td>
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<tr>
<td>PM</td>
<td>Particulate Matter</td>
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<tr>
<td>R&amp;R</td>
<td>Renewal and Replacement</td>
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<td>RWQCB</td>
<td>Regional Water Quality Control Board</td>
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<tr>
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<td>Southeast Bay Outfall</td>
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<td>Southeast Water Pollution Control Plant</td>
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<td>SFPUC</td>
<td>San Francisco Public Utilities Commission</td>
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<tr>
<td>SPUR</td>
<td>San Francisco Planning and Urban Research Association</td>
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<tr>
<td>SSIP</td>
<td>Sewer System Improvement Program</td>
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<tr>
<td>SSMP</td>
<td>Sewer System Master Plan</td>
</tr>
<tr>
<td>SWALE</td>
<td>Sustainable Watershed Alliance</td>
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<tr>
<td>SWO</td>
<td>Southwest Ocean Outfall</td>
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<tr>
<td>TAC</td>
<td>Technical Advisory Committee</td>
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<tr>
<td>TRC</td>
<td>Technical Review Committee</td>
</tr>
<tr>
<td>T/S</td>
<td>Transport/Storage Structures</td>
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<tr>
<td>U.S. EPA</td>
<td>United Stated Environmental Protection Agency</td>
</tr>
<tr>
<td>VOCs</td>
<td>Volatile Organic Compounds</td>
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<tr>
<td>WWE</td>
<td>Wastewater Enterprise</td>
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</table>
Executive Summary

The Sewer System Master Plan (SSMP) was developed to analyze the current and future needs of sewer system of the city of San Francisco. The SSMP is based on a collective vision of how to improve the sustainability of the sewer system and to implement an Integrated Urban Watershed Management approach that encompasses land management, development, and transport aspects of urban planning.

The three overarching themes for the SSMP are:
1. To be consistent with the San Francisco Public Utilities Commission mission, and specifically the Wastewater Enterprise purpose which is to protect the public health and the environment by managing San Francisco’s wastewater, stormwater, and biosolids safely and cost-effectively.
2. To achieve long-term sustainable sewer system operations as evaluated and defined by consideration of engineering, social, environmental, and economic criteria.
3. To implement a systematic approach to planning and managing the sewer system watershed as an integrated whole (i.e., Integrated Urban Watershed Management).
The SSMP originated after the proposed bond request in 2001 for wastewater capital improvements was withdrawn. The public requested that the 2001 bond capital improvements be presented in the broader context of how to improve the management of the sewer system citywide.

This SSMP was initiated in 2005, and public input was received through meetings, home mailings, and the SFPUC Web site. The public offered suggestions and acted as a sounding board throughout the process to encourage the SSMP team to look at how the wastewater system was managed. The public has been a steadfast critic and supporter.

Sewer System Master Plan Evolution

The San Francisco wastewater collection and treatment system has been developed over the past 110 years. It is a major financial investment in infrastructure, and provides multiple benefits. However, these facilities have been underfunded over the preceding decade or more. If no additional money is invested in the sewer system, fifty percent of the system will be over 100 years old by 2030. As the service life of sewers exceeds 100 years, the rate of failure is more imminent, and may result in failure rates many orders of magnitude higher than the current rate. If
failure rates continue to increase, the public will be impacted by an increasing number of sinkholes in city streets.

The three treatment plants also face the possibility of significant failure due to aging infrastructure. The Southeast Plant digesters are roughly 60 years old and use antiquated treatment processes, which make maintenance labor intensive; one of the digester roofs collapsed in 1996 and the digester is no longer functional. Structural failures could inhibit the ability of the SFPUC to meet the current biosolids regulatory requirements and impact San Francisco’s future ability to dispose of San Francisco biosolids in the marketplace.

These significant infrastructure issues demand that the City invest in a repair and replacement program. The U. S. Environmental Protection Agency (U.S. EPA) estimates that the nation must invest around $390 billion over the next 20 years to replace existing wastewater systems and build new ones, as many systems have reached the end of their useful life. In the 2005 Infrastructure Report Card, U.S. wastewater systems are given a grade of D-, and it is noted that in less than a generation from now, the U.S. could have a poorer overall wastewater collection and treatment infrastructure than existed before the 1972 Clean Water Act (Association of Civil Engineers, 2005). The SFPUC Wastewater Enterprise is not alone or unique in the number or type of current and future challenges that must be addressed to maintain and upgrade the City’s sewer system infrastructure.

This Master Plan proposes a long-term direction for the next 20 years. A formal planning process assessed the need for redirection and investment in the existing system to accommodate planned growth, meet anticipated regulatory requirements, identify repair and replacement needs, and develop innovative ways to improve service and reduce costs of the existing wastewater treatment and conveyance facilities. The last systemwide Master Plan was completed in 1974.

Planning Period and Forecast

Projections to 2030 were made to determine future population, flows, and loads based on (1) population information provided by the Association of Bay Area Governments and accepted by San Francisco’s Planning Department; (2) flows projected by the San Francisco Water Department based on water usage within the city; and (3) flows projected by the outside agencies that are discharging into San Francisco’s sewer system based on agreements made with the U.S. EPA during the grants programs of the 1970s and 1980s.

Challenges

Many elements of the system, though currently functional, are reaching the end of their useful life and must be replaced or repaired to maintain a high level of service and meet the SFPUC’s objectives. Considerable opportunities exist to address and achieve sewer system objectives through innovative and sustainable means and methods. The following challenges must be addressed:

- Increased need for investment in repair and replacement of aging and unreliable infrastructure
- Increased concern of seismic risks to sewer system integrity
- Localized flooding caused by subsidence in fill areas and new development in low-lying areas
- Climate change impacts, especially sea level rise and changing rainfall patterns
- Increased public sensitivity to negative community impacts of the sewer system facilities
- Increased residential development in industrial areas
- Increased operations and maintenance costs
- Increased scarcity of water and the need to pursue potable water offsets
• More stringent restrictions for Class B biosolids at reuse sites
• Development of new cost-effective and sustainable technologies

Recommendations to Address Immediate Needs

The recommendations described in this report present a vision for sustainable sewer system management that both outlines corrective measures to address critical near-term needs and defines a roadmap for sustaining the vital services of wastewater management for the city of San Francisco. The SSMP establishes a new direction for the SFPUC that balances the required system performance with social, economic, and environmental priorities. The recommendations of this report, are designed to integrate and improve the City’s sewer system for the 21st century.

The SSMP report is a culmination of the work that focused on the San Francisco sewer system to determine what was working, what was not working, and what could be done better. The recommendations from the master planning effort are broad and identify a way forward to address immediate system needs. The Master Plan also addresses future considerations.

The recommendations for addressing the immediate system needs are detailed below.

Aging Collection System
• It is recommended that the aging sewers replacement program be brought into line with prudent practice, which is to replace the sewers on a 100-year cycle. The current replacement cycle is about 240 years. It is proposed that an accelerated replacement program be implemented to bring the system into compliance over the next 30 years.
• In conjunction with the SFPUC sewer replacement program, it is recommended that a side sewer policy be developed to delineate the responsibility between the City and homeowner.

Aging Treatment Systems
• An asset management program for all three treatment facilities is recommended to determine the condition and risk of failure for all facility components. Much of the aging equipment, similar to the aging sewers, is in need of replacement. The Federal Register 40 CFR Chapter 1 has the following guidelines for useful life: Structures - 40 to 60 years; Mechanical Equipment - 15 to 25 years; Electrical Equipment - 10 to 25 years; and Outfalls - 50 to 100 years. While most of the liquid treatment structures at the Southeast Plant (SEP) have an expected life remaining of 20 to 30 years, much of the equipment (e.g., the secondary clarifiers mechanisms) is in need of replacement.
• The single largest aging infrastructure in need of replacement is the solids handling facilities and digesters at the SEP. The digesters went into service in the early 1950’s and have been in continuous service for 60 years.
• In conjunction with the replacement of the Southeast Plant digesters, it is recommended that treatment improvements of the solids be made to meet the U.S. EPA Class A requirements, and that market studies and continuous adaptation strategies be developed for reuse of the solids.

Flood Reduction
• Sewer system flood control projects are needed throughout the city, and need to be developed for each watershed. The flood control projects provide a great opportunity to incorporate low impact development (LID) projects. Flood control projects in the low-lying fill areas of the city (e.g. south of Market Street) need to consider pump station solutions and include sea level rise over the life of the project when considering the effectiveness of the solution.
• Develop and implement LID projects and policies to further the goal of stormwater management, reduction, and reuse. This effort will involve developing a project review and cost-to-benefit analysis of all sewer pipe projects to include LID.
• Policies are needed in relation to sewer system flood control in areas that may be subject to flooding simply because the street grade is not in conformance with the City’s “official grade.”
• Funding and contracts/staffing for sewer cleaning need to be sustained to maintain sewer system capacity.
• The subdivision regulations need to be revised to consider design guidelines that are applicable across the city and take into consideration sea level rise and potential changes in precipitation patterns.
• The 29 bayside combined sewer discharge (CSD) structures need to be retrofitted in the near term with backflow prevention devices to prevent the occasional intrusion of bay water into the sewer system due to high tides and ongoing sea level rise.

Seismic Safety
• One specific recommendation is to provide redundancy to the Channel Force Main. The current recommendation is to build a tunnel between the existing Channel Transport/Storage System and the Islais Creek Transport/Storage System. The tunnel will be less likely to be damaged in a seismic event, will provide a lower energy conveyance system for all flows, and will provide storage that will further reduce overflows.
• The condition of all pump stations and force mains need to be evaluated for reliability and redundancy. Consideration should be made to provide seismically improved redundant force mains and connections.

Odor Control
• All of the wastewater facilities need to have improvements with respect to odor control.
• The improvements include structural improvements such as vents on the collection system and covers, ventilation, and
treatment at the treatment plants. Some of the solutions may involve chemical addition. All of the solutions require constant monitoring and maintenance.

**Water Reuse**

- It is recommended that the WWE work with the Water Enterprise in the development of water reclamation projects.
- It is proposed to look for opportunities to develop water reclamation facilities on the bay side that are distributed, such that the source of wastewater and the recycled water demand are sited together with due consideration of the sustainability criteria.

**Integrated Urban Watershed Management** — Develop specific programs and policies across department lines that will support the Integrated Urban Watershed Management program, based on the total watershed, to integrate absorption and reuse of stormwater into the urban setting.

**Future Sustainability** — All capital projects need to be evaluated through a sustainability matrix that includes the triple bottom line of environmental, social, and economic considerations. To be effective all air, land, and water impacts must be considered in the matrix. Ideally, the level of treatment chosen must not cause degradation of the whole environment.

**Environmental Justice** — It is recommended that all implemented projects are fair to people of all races, cultures, and incomes, and that no group bears a disproportionate share of negative environmental consequences resulting from the operation, programs, and/or policies of the SFPUC.

**Asset Management** — Develop and implement an asset management program across the WWE. The asset management program will combine condition assessment and risk of failure analysis to help prioritize specific projects. This program is especially important to the collection system, as by 2030, if no investment is made to repair or replace the aging sewers, a third of them could fail, substantially increasing the number of sinkholes that will also need repair.

**Budget Reporting** — It is recommended that the WWE budget be realigned around the Enterprise’s objectives. This realignment would make it possible to better benchmark the actual costs to achieve the necessary treatment, as required by the State and Federal regulators. Currently, the budget is aligned around the divisions and not tracked well by function.

**Recommendations for Future Considerations**

Because regulatory and facility design and implementation activities require a considerable lead time, it is important to plan for the future in a formal methodical fashion. The next planning effort for the sewer system should begin well before 2030. Many future issues of concern were considered in the development of the SSMP recommendations and are reviewed below.

**Issues resulting from sea level rise due to climate change** — Based on current projections, sea level rise may reach 55 inches by 2100. At that rate, by 2040, it is expected that the bayside CSD structures will begin to have bay water above the overflow weir elevation on a daily basis. This means there will be increased localized flooding near the CSD structures during storms. The seven westside CSD weirs will still be above the estimated sea level rise by 2100, but the shoreline will be subject to more erosion if not protected. It is anticipated that before 2030, planning should be undertaken for projects to pump down the sewer hydraulic grade line to prevent flooding throughout the bay side.

**Issues resulting from increasing rainfall due to climate change** — It is predicted that rainfall intensity may increase. Unlike sea level rise, which has been documented to be rising continuously over the last 150 years, there is no such clear documentation for rainfall intensity. Since the projection for change
in rainfall needs more study, consideration should be made for the possible change in rainfall patterns and intensity in future design guides.

**The Southeast Plant and the bay outfalls will be near the end of their useful life after 2030 —** Plans and funding will be needed to address the needs of these facilities. Because the SEP will need major rehabilitation in the 2030 time frame, studies must be undertaken before that time to assess feasible options. It is expected that changes in technology will occur that may change the solutions from what might be done today.

**Regulatory issues need to be monitored continuously —** Changes in regulatory requirements and technologies should be addressed as they develop. It is not known at this time what specific change may occur. Thus, the City needs to be flexible and adaptive.

**Sewer System Improvement Program**

The Sewer System Improvement Program (SSIP) is a capital improvement plan that will be developed to implement the project recommendations. The development of the SSIP is the next phase in providing more specific definition of the projects, the first phase being the SSMP Report.

Changes to the policies and operation and maintenance budgets including the renewal and replacement program budgets will need to be developed in addition to the SSIP.
Chapter 1

Development of the Sewer System Master Plan

This report is a summary of the results of a five-year (2005 to 2009) master planning effort for the San Francisco sewer system. The Sewer System Master Plan (SSMP) was prepared by a team consisting of the San Francisco Public Utilities Commission (SFPUC), the Wastewater Enterprise (WWE) staff, and outside consultants. Technical memoranda, background information, and a more detailed presentation of materials that support this report are presented in separate volumes and appendices. The implementation plans for the SSMP are described in a companion Sewer System Improvement Program (SSIP) report (pending). The topics considered in this chapter include: the purpose of the master plan, a review of previous master plans, the consideration of environmental justice in the planning process, the participants in the current planning process, and the vision and structure of the SSMP. The information presented is intended to provide the reader with an understanding of the many complex elements that go into the preparation of a master plan.
Purpose of a Master Plan

The purpose of a master plan is to provide an assessment of the current situation and, in the light of known and assumed conditions, provide a framework for future actions. A master plan is a useful tool for evaluating complex systems such as the sewer system of a large city. Its preparation affords an opportunity for all those involved to take the long, broad view — like that from a glider at 10,000 feet above the landscape on a cloudless day. Finally, a master plan is prepared to provide guidance for future generations.

The periodic preparation of a master plan is an important activity of the SFPUC in carrying out its mission. To appreciate the guiding principles, goals, and objectives of the current SSMP and the methodology used in its development, it is useful to review the mission of the SFPUC.

The mission of the SFPUC is to provide its customers with high quality, efficient and reliable water, power and wastewater services in a manner that values environmental and community interests and sustains the resources entrusted to its care.

Previous Sewer System Master Plans

The City of San Francisco has prepared a master plan for its sewer system every 35 to 40 years. The last master plan was prepared in 1974. This current SSMP is the fourth wastewater master plan prepared by the City (Figure 1-1). The previous master plans, prepared in 1899, 1935, and 1974, were prompted by public health and regulatory requirements. The achievements of the first three master plans are presented below. The current SSMP was not carried out because of pressing specific regulatory concerns or significant public nuisances (as were the past master plans). Rather, the focus of this SSMP is with the issues related to the provision of reliable, resilient, sustainable, and environmentally acceptable operation and management of the sewer system through addressing both critical near-term needs and long-term issues.

1899 Master Plan

The boomtown development of San Francisco, as a result of the California Gold Rush in 1848, propelled the city into a period of rapid growth that transformed it into the largest city on the West Coast at the time. To support this burgeoning population, the original collection system was designed to carry combined wastewater and stormwater flows to the shoreline and by 1899 over 300 miles of combined sewers had been completed. At this point, the City’s first coordinated sewerage plan was developed (Grunsky, 1899). The main accomplishments were:

- Development of a standardized, coordinated sewer design to provide effective drainage
- Construction of four pump stations
- Consolidation to eliminate on-land discharges
- Construction of 700 miles of combined sewers

1935 Master Plan

The 1935 Master Plan led to the construction of the first treatment plants – the Richmond-Sunset Plant (1938), the North Point Water Pollution Control Plant (1951), and the Southeast Water Pollution Control Plant (1952). Operation of these primary treatment facilities combined with discharge of the treated sewage through deepwater outfalls significantly reduced nearshore water pollution. In addition, the amount of untreated combined wastewater bypassed to the bay and ocean were substantially reduced. The main accomplishments were:

- Consolidation of sewer districts
- Construction of three primary wastewater treatment plants
- Construction of offshore deepwater effluent outfalls
- Elimination of dry-weather sewage overflows
Construction of additional combined sewers - 900 miles total
Construction of 56 sewage diversion structures
Construction of 35 miles of intercepting sewers
Construction of additional pump stations - 22 total

1974 Master Plan

The 1974 Master Plan was developed in response to the “Clean Water Act” (Federal Water Pollution Control Amendments of 1972 (33 U.S.C. §1251)) and led to construction projects, which were implemented over an approximately 25-year period. The main accomplishments resulting from this plan were:

- Provision of secondary treatment for all dry-weather flows
- Decommissioning of the Richmond Sunset Water Pollution Control Plant and construction of the Oceanside Water Pollution Control Plant
- Upgrade and expansion of the Southeast Water Pollution Control Plant
- Construction of the Southwest Ocean Outfall
- Provision of expanded wet-weather treatment
- Construction of 17 miles of transport/storage structures and large connecting sewers to provide 197 million gallons of storage
- Reduction wet-weather overflows to an average of 4.4% of the total annual flow
- Improvement of combined wastewater discharge water quality by providing Transport/Storage (T/S) box flow-through treatment equivalent to wet-weather primary treatment

Environmental Justice and the Master Planning Process

The SFPUC recently adopted an environmental justice policy (San Francisco Public Utilities Commission, 2009) that affirms and
commits to the goals of environmental justice to prevent, mitigate, and lessen disproportionate environmental impacts of its activities on communities in all SFPUC service areas and to ensure that public benefits are shared across all communities. The SFPUC defines environmental justice as:

The fair treatment of people of all races, cultures, and incomes and believes that no group of people should bear a disproportionate share of negative environmental consequences resulting from the operations, programs, and/or policies of the SFPUC.

The issue of environmental justice is especially important in the development of an SSMP that is responsive to the citizens of San Francisco. For this reason, the SFPUC ensured that the public had extensive opportunities to become involved in the development of both the overall SSMP and its recommendations through the vigorous public outreach process discussed in the following section.

Participants in the Current Planning Process

The SSMP team consisted of the SFPUC, WWE staff, and the joint venture consultant team (aka BCM Joint Venture) of Brown and Caldwell, Carollo Engineers, and AECOM (Metcalf and Eddy). Throughout the SSMP process, the team sought the advice and counsel of the following:

- SFPUC Commissioners
- San Francisco Citizens
- Citizens’ Advisory Committee (CAC) to the SFPUC
- Technical Advisory Committee (TAC) to the WWE
- San Francisco Planning and Urban Research Association (SPUR)
- Sustainable Watershed Alliance (SWALe)

By conducting an open planning process involving all of these participants, the SSMP preparation process exceeded local and State planning and meeting requirements, and was also consistent with the U.S. Environmental Protection Agency Definition of Environmental Justice (U.S. Environmental Protection Agency, 2008a). The nature of the participant’s involvement and the impacts of their goals, ideas, and suggestions on the SSMP are presented below.

SFPUC Commissioners

The five-member Commission (Table 1-1) provided policy-level direction and review throughout the SSMP development. During the course of preparing the SSMP, the SFPUC held three workshops (fall and winter, 2005 – 2006) and four progress meetings (June 2006, November 2006, November 2007, and May 2008) with the WWE. All WWE staff presentations to the SFPUC were open to the public. At the workshop sessions the WWE staff provided SSMP overview, reported the results of baseline public opinion research, and sought direction on levels of service. At the progress meetings, the WWE staff provided the Commissioners with planning alternatives under consideration and sought

| Table 1-1. SFPUC Commissioners during Master Planning Process |
|---------------------------------------------|-----------------|
| Commissioners                              | Dates of Service |
| **Current**                                |                 |
| F. X. Crowley (President)                  | 2008 - present  |
| Francesca Vietor (Vice-President)          | 2008 - present  |
| Ann Moller Caen                            | 1997 - present  |
| Anson B. Moran                             | 2009 - present  |
| Juliet Ellis                               | 2008 - present  |
| **Past**                                   |                 |
| Ryan Brooks                                | 2003 - 2008     |
| David Hochschild                           | 2007 - 2008     |
| E. Dennis Normandy                         | 1994 - 2008     |
| Richard Sklar                              | 2004 - 2008     |
| Adam Werbach                               | 2003 - 2007     |
advice on the structure and content of the SSMP report.

The Commissioners set out the following guiding principles for the SSMP1:

- The SSMP should, as much as possible, minimize the discharge of effluent to the bay even if this requires some increase in the amount of effluent being discharged to the ocean.
- The SSMP should result in the least possible impact on the southeast community.
- The SSMP should provide sufficient redundancy to function if facilities became inoperable due to an earthquake or a breakdown.
- The SSMP should minimize the use of natural resources and maximize the output of energy.
- The SSMP should emphasize non-engineering solutions over engineering solutions.

San Francisco Citizens

Public input was solicited through focus groups, formal and informal surveys, and SFPUC-sponsored workshops and meetings throughout the development of the SSMP (Table 1-2).

Public Workshops

Three workshops were held during the development of the SSMP to inform, update, and seek input from the public. Each workshop was held at several locations throughout the city to provide comprehensive coverage of the citizens. Each workshop consisted of an open-house session, a presentation (Figure 1-2), and ample time for discussion. The public workshops also provided the opportunity for one-on-one meetings between citizens and WWE staff.

The first workshop (March 2006) dealt with sewer system issues, SSMP objectives, and SSMP schedule. The second workshop (January 2007) sought public comment on draft proposed alternatives. The third workshop (November 2007) addressed alternatives, the draft recommended alternative, costs, and the proposed capital improvement plan.

Focus Groups

Four citywide focus groups were used to help develop the questions for a random-sample survey designed to provide a statistically-reliable, citywide assessment of San Franciscans’ perceptions (concerns) about the sewer system.

Survey

A random public opinion survey was conducted to assess citywide perceptions about the sewer system. An analysis of the 8,000 survey responses to the public opinion survey ranked the concerns about the sewer system as follows:

- Aging Infrastructure - 54%
- Overflows - 25%
- Flooding - 15%
- Biosolids Disposal - 11%
- Odors - 9%

 Citizens’ Advisory Committee

The CAC was formed (City Ordinance No. 58-04) to provide recommendations to the SFPUC General Manager, the SFPUC, and the Board of Supervisors on the SFPUC long-term strategic, financial, and capital improvement plans. The 17-member CAC has three Subcommittees: water, wastewater, and power. The wastewater subcommittee

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1. From the minutes of the November 14, 2006 SFPUC Commission meeting
met monthly to review and comment on the SSMP development process, as well as to review and comment on wastewater collection and treatment activities and operations (standing agenda item). The CAC wastewater subcommittee members are listed in Table 1-3.

**Technical Advisory Committee**

To provide an independent technical perspective, the WWE established a Technical Advisory Committee. The TAC members were selected to represent a broad range of experience in the planning and design of wastewater management facilities and associated technologies.

**Evolution of the TAC**

Originally named the Technical Review Committee (TRC), the TRC was formed in 1995 and provided technical review and advice for San Francisco wastewater projects over the past 15 years. The original TRC comprised six members. Following concurrence of the SFPUC staff, TRC members, and public stakeholders, the TAC was renamed and expanded in 2005 to eight members to include experts on biosolids, odors, and collection system alternatives (Table 1-4).

<table>
<thead>
<tr>
<th>Activity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Participation Plan</td>
<td>Prepared draft plan in February 2006 and updated in 2007</td>
</tr>
<tr>
<td>Public Opinion Research</td>
<td>Conducted citywide focus groups in October 2006</td>
</tr>
<tr>
<td></td>
<td>Conducted citywide statistically accurate survey in December 2006</td>
</tr>
<tr>
<td>Contact Database</td>
<td>Prepared database in December 2006 and updated periodically.</td>
</tr>
<tr>
<td></td>
<td>Held briefings/presentations with more than 60 organizations and stakeholders</td>
</tr>
<tr>
<td></td>
<td>Provided opportunity for public comment at monthly meetings of the CAC Wastewater Subcommittee, meetings of the Technical Advisory Committee, and workshops for the SFPUC Commission</td>
</tr>
<tr>
<td>Website</td>
<td>Launched Website February 2006 and updated regularly</td>
</tr>
<tr>
<td>Other Surveys</td>
<td>Mailed response cards to 350,000 households in March 2006</td>
</tr>
<tr>
<td></td>
<td>Posted several online surveys on Website.</td>
</tr>
<tr>
<td>Media</td>
<td>Placed extensive outdoor ads and ads in newspapers to publicize launch of master plan</td>
</tr>
<tr>
<td></td>
<td>Placed ads before each round of workshops to encourage participation</td>
</tr>
<tr>
<td></td>
<td>Conducted tours of sewer system with media</td>
</tr>
<tr>
<td></td>
<td>Issued event advisories to press before all workshops</td>
</tr>
<tr>
<td>Communication Materials</td>
<td>Mailed trilingual citywide brochure March 2006</td>
</tr>
<tr>
<td></td>
<td>Distributed trilingual newsletter and e-newsletter to extensive list in the summer of 2006 and fall of 2007</td>
</tr>
<tr>
<td></td>
<td>Placed informational kiosks at more than 70 libraries citywide and updated with new inserts</td>
</tr>
<tr>
<td></td>
<td>Distributed video of wastewater system in the fall of 2007</td>
</tr>
</tbody>
</table>
Table 1-3. Citizens’ Advisory Committee Wastewater Subcommittee Members

<table>
<thead>
<tr>
<th>Member</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robin Chiang</td>
<td>Friends of Islais Creek</td>
</tr>
<tr>
<td>Jennifer Clary¹</td>
<td>Clean Water Action, Alliance for a Clean Waterfront, San Francisco Sustainable Watershed Alliance</td>
</tr>
<tr>
<td>Richard Hansen</td>
<td>Richmond District Democratic Club</td>
</tr>
<tr>
<td>Alex Lantsberg¹</td>
<td>Alliance for a Clean Waterfront, San Francisco Sustainable Watershed Alliance</td>
</tr>
<tr>
<td>Jack Lendvay¹</td>
<td>Professor at University of San Francisco Department of Environmental Science</td>
</tr>
<tr>
<td>David Pilpel¹</td>
<td>Sierra Club, Sunshine Task Force</td>
</tr>
<tr>
<td>Judy West¹</td>
<td>The Madrina Group</td>
</tr>
<tr>
<td>Laurie Schoeman¹</td>
<td>Literacy for Environmental Justice</td>
</tr>
<tr>
<td>Laura Tam¹</td>
<td>San Francisco Planning and Urban Research Association</td>
</tr>
</tbody>
</table>

Note: ¹ Current members

TAC Workshops

Six TAC workshops were held to familiarize the TAC with the sewer system, to review planning and technical issues and constraints, and to receive input on the SSMP. Reports of the TAC meetings are on file and are presented in full in the supporting volumes to this report.

TAC Consensus Statements

During the conduct of the SSMP, the TAC was asked to develop consensus statements for a series of technical questions posed by the SSMP planning team. The answers to the questions posed by the team were useful in the development of specific elements of the SSMP. The full text of the questions posed and the corresponding TAC consensus statements can be found in the appendices to the supporting volumes. Briefly, the TAC concluded that:

- The SSMP should not consider full separation of the existing collection system; rather criteria for sewer separation should be formulated for redevelopment areas.
- Treated effluent discharges are less likely to impact the environment negatively if discharged to the ocean rather than the bay. It was also noted that future discharge regulations to the bay would likely be more stringent than those for ocean discharge.
- The 5-year design storm and 5-year storm period should continue to be used for hydraulic modeling of the collection system and treatment plants. The long-term effects of climate change on these design parameters should continue to be evaluated.
- A wide range of sustainable technologies and programmatic options suitable for San Francisco have been reviewed and evaluated by the SSMP team. It is recommended that the WWE continue with its research and development program to investigate new and innovative technologies that may enhance the sustainability of the wastewater collection and treatment systems.
- Application of the Integrated Urban Watershed Planning in the development of the SSMP will allow the SFPUC to achieve a more sustainable sewer system.

San Francisco Planning and Urban Research Association (SPUR)

Through research, education, and advocacy, SPUR promotes good planning and good government in the San Francisco Bay Area. SPUR’s history dates back to 1910, when a group of young city leaders came together to
improve the quality of housing after the 1906 earthquake and fire. Since then, SPUR has been involved with most major city planning decisions.

SPUR provided guidelines for their members’ use in evaluating how the SSMP objectives would meet the group’s goals for the sewer system (Tam, 2008). Their goals are:

- Minimize sewer overflows and flooding
- Maximize low-impact tools to retain and reuse stormwater and to benefit environmental restoration
- Establish seismic reliability
- Maximize the beneficial reuse of resources extracted from wastewater, including biofuels, biosolids, and reclaimed water
- Design the system to respond to a range of climate change scenarios
- Adopt a rate structure that reflects the contribution of stormwater to the system
- Collaborate with other City departments to achieve multiple benefits from investments
- Set ambitious quantifiable performance measures

**Sustainable Watershed Alliance (SWALe)**

SWALe, the “environmental watchdog for a wise wastewater plan” is a loose association of 18 environmental advocacy groups (Arc Ecology, Bayview Office of Community Plan-
Summary Report Final Draft

1-9

Development

ning, Clean Water Action, Farallones Marine Sanctuary Association, Friends of the Urban Forest, India Basin Neighborhood Association, Literacy for Environmental Justice, Madrina Group, Mission Creek Conservancy, Neighborhood Parks Council, Plant*SF, San Francisco Baykeeper, San Francisco Bicycle Coalition, San Francisco Tomorrow, Sierra Club, San Francisco Chapter, Transportation for a Livable City, Treasure Island Wetlands Project, Visitacion Valley Planning Alliance). SWALe’s overarching principle is that all water is a resource. SWALe stated that this principle must form the basis of the SSMP. SWALe developed seven policy goals and associated metrics that could be used to determine whether their overarching principle was being met. These goals are summarized below:

- Redress environmental injustices
- Reduce pollutant loading to the bay and ocean
- Minimize volume of water entering the system
- Build in sewer system reliability and flexibility
- Provide environmental benefits
- Address climate change
- Achieve economic and environmental sustainability

Structure and Vision of the SSMP

All of the participants involved in the SSMP planning process were unified in their desire to develop a sustainable, flexible sewer system that will allow the City to respond to regulatory changes, climatic conditions, emergencies, and innovative technology. Thus, the overarching themes of the SSMP are sustainability and integrated urban watershed management. Application of the principles of sustainability and integrated urban watershed management to the SSMP is considered in this section.

Sustainability

Sustainability² in the SSMP will be achieved by applying the Sustainability Criteria in which environmental, social, and economic factors are balanced with engineering design to develop feasible solutions to problems.

Integrated Urban Watershed Management

To achieve sustainable sewer system management the entire watershed and “sewershed,” must be considered all the way from the most upstream locations through the collection system to the treatment facilities and the disposal or reuse of the treated effluent and biosolids.” Integrated Urban Watershed Management is considered in greater detail in Chapter 5.

Guiding Principles

The guiding principles reflect the core values, aspirations, and the vision of the public and the SFPUC for the wastewater collection, treatment, and discharge facilities. These principles helped focus the SSMP goals and objectives, guided planning decisions, and sustainability improvements. The development of the SSMP guiding principles and goals and objectives received considerable input and review from the SSMP Project Team, SFPUC Commissioners, the TAC, the CAC, and members of the public.

The guiding principles for the SSMP are to:

- Protect public health, safety, and the environment
- Ensure the long-term sustainability of the sewer system
- Strive to ensure that all sectors of the community are protected from nuisances associated with the sewer system and that no community bears a disproportionate share of the negative environmental consequences resulting from system operations

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² Sustainable development has been defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987).
• Promote environmental stewardship that includes the sustainable use of natural resources

Living Document
The SSMP will be updated in response to changing system needs, technological advancements, and regulatory requirements. This ensures that the SSMP can be maintained as a living document.

Goals and Objectives
The overall goal of the SSMP is to provide the basis for the near- and far-term development of a reliable, efficient, and sustainable system for sewage and stormwater collection, treatment, and discharge. In keeping with the guiding principles, the SSMP recommendations will ensure that the WWE will continue to meet the following specific objectives.

Protect Public Health and the Environment
The implementation of the SSMP recommendations must:
• Maintain compliance with all current local, State, and Federal regulations applicable to the building and operation of wastewater collection, treatment, and disposal systems
• Design new system components that will accommodate foreseeable future wastewater collection, treatment, and disposal regulations

Protect Worker Health and Safety
The WWE will design and operate the collection system and treatment facilities that will:
• Improve indoor air quality of system buildings for workers
• Increase the safety and ease of maintenance of key equipment

Minimize Impacts to Ratepayers
Implementation of SSMP recommendations will produce a well-run system for the lowest cost possible by:
• Considering both capital and life-cycle costs, in keeping with asset management principles, when prioritizing renewal and replacement and capital projects for implementation
• Designing projects to meet multiple objectives to maximize benefits to the residents of the city
• Increasing operational efficiency
• Minimizing energy costs and maximizing the use of renewable power
• Accelerating implementation of capital intensive projects to minimize the impact of escalating costs on the overall cost of the capital improvement plan

Improve Seismic Reliability
Seismic design and operation standards have evolved considerably since the wastewater system was first constructed. Seismic reliability will be achieved by:
• Retrofitting critical collection and treatment structures
• Designing new system components to meet current seismic standards and code requirements
• Identifying and upgrading critical facilities to reduce damage during a seismic event
• Providing redundant conveyance and treatment facilities to improve service following a major seismic event or other emergency

Improve System Reliability and Flexibility
To achieve reliability and flexibility, the implementation of the SSMP recommendations will:
• Promote policies that improve sewer performance and require individual dischargers to reduce sewer impacts
• Prioritize sewer renewal and replacement based on risk and consequences of failure
• Improve frequency of routine cleaning and inspection of the collection system to reduce blockages and sewer failures
• Provide comprehensive source control to address pollutants of concern that impact the collection system and/or treatability of wastewater
• Protect collection system assets from the impact of rising seawater level
• Design new system components to accommodate foreseeable future regulatory, technological, and demand changes
• Design equipment and treatment processes to allow efficient operation and maintenance
• Identify and rehabilitate critical facilities whose structural integrity threatens the ability to meet regulatory requirements
• Provide redundancy and automation to increase sustainability of operations

Reduce Community Impacts
Implementation of the SSMP recommendations will reduce the negative community impacts while providing safe and reliable wastewater collection and treatment by:
• Constructing improvements that reduce odors from the collection system, the wastewater treatment facilities, and the biosolids reuse sites
• Improving customer service response to flooding and odor complaints
• Designing stormwater management projects that provide community amenities
• Employing stormwater controls that reduce the potential of neighborhood flooding

Promote Environmental Stewardship
To promote environmental stewardship, WWE will:
• Increase the use of Low Impact Development and green infrastructure where feasible to reduce, reuse, and/or delay stormwater flows
• Reduce the creation, use, and release of toxic compounds into the air and receiving waters
• Select processes and equipment that minimize energy use

Enhance Sustainable Use of Natural Resources
In order to maximize the use of renewable resources, the WWE will:
• Incorporate improvements in water conservation and demand management
• Increase stormwater harvesting/reuse and wastewater reuse
• Employ biosolids reuse methods
• Design new facilities and systems to promote resource reuse and conservation
• Increase/enhance pollution prevention
• Use Leadership in Energy and Environmental Design (i.e., LEED) guidelines in the design and rehabilitation of all new system buildings
Chapter 2

The Setting of the Master Plan

An important element of every wastewater master plan is an understanding of the quantity of wastewater that will have to be conveyed, treated, and discharged over the period for which the sewer system is being planned. The purpose of this chapter is multi-fold: the first is to describe the current physical setting of the city and surrounding waters as they impact the development of the master plan; the second is to describe the principal physical elements that comprise the sewer system including the collection system network, treatment facilities, and deepwater outfalls; the third is to present the results of analysis of four major systemwide changes to the configuration and operation of the San Francisco wastewater collection system and treatment facilities that shaped the direction of the master plan; the fourth is to present the predictions of future sewage flows and pollutant loads, based on an analysis of current data and anticipated trends. Because regulatory requirements significantly impact the type of wastewater treatment and discharge facilities, it is also necessary during the master planning process to make an attempt to predict how these regulations may change. These predictions are also addressed in this chapter.
Service Area

The service area can be characterized by its climate, land use, surrounding waters (including beneficial uses and water quality), and air quality. Each of these characteristics is addressed in the following discussion.

Physical Characteristics

San Francisco is situated on the northern end of a narrow peninsula between the Pacific Ocean on the west and the San Francisco Bay estuary on the north and east. The city occupies a total land area of 29,773 acres. Its topography is a diverse mixture of low hills, valleys, beaches, sand dunes, wetlands, lakes, and headlands. The low hills run in a generally north/south direction and demarcate the east and west sides of the city. This topography also divides San Francisco into two major watershed areas: the Westside Watershed and the Bayside Watershed (Figure 2-1).

The Bayside Watershed represents 64% of the total city area (18,597 acres) and drains to the San Francisco Bay. The Westside Watershed is 36% of the total city area (11,176 acres) and drains to the Pacific Ocean. The Westside Watershed is divided into three major drainage basins: Richmond, Sunset, and Lake Merced. The Bayside Watershed is divided into five major drainage basins: North Shore, Channel, Islais Creek, Sunnydale, and Yosemite.

In addition to wastewater flows generated in the city, the Wastewater Enterprise (WWE) sewer system receives and treats flows from three other agencies (North San Mateo County Municipal District, Bayshore Sanitary District, and City of Brisbane), most of which discharge to the Bayside Watershed.

Climate

While San Francisco is characterized by moderately wet winters, dry summers, and few days of extreme temperatures, its topography and the maritime surroundings create several microclimates.

The west side of the city experiences more fog, lower average temperature (by 1-2°F) and higher rainfall levels (by 2 inches) than the east side. The San Francisco average daily temperature ranges from 45°F in January to approximately 70°F in September. The record high temperature is 103°F (June 14, 2000) and the record low temperature is 27°F (December 11, 1932). The data plotted in Figure 2-2 show that the average annual San Francisco temperature has increased at an average rate of 0.016°F per year between 1914 and 2006. (Western Regional Climate Center, 2007).

The 5-year running average rainfall for the National Weather Service gauge for the period from 1911 to 2003 together with the Pacific Decadal Oscillation (PDO) Index climate pattern is shown in Figure 2-3. When the PDO Index is positive (warm), the southern half of the United States (including San Francisco) experiences higher-than-average rainfall; lower-than-average rainfall occurs during a negative PDO. These effects are especially evident in the recent record.

For the period from 1914 to 2006 the average annual rainfall was about 21 inches per year (Table 2-1). Approximately 84% of the total annual rainfall occurs from November to March with 40% of the total occurring during December and January.

Land Use

Of the total city land area, 82% is developed. Somewhat less than half of this developed area is residential (Association of Bay Area Governments, 2004). It is estimated that there are 354,963 housing units (Association of Bay Area Governments, 2007); the citywide residential population density is 16,526 persons per square mile.

Industrial use accounts for 7% of the total city area, cultural/institutional/educational use occupy 6% of the total city area, and 6% is classified as a mixed use/other. The

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1 Currently located at the United States Mint at Hermann and Buchanan Streets, formerly located at a variety of locations in the northeastern quadrant and, after 1936, in several central locations in the city.
The west side of the city is 51% residential/residential mixed, 38% public use/open space, 8% cultural/institutional/educational with retail, industrial, and hotel comprising the remaining 3%. The east side is 44% residential/residential mixed, 18% public use/open space, 12% industrial, 3% retail, and 3% office with other uses comprising the remaining 20% (Table 2-2).

There are 4,090 acres of permanently dedicated open space in the city limits. Large public lands on the west side include Lincoln Park, Golden Gate Park, Mount Sutro, the Lake Merced environs, and part of the Presidio. The east side includes McLaren Park, Bayview Park, Candlestick Point State Recreation Area, Hunters Point, Buena Vista Park, the Marina, and part of the Presidio. Almost all natural lands, wetlands, and shorelines have been compromised or destroyed and more than three square miles of artificial fill have been added to the city shoreline.
Surrounding Waters

The San Francisco Bay surface area is 480 square miles and approximately 70% is less than 18 feet deep (Sloan, 2006). Approximately 40% of the land area of California drains through the bay (Conomos, 1979) with 90% of this freshwater drainage entering through the Sacramento-San Joaquin River Delta. There are typically two tidal cycles per day and up to 30% of the bay water volume is exchanged with the Pacific Ocean during each tidal cycle.

San Francisco has approximately 8.5 miles of shoreline along the Pacific Ocean within the area known as the Gulf of the Farallones that extends about 26 nautical miles to the west of the Golden Gate Strait to the Farallon Islands. The Monterey Bay National Marine Sanctuary, a federally protected marine area off California since 1992, extends from Marin County on the north to Cambria on the south and encompasses 6,094 square miles of ocean.

The oceanographic climate in central California consists of two major seasons: the California Current season, during which the principal nearshore flow is southerly, and the Davidson Current season, during which the principal nearshore flow is northerly. In addition to the oceanographic seasons, the intermittent phenomena known as El Niño, La Niña, and the PDO have global weather consequences and can impact the Gulf of the Farallones.

| Table 2-1. Annual and Monthly Rainfall for San Francisco from 1914 to 2006 |
|-----------------------------|-----------------------------|-----------------------------|
| Month          | Mean Rainfall (inches) | Mean Rainfall (percent) |
| January         | 4.41                      | 20.9                       |
| February        | 3.81                      | 18.0                       |
| March           | 2.81                      | 13.3                       |
| April           | 1.38                      | 6.5                        |
| May             | 0.57                      | 2.7                        |
| June            | 0.15                      | 0.7                        |
| June            | 0.15                      | 0.7                        |
| July            | 0.02                      | 0.1                        |
| August          | 0.05                      | 0.2                        |
| September       | 0.23                      | 1.1                        |
| October         | 1.02                      | 4.8                        |
| November        | 2.61                      | 12.3                       |
| December        | 4.08                      | 19.3                       |
| Annual          | **21.14**                 | **100**                    |

Source: Western Regional Climate Center 2007

Figure 2-2. Average Annual Temperatures for San Francisco from 1914 to 2006

Source: Western Regional Climate Center 2007
Figure 2-3. Five-Year Running Average Rainfall for San Francisco

Notes: Pacific Decadal Oscillation - PDO

Table 2-2. San Francisco Land Use Areas

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Westside Watershed (1,000 sf)</th>
<th>Bayside Watershed (1,000 sf)</th>
<th>Total City (1,000 sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>183,775</td>
<td>241,776</td>
<td>425,551</td>
</tr>
<tr>
<td>Residential Mixed</td>
<td>1,679</td>
<td>8,029</td>
<td>9,707</td>
</tr>
<tr>
<td>Office</td>
<td>959</td>
<td>14,866</td>
<td>15,826</td>
</tr>
<tr>
<td>Retail</td>
<td>5,497</td>
<td>16,689</td>
<td>22,186</td>
</tr>
<tr>
<td>Industrial</td>
<td>755</td>
<td>67,608</td>
<td>68,363</td>
</tr>
<tr>
<td>Cultural/Institutional/Educational</td>
<td>27,863</td>
<td>28,443</td>
<td>56,306</td>
</tr>
<tr>
<td>Hotel</td>
<td>35</td>
<td>2,899</td>
<td>2,934</td>
</tr>
<tr>
<td>Mixed Uses</td>
<td>1</td>
<td>50,104</td>
<td>51,230</td>
</tr>
<tr>
<td>Public/Open Space</td>
<td>141,092</td>
<td>103,132</td>
<td>244,224</td>
</tr>
<tr>
<td>Vacant</td>
<td>3</td>
<td>20,669</td>
<td>23,587</td>
</tr>
<tr>
<td>Other</td>
<td>1,206</td>
<td>17,485</td>
<td>1,869</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>366,904</strong></td>
<td><strong>571,700</strong></td>
<td><strong>938,604</strong></td>
</tr>
</tbody>
</table>

Source: San Francisco Planning Department 2006

Notes: Units in 1,000 square feet; data reported may be slightly different due to rounding discrepancies and date of data entry by the San Francisco Planning Department for this report; areas reported do not include street and freeway areas.
Beneficial Uses

The San Francisco Bay provides a wide variety of beneficial uses. These include swimming, boating, fishing, duck hunting, tourism, and municipal and industrial water supplies. The bay waters contain more than 500 species of phytoplankton. There are more than 120 species of fish including California halibut, leopard shark, shiner perch, and jacksmelt (Association of Bay Area Governments, 2002a). Common marine mammals are the California sea lions, harbor seals, elephant seals, gray whales, humpback whales, and sea otters. Common shorebirds include egrets, herons, sandpipers, godwits, willets, and avocets and common open water birds include ducks, cormorants, brown pelicans, grebes, terns, and gulls.

The cold waters of the Pacific Ocean provide habitats or migratory routes for whales, king and silver salmon, steelhead trout, and striped bass. The ocean beaches provide recreational opportunities for such as surfing, walking, jogging, dog walking, wildlife viewing, and fishing.

Water Quality

The contamination and decline of many San Francisco Bay species is related to the deterioration of water quality. Many San Francisco Bay species are contaminated and in decline. Factors contributing to this situation may include increasing concentrations of xenobiotic chemicals; dredging and sediment toxicity from legacy pollutants such as mercury, polychlorinated biphenyls (PCBs), and dichlorodiphenyltrichloroethane (DDT); wetland habitat loss; and change in the magnitude and frequency of freshwater inflows. High levels of mercury, organochlorine pesticides, PCBs, and dioxin in fish have led to a fish consumption advisory, and high levels of selenium in ducks have led to a duck consumption advisory (Association of Bay Area Governments, 2002b). San Francisco Bay is on the U.S. Environmental Protection Agency 303d list of impaired waters for mercury, nickel, selenium, chlordane, DDT, diazinon, dieldrin, PCBs, dioxins, furans, exotic species, nutrients, and pathogens (San Francisco Estuary Institute, 2006; San Francisco Bay Regional Water Quality Control Board, 2007).

Outflow from the San Francisco Bay affects sediment and water quality in the Gulf of the Farallones. The Sacramento-San Joaquin River Delta carries a significant sediment load as well as agricultural, industrial, and municipal contaminants into the bay and then the Pacific Ocean. Monterey Bay National Marine Sanctuary regulations require that all point sources discharging into sanctuary waters must achieve a minimum of secondary treatment.

Air Quality

San Francisco air quality is strongly influenced by wind direction and velocity and the concentration of pollutant emissions. Generally, the wind velocity is strongest in summer with a predominant westerly direction (Bay Area Air Quality Management District, 2007). Summer winds and fog reduce tropospheric ozone production compared to surrounding counties even though the high density of road vehicles can result in greater pollutant emissions.

The three major types of Bay Area air pollutant are gases, particulate matter, and photochemical smog or ozone. Significant gases are sulfur oxide, nitrogen dioxide, carbon monoxide, ozone, greenhouse gases (GHGs), and volatile organic compounds (VOCs) (Bay Area Air Quality Management District, 2006a).

Greenhouse gases are of both natural and anthropogenic origin. Naturally occurring GHGs include water vapor, carbon dioxide (CO₂), methane, and nitrous oxide (N₂O). Anthropogenic GHGs include carbon dioxide, methane, halocarbons, chlorofluorocarbons, and sulfur hexafluoride. Fewer than 5% of the total methane emissions are from wastewater treatment sources (U.S. Environmental Protection Agency, 2008b).

— The Southwest Ocean Outfall discharges into an area adjacent to, but excluded from, the Monterey Bay National Marine Sanctuary.
The major sources of Bay Area CO₂ gas emissions are fossil fuel combustion in mobile sources and energy generation (Bay Area Air Quality Management District, 2002). The major sources of nitrous oxide emissions are related to microbial action in fertilized agricultural soils (Bay Area Air Quality Management District, 2006b).

Atmospheric particulate matter (PM) consists of solid or liquid particles (e.g., pollen, dust, mist, and smoke). Concentrations are expressed in two size ranges: 10 microns or less (PM₁₀) and 2.5 microns or less (PM₂.₅) (Water Environment Federation 2004). PM is an important Bay Area wintertime air pollutant when temperature inversion, wind pattern reversal, and wood burning are more common than in the summer.

Tropospheric (ground-level) ozone production by chemical reactions between nitrogen oxides and VOCs in the presence of sunlight is a major Bay Area air quality problem. Ozone levels during stagnation/offshore flow events in the summer, when wind velocities can be low and there is the most sunlight, can exceed State and Federal health-based air quality standards.

The Current Sewer System

The current San Francisco sewer system effectively collects, conveys, treats, and discharges all of the dry-weather domestic wastewater and urban runoff flows and most of the wet-weather runoff. This dual function allows the system to treat both point and non-point sources of pollution. The system utilizes natural watershed areas wherever possible to take advantage of gravity flow for the collection, transport, treatment, and discharge of wastewater and stormwater.

The current configuration is largely the result of implementing the recommendations of the 1974 Master Plan (San Francisco Department of Public Works, 1972). The city is primarily served by combined sewers that collect both wastewater and stormwater for treatment at one of three San Francisco treatment facilities. There are two centralized dry-weather treatment plants — the Southeast Water Pollution Control Plant (SEP) and the Oceanside Water Pollution Control Plant (OSP), and one wet-weather facility — the North Point Wet-Weather Facility (NPF). There are three currently functioning deepwater outfalls locations – the Southeast Outfall (SEO), the North Point Outfalls (NPOs), and the Southwest Ocean Outfall (SWO). The OSP serves the Westside Watershed, the SEP serves the Bayside Watershed, and the NPF operates only during wet weather to provide supplementary treatment capacity for the Bayside. The treatment facilities and the deepwater outfalls used to disperse the treated wastewater to the environment are described in the Wastewater Treatment Facilities section on page 2-8 and in the Deepwater Outfalls section on page 2-12, following the discussion of the collection system.

The Collection System

The combined sewer system collects wastewater and stormwater runoff and conveys them to transport/storage (T/S) structures. There are 976 miles of sewers that range in size from 8-inch diameter to large rectangular, multi-compartment T/S structures with cross-sectional areas of 44 feet by 25 feet (Table 2-3).

Over 90% of the city is served by the combined sewers. The remainder of the city, along with the flows from other agencies served by the San Francisco plants (City of Brisbane, Bayshore Sanitary District, and North San Mateo County Sanitation District), are separate sewers.

Transport/Storage Structures

The box sewers and tunnels making up the underground T/S structures are located, like a moat, around the city perimeter. The primary purpose of the T/S structures is to reduce the frequency and volume of wet-weather nearshore discharges (combined sewer overflows³, CSOs). The structures

³ A CSO is an untreated discharge of combined wastewater and stormwater to receiving waters as a result of wet-weather flow exceeding collection system and treatment plant capacity
intercept and temporarily store commingled sewage and stormwater that is then transported to the treatment facilities after a storm has passed (Figure 2-4). In addition to storage and retention, the T/S structures provide the equivalent of wet-weather primary (or decant) treatment for nearshore discharges by settling of solids and trapping of floatable materials.

Combined Sewer Discharge Sites

The T/S structures have 36 permitted nearshore discharge sites around the city perimeter (Figure 2-5). Discharges through these sites are called combined sewer discharges (CSDs) rather than CSOs because they have received decant treatment. The T/S structure performance complies with the City’s Long-Term Control Plan (completed as part of the 1974 Master Plan) and meets the requirements of the National Combined Sewer Overflow Control Policy (U.S. Environmental Protection Agency, 1994).

Pump Stations, Force Mains, and Tunnels

The collection system has a total of 27 pump stations. The major all-weather pump stations are each equipped with auxiliary pumps that guarantee full pumping capacity with the largest unit out of service. In the event of a power failure, all major pump stations have upstream storage in the T/S structures.

The major force mains are North Shore, Channel, and Westside. The North Shore Force Main connects the discharge of the North Shore Pump Station to the Channel T/S. The Channel Force Main connects the discharge of Channel Pump Station to the SEP. This force main has failed four times since it was constructed in the late 1970’s. It is a highly vulnerable component of the bayside sewer system, because it is a major artery that has no redundancy. The Westside Force Main conveys the Westside Pump Station flows to the OSP. There are twelve active tunnels in the collection system. Most of these lack functional redundancy and are subject to failure from materials deterioration and seismic activity.

Wastewater Treatment Facilities

The bayside treatment facilities are the SEP and the NPF; the westside treatment facility is the OSP. Each of these treatment plants is described separately in the following discussion. The overall capacity of the system is discussed in the Current Sewer System Capacity section on page 2-14.

Southeast Water Pollution Control Plant

The SEP is located in the Bayview District, in a mixed industrial, commercial, and residential neighborhood. It provides secondary treatment (oxygen-activated sludge) for the wastewater from the Bayside Watershed plus 1.65 mgd of flow from other agencies. The SEP was originally commissioned in 1952 and major upgrades/expansions were added in 1982 and 1996. After the 1982 upgrades and consolidation of bayside treatment, the SEP was designed to treat all bayside dry-weather flows, with a daily average and peak hourly flows of 85 and 142 mgd, respectively. The current daily average dry-weather flow is approximately 63 mgd (2003 to 2007). During wet weather, the SEP facilities can provide full secondary treatment for up to 150 mgd and primary treatment for an additional 100 mgd of combined wastewater flow for a total wet-weather flow rate of 250 mgd. Treated wastewater is discharged to San Francisco Bay through two outfalls, as described in the Deepwater Outfalls section on page 2-12.

<table>
<thead>
<tr>
<th>Description</th>
<th>Total Length (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Sewers (36 inches or less)</td>
<td>781</td>
</tr>
<tr>
<td>Major Collecting Sewers</td>
<td></td>
</tr>
<tr>
<td>• Sewers (greater than 36 inches)</td>
<td>120</td>
</tr>
<tr>
<td>• Brick Sewers</td>
<td>51</td>
</tr>
<tr>
<td>• Transport/Storage Structures</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>976</strong></td>
</tr>
</tbody>
</table>

Table 2-3. Collection System Inventory
The SEP treatment process (Figure 2-6) consists of pretreatment, primary treatment, secondary treatment, disinfection, disinfectant removal, and solids stabilization. Influent flows are first screened and degritted then settled in primary sedimentation tanks. The settled solids separated from wastewater are sent to the solids handling processes. The primary effluent then flows to the aeration basins for secondary treatment and then to secondary clarifiers where the microbial solids are removed by settling. The clarified flow is disinfected with sodium hypochlorite then treated with sodium bisulfite to remove excess chlorine. The final effluent flows to the Booster Pump Station which pumps it to the SEO for discharge to the San Francisco Bay.

Solids from the primary and secondary processes are thickened then stabilized in anaerobic digesters. The biogas produced as a by-product of digestion is used for operating a cogeneration engine and the hot water boilers for heating the digesters and buildings. Digested sludge is dewatered by centrifuging then used either for land application or landfill cover in Solano, Sonoma, and Merced counties.

During wet weather, the treatment process mirrors the dry-weather treatment process. Flows of up to 250 mgd receive primary treatment through the engagement of additional primary clarifiers. Of the 250 mgd, up to 150 mgd receives full secondary treatment. The primary and secondary streams have separate disinfection facilities. The primary effluent (100 mgd) and a small portion of the secondary effluent (up to 10 mgd) are discharged to the bay through the Booster Pump Station and the SEO. The remaining secondary effluent (140 mgd) is discharged through the Quint Street Outfall to Islais Creek.

**North Point Wet-Weather Facility**

The NPF was commissioned in 1951. In the early 1980’s it was connected to the SEP through a force main and the T/S system and decommissioned as a dry-weather plant. The NPF is now used as a primary treatment plant (Figure 2-7) for wet-weather flows from the northeast portion of the Bayside Watershed.

The NPF only operates during, and shortly after, significant rainfall events. Its peak hourly treatment capacity is 150 mgd. On
average, it operates 30 times per year (450 hours) treating an annual average total flow of 0.7 billion gallons (4% of the annual average total citywide wastewater flow). The NPF process consists of pretreatment, primary treatment, disinfection, and disinfectant removal. The plant influent flow is screened then chlorinated prior to primary sedimentation for grit and settleable solids removal. The primary effluent is dechlorinated prior to gravity discharge through the NPOs (see North Point Outfalls section, page 2-14). After each wet-weather event, the removed grit and settled solids are flushed out of the sedimentation tanks and pumped through the collection system to the SEP for treatment.

**Oceanside Water Pollution Control Plant**

The OSP is located on the Great Highway adjacent to Lake Merced and the San Francisco Zoo. It provides secondary treatment (oxygen-activated sludge) (Figure 2-8) for the wastewater from the Westside Watershed and 0.004 mgd from North San Mateo County. All dry-weather, secondary treated
Figure 2.6. Southeast Water Pollution Control Plant Process Schematic
effluent flows by gravity to the ocean through the SWO, as described the Southwest Ocean Outfall section on page 2-14.

Dry- and wet-weather wastewater flow from the Westside Watershed is routed through the Richmond Tunnel, the Westside T/S, and the Lake Merced Tunnel to the Westside Pump Station, which pumps it to the OSP. The OSP was designed for an average dry-weather flow of 21 mgd and currently treats approximately 16 mgd (2003 to 2007). It has a peak dry-weather flow capacity of 43 mgd.

The OSP treatment process (Figure 2-8) consists of pretreatment, primary treatment, secondary treatment, and solids stabilization. Influent flows are first screened and degritted then settled in primary sedimentation tanks. The primary effluent flows to the aeration basins for secondary treatment, and then to secondary clarifiers where the microbial solids are removed by settling. The clarified flow is discharged by gravity through the SWO.

Primary solids, secondary solids, and secondary scum are thickened by gravity belts, combined with primary scum and then digested in egg-shaped anaerobic digesters. The digested sludge is dewatered by belt presses and the dewatered biosolids are used as landfill cover or land applied (see discussion in the Southeast Water Pollution Control Plant section on page 2-8.)

During wet weather, flows of up to 65 mgd receive primary treatment and, of this, up to 43 mgd receives full secondary treatment. The primary and secondary effluents are then blended prior to discharge to the Pacific Ocean through the SWO.

Deepwater Outfalls

Treated wastewater is discharged to the bay or ocean receiving waters through a series of deep water outfalls. These outfalls are described below.

Southeast Outfalls

The SEP has two outfalls: the SEO at Pier 80 has a capacity of 110 mgd and the Quint Street Outfall on the south bank of Islais Creek has a capacity of 140 mgd. The SEO extends 810 feet from Pier 80 into the bay. The easternmost 300-foot discharge section is 42 feet below mean lower low water (MLLW). The outfall pipe is buried and protected by rocks and riprap. The SEO can handle all of the current 63 mgd SEP average dry-weather effluent flow. During wet weather, flows of up to 65 mgd receive primary treatment and, of this, up to 43 mgd receives full secondary treatment. The primary and secondary effluents are then blended prior to discharge to the Pacific Ocean through the SWO.

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Figure 2-8. Oceanside Water Pollution Control Plant Process Schematic
weather, the SEO can discharge up to 100 mgd of primary treated effluent and up to 10 mgd of secondary effluent. The remaining 140 mgd of secondary effluent is discharged through the shallow-water Quint Street Outfall.

North Point Outfalls
The four NPOs were constructed in the 1950’s and diffusers were added in the 1970’s. The NPOs consist of an 8-foot reinforced concrete outfall sewer that branches into two 6-foot concrete pipes. Each 6-foot pipe in turn branches into two 48-inch cast-iron outfalls. One set is located under Pier 33 and the other under Pier 35. Each outfall extends off shore into the bay for about 800 feet to an 80-foot diffuser section with 10-inch-diameter ports at a depth of about 18 feet below MLLW. The estimated total hydraulic capacity of the NPOs is 170 mgd.

Southwest Ocean Outfall
The SWO, commissioned in 1986, extends in a southwesterly direction from the shoreline to approximately four miles offshore. The outfall is a 12-foot diameter reinforced concrete pipe, buried 12 to 20 feet beneath the sea bed. It terminates in a 3,250-foot-long angled section fitted with 85 diffusers and situated at approximately 80 feet below MLLW. The diffuser section is located in open coastal water outside of designated shipping lanes.

Current Sewer System Capacity
When the three treatment facilities, and all pump stations and T/S structures are operating at capacity, the sewer system can treat 575 mgd of combined wastewater and stormwater with 193 mgd receiving secondary treatment, 272 mgd receiving primary treatment, and 110 mgd receiving decant treatment. Of this total, 435 mgd can be discharged through deepwater outfalls and 140 mgd of secondary effluent can be discharged through a shallow-water outfall into Islais Creek.

Decisions Regarding Systemwide Changes
Four major systemwide changes to the configuration and operation of the San Francisco wastewater collection system and treatment facilities were evaluated as major decisions that would guide the SSMP Project Team in the development of recommendations.

City management and public sentiment from prior and current planning efforts helped shape these key decision areas. The continued public interest in reducing CSD event counts and volume factored into the evaluation of each proposed reconfiguration of the system. Additional considerations included system flexibility and reliability, and future regulatory developments pertaining to bay discharge.

Separation of Sewers
*Should the combined collection system be converted to a separate sewer system?*

Systemwide sewer separation is not recommended because the existing system provides treatment for all dry-weather sewage, all dry-weather runoff and all stormwater. No other system in California provides a similar level of pollutant removal. Separation of all sewers would be a massive, long-lasting, disruptive undertaking that provides no significant environmental benefit. Localized sewer separation in new developments will be considered when water reuse or stormwater reduction is possible.

Key considerations include:
- Excessive financial burden to the City and residents
- Estimated construction cost of $2 to $4 billion
- Significant public disruptions for 50 years or longer
- High risks for successfully implementing modifications on private properties
- No significant benefit to the environment
Decentralization of Treatment

Should the centralized treatment plants be replaced with a decentralized treatment system? While many innovative approaches to decentralized treatment are being implemented throughout the U.S. and other nations, continued use of centralized treatment facilities is recommended because of economies of scale, the complex logistics for operation and maintenance, significant permitting difficulties, and the higher energy use and greenhouse gas emissions of a decentralized system. There may be opportunities to shift the distribution of flow between the two centralized facilities or recommission out-of-service facilities for dry-weather treatment that should be considered in continuing planning efforts. Future planning efforts could consider a small package plant to address local recycled water needs and localized stormwater management.

Key considerations include:
- Estimated construction cost of $2 billion to $10 billion and very high operating and maintenance costs
- No prior experience of such operating scheme; highly complex logistics for operation and maintenance
- Significant permitting and water quality monitoring requirements
- Much greater energy use and GHG emissions

Elimination of Bay Discharges

Should all treated effluents and CSDs be discharged to the ocean only?

Modeling has shown that citywide peak wet-weather flows would exceed the SWO capacity and therefore would require construction of a second ocean outfall. Conveyance of the SEP dry-weather effluents to the SWO and eliminating the Southeast Bay Outfall dry-weather discharge was considered a feasible option. As a variant, part or all of the SEP treatment could be relocated to the west side (most likely to the OSP site), depending on site availability. Wet-weather discharges can be reduced by implementing stormwater harvesting and LID elements.

Key considerations include:
- Peak wet-weather flows would exceed SWO capacity, requiring an additional ocean outfall
- Bayside CSDs would not be completely eliminated, unless another outfall is built
- Associated wet-weather system upgrades would require very high estimated construction costs

Also, eliminating wet-weather discharge at the North Point Outfalls would have fairly low feasibility for the following reasons:
- Difficulty constructing a 150-mgd conveyance alignment from the North Point Wet-Weather Facility to the westside
- High pumping energy consumption
- Significant investment in a conveyance facility that would only be used 200 to 500 hours per year

Relocation of Bayside Flows from the SEP

Should the current configuration of bayside treatment facilities be altered to either completely eliminate facilities at 750 Phelps Street or reduce the volume of flow treated at this location?

Because the useful life of the SEP liquid treatment facilities extends beyond the SSMP planning horizon, at this time the SEP should be retained and brought to a state of good repair. Odor control and architectural and landscape improvements will minimize or eliminate local community impacts of the treatment facility. In the future, when the SEP facility needs to be replaced, the system configuration would be evaluated and changed, as needed, to meet the goal of sustainability.
Projected Wastewater Flows and Loads

An important element of every wastewater master plan is an understanding of the quantity of wastewater that will have to be conveyed, treated, and discharged over the period for which the sewer system is being planned. The purpose of this section is to present predictions of these sewage flows and pollutant loads.

Population Projections

The long-term water demands study titled “Retail Water Demands and Conservation Potential Report” (Hannaford, 2004; henceforth referred to as “Demands Report”) provided the basis for making population-based wastewater projections. The Demands Report’s predictions were based on the San Francisco Planning Department’s population projections documented in the Land Use Allocation 2002 Report (San Francisco Planning Department, 2002) which in turn was based on the Association of Bay Area Government’s “Projection 2002” Report (Association of Bay Area Governments, 2001) for the city’s household population and number of jobs. The Retail Water Demands and Conservation Potential Report further extends the Land Use Allocation 2002 projections to 2030 by linear extrapolation.

Residential population and employment data from the Demands Report by watershed area for 2000 and 2030 are presented in Table 2-4. Based on the more recent projections published by the Association of Bay Area Governments, somewhat higher growth levels are predicted for San Francisco (Association of Bay Area Governments, 2004 and 2006). The San Francisco Public Utilities Commission (SFPUC) will review subsequent projection updates when they are adopted by the Planning Department.

Water Demand Projections

Water demand and population estimates from the Demands Report were used to calculate per capita residential and non-residential demands. These were then used to estimate the residential and non-residential water demands. A simplified version of the water demand model used in the Demands Report was used to calculate water uses in the city as follows:

\[
\text{Total Water Demand} = \text{Residential Demand} + \text{Non-Residential Demand} + \text{Other Demand} + \text{Unaccounted-for Water (Losses)}
\]

Because of the availability of census data, the year 2000 was used as the base year for current conditions. The year 2000 per capita residential and non-residential demands were 63.5 and 44.5 gal/person-day, respectively. The year 2030 per capita residential and non-residential demands were 50.5 and 43.0 gal/person-day, respectively.

<table>
<thead>
<tr>
<th>Watershed Area</th>
<th>Residential Population (number of people)</th>
<th>Employment (number of jobs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2030</td>
</tr>
<tr>
<td>Bayside</td>
<td>536,000</td>
<td>618,000</td>
</tr>
<tr>
<td>Westside</td>
<td>220,000</td>
<td>230,000</td>
</tr>
<tr>
<td>City Total</td>
<td>756,000</td>
<td>848,000</td>
</tr>
</tbody>
</table>

Notes: Totals may not equal the sum due to significant figure rounding.
significant decrease in per capita residential demands is projected by 2030, because of gradual market penetration of low-flow plumbing fixtures. The total water demands (Residential Demand, Non-Residential Demand, Other Demand, and Unaccounted-for Water (Losses)) for 2000 and 2030 were 84.5 million gallons per day (mgd), and 83.7 mgd, respectively (Table 2-5). Thus, the total San Francisco water demand is predicted to remain unchanged from its current level.

Wastewater Flow and Load Projections

Wastewater flow and load projections were developed based on population projections and water demands through 2030. The water demand projections were consistent with those used for planning future water supply needs for the City.

Projected 2030 Average Dry-Weather Flows

Average dry-weather wastewater flow projections for the city were calculated from the water demands using a historical ratio\(^5\) of wastewater flow to water demand. The projected 2030 average wastewater flow for the City was 80.2 mgd (Table 2-6) based on the 2030 total projected water demand flow of 83.7 mgd.

In addition to the wastewater flows generated in the city, the sewer system currently receives and treats flows of approximately 1.65 mgd from three other agencies. The 2030 projected flows from these agencies is estimated at 6.61 mgd: 0.79 mgd from the North San Mateo County Sanitation District, 5.0 mgd from the Bayshore Sanitary District, and 0.78 mgd from the City of Brisbane.

In addition to wastewater flow, there is bay water infiltration into the sewers on the bayside. The bay water intrusion value of 2 mgd is an estimate based on the chloride levels in the SEP influent.

\(^5\) The city’s historical water usage and dry-weather wastewater flow from 1998 to 2004 were compared. The wastewater flow ranged from 85% to 95% of the water usage. As a conservative measure, a 0.95 wastewater-to-water ratio is used to estimate the future wastewater flows.

<table>
<thead>
<tr>
<th>Table 2-5. Projected San Francisco Water Demands for 2000 and 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand Category</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Residential</td>
</tr>
<tr>
<td>Nonresidential</td>
</tr>
<tr>
<td>Unaccounted-For</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Notes: Presidio National Park flows not included for 2000 and 2030 water demand estimation, as they have their own water supply.

<table>
<thead>
<tr>
<th>Table 2-6. Average Dry-Weather Wastewater Flows for 2000 and 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Watershed Area</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Bayside</td>
</tr>
<tr>
<td>Westside</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Notes: Presidio National Park flows included for 2000 and 2030 wastewater flow estimates; Totals may not equal the sum due to significant figure rounding.
The projected dry-weather wastewater flow for 2030 is 88.7 mgd that is approximately 6.7% higher than the 2000 wastewater flow of 83.1 mgd. All of the projected flow increases are on the bay side. Table 2-6 presents the total wastewater flow projections for 2030, including other agencies and estimated bay water intrusion.

Pollutant Loadings

Conventional pollutants were projected using per capita influent loading. As the city has a significant non-residential population that is anticipated to grow, an “equivalent population” was used to factor in pollutant contributions from both residential and non-residential populations. The 2000 equivalent population and flow were used to calculate per capita loads. These per capita loads are assumed to remain constant. The 2030 pollutant loads and concentrations were then calculated using projected populations, per capita loads, and wastewater flows. Current and projected wastewater loads are presented in Tables 2-7 and 2-8.

Contributions from outside dischargers were estimated assuming their pollutant concentrations remain at the current levels.

In the SSMP planning period, the City is expected to see a 12% increase in residential population and 23% increase in employment. Most of the increases would be located in the Bayside Watershed. However, the future dry-weather wastewater flow is expected to only increase modestly, due to the projected reduction in per capita water usage. On the other hand, the future pollutant loads would reflect the population trends more directly and show more significant increases. The Bayside Watershed area would see most of these increases.

The projected dry-weather flows and loads are within the design capacities of existing bayside and westside treatment facilities. They will also form the planning parameters, along with wet-weather capacities, for any new or relocated treatment facilities developed in the SSMP.

### Table 2-7. Average Dry-Weather Pollutant Concentrations and Mass Loads for 2000

<table>
<thead>
<tr>
<th>Watershed Area</th>
<th>Concentration (mg/L)</th>
<th>Mass Load (ppd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TSS</td>
<td>BOD₅</td>
</tr>
<tr>
<td>Bayside</td>
<td>267</td>
<td>251</td>
</tr>
<tr>
<td>Westside*</td>
<td>267</td>
<td>251</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

*Notes: *Bayside TSS and BOD₅ concentrations are used to estimate Westside Watershed concentrations due to Westside Watershed influent sampler difficulties.*

### Table 2-8. Projected Dry-Weather Pollutant Concentrations and Mass Loads for 2030

<table>
<thead>
<tr>
<th>Watershed Area</th>
<th>Equivalent Population (number of people)</th>
<th>Concentration (mg/L)</th>
<th>Mass Load (ppd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TSS</td>
<td>BOD₅</td>
<td>TKN</td>
</tr>
<tr>
<td>Bayside</td>
<td>744,000</td>
<td>304</td>
<td>285</td>
</tr>
<tr>
<td>Westside</td>
<td>211,000</td>
<td>333</td>
<td>313</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>955,000</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
Regulatory Considerations

Currently, all treatment plant discharges are in full compliance with permit requirements; however, several existing and developing regulatory programs, regulatory policies, and constituents of emerging concern may change these requirements during the implementation period of the SSMP. A number of these concerns are identified below.

Relocate or Eliminate CDSs

There is language in the 2009 Oceanside Permit to assess techniques (including green infrastructure and low impact development) to eliminate or relocate CSDs from sensitive areas and discuss the level of treatment that would be required for any remaining CSDs to meet water quality standards.

Monterey Bay National Marine Sanctuary

Primary treated wastewater and CSDs are allowed to be discharged into an exclusion zone established in the Monterey Bay National Marine Sanctuary by a Memorandum of Agreement between National Oceanic and Atmospheric Administration (NOAA) and U.S. Environmental Protection Agency, State Water Resources Control Board, and the San Francisco Regional Water Quality Control Board. If it is found that discharges compromise the beneficial uses of Monterey Bay National Marine Sanctuary, NOAA could require additional treatment. If the exclusion zone were to be eliminated, San Francisco could be required to treat all discharges (including wet-weather primary-treated effluent and nearshore CSDs) to secondary levels.

Total Maximum Daily Loads

The WWE must continue to engage in the development of Total Maximum Daily Loads for San Francisco Bay receiving waters and sediments to prepare for upcoming wastewater and stormwater allocations.

Dioxin Toxic Equivalent

Dioxin Toxic Equivalent (TEQ) is the only pollutant of concern that presents a compliance challenge for the SFPUC during the current permit cycle for the 2008 Bayside Permit. Dioxin-TEQ is considered a storm-generated pollutant because rain events not only transport the atmospherically deposited pollutants on city streets into the sewers, but also facilitate the transport of pollutant particulates remaining in the atmosphere. The permit requires that the SEP effluent achieve compliance (mass loading must not exceed 1.6 mg/year) with the Dioxin-TEQ limit by June 30, 2012. The WWE is beginning to implement stormwater best management practices that can be utilized in an offset plan in combination with source control measures that will show a sufficient reduction in Dioxin-TEQ-contaminated flows to the combined sewer system to meet the requirements to demonstrate a reduction in dry-weather Dioxin-TEQ loading to the facilities.

Nutrient Loadings to the Bay

The impacts of nutrient loadings to the San Francisco Bay, including loadings from wastewater treatment plant effluents, are not fully understood; however, it is known that nutrients play a key role in the phytoplankton ecology of the San Francisco Bay. Given this uncertainty, longer-term master planning considerations should include adequate flexibility to address ammonia and nitrogen loadings to the bay.

 Constituents of Emerging Concern

 Constituents of emerging concern include several categories of compounds such as endocrine disrupting chemicals (EDCs) and nanomaterials. EDCs are hormonally active compounds that disrupt the hormonal system. Nanomaterials are materials with dimensions in the nanometer range, which are produced by nanotechnology. Currently, it is a matter of speculation whether regulations will be developed for constituents of emerging concern.
Class B Biosolids

The application of Class B quality biosolids to agricultural land does not appear to be a sustainable biosolids management practice for wastewater agencies that serve large urban areas. It is therefore prudent for San Francisco to focus efforts on creating higher-quality biosolids products (Class A) that are more readily accepted by the communities that receive and use them. As a longer-term strategy, exploring the production of a marketable biosolids product that bears little resemblance to biosolids cake may help to open more outlets and/or markets for biosolids reuse.

Greenhouse Gas Emissions

According to the Bay Area Air Quality Management District Greenhouse Gas Emissions Source Inventory of the Bay Area (Bay Area Air Quality Management District, 2002), if the current increasing emissions trend continues, Bay Area GHG emissions are expected to increase at a rate of 1.4% per year. New regulations have been recently issued to address GHG emissions in California and in the San Francisco Bay Area in particular. In 2004, the SFPUC and the San Francisco Department of the Environment created the “Climate Action Plan” (San Francisco Department of the Environment, 2007). This project describes the steps local agencies and San Francisco residents should follow to reduce the City’s annual GHG emissions (measured in carbon dioxide equivalents) by more than 2.5 million tons by 2012.

In 2006, the California State Assembly passed AB 32, the California Global Warming Solutions Act of 2006 (California Climate Change Portal, 2007). This bill contains targets that limit nonbiogenic sources of GHG emissions in California. The SFPUC is a member of the California Climate Action Registry and currently reports its direct and indirect GHG emissions based on power and gas consumption to the registry. The full implications of this legislation to the SFPUC are not well defined at this time and need to be further evaluated.
Chapter 3
Collection System

San Francisco has effectively managed its wastewater collection system and treatment facilities for many years, upgrading them at key points through a series of planning efforts and master plans. The success of the previous planning efforts can be gauged from the recognition that the treatment facilities have received including numerous National Association of Clean Water Agencies awards. In the current master planning effort, the San Francisco Public Utilities Commission (SFPUC) has recognized that continuing “business-as-usual,” although successful in the past, will not result in the sustainable city that it is hoped San Francisco will become. A new direction and a new approach are required. The collection system challenges and planning recommendations for the sewers, tunnels, transport/storage (T/S) structures, combined sewer discharge (CSD) structures, pump stations, and force mains are presented and discussed in this chapter. Wastewater treatment and biosolids and energy management are considered in Chapter 4. The proposed plans for implementing the recommendations presented in this chapter are discussed in Chapter 5.
Challenges

The City’s combined sewers (36 inches or less) range in age from newly installed to over 100 years old, with almost 59% over 70 years old and 10% 106 years or older (Table 3-1). Improvements to the collection system must address: the aging infrastructure, the system deficiencies, operational efficiency, and community impacts.

Aging Infrastructure

The two principal issues related to aging infrastructure are: structural integrity and seismic reliability.

Structural Integrity

Structural defects in the underlying sewers are causing an increasing number of “sinkholes” in streets throughout San Francisco (Figure 3-1). Based on empirical data from Department of Public Works (Figure 3-2), the failure rate for sewers increases with the age. The useful life standard for sewer system structures is given in Table 3-2. Current SFPUC funding only allows for a sewer replacement cycle of more than 200 years.

Seismic Reliability

The main seismic problem areas and challenges derived from geotechnical evaluation include:

- Portions of the 66-inch Channel Force Main (located between Islais Creek and the Mission Creek Channel) have failed four times (once in 1989 during the Loma Prieta earthquake) and are vulnerable to the effects of liquefaction in the event of a future major earthquake.
- Portions of the North Point Main, which carries combined flow from the Upper Channel area by gravity to the Jackson T/S are susceptible to the effects of liquefaction in the event of a major earthquake.
- The Marina Boulevard T/S structure could experience lateral deformations in the range from 6 inches to 3 feet in the event of a major earthquake.
- Although the effect of liquefaction should not affect the Fifth and Sixth Street sewers, the many connector sewers that run in the east-west direction and tie into the Fifth and Sixth Street sewers could be damaged due to the effects of liquefaction in the event of a major earthquake.

System Deficiencies

The principal system deficiencies are related to the impacts of climate change. These impacts include flooding and bay water intrusion. Sea level rise and changes in storm intensity and frequency will aggravate these impacts.

Flooding

Low-lying areas in San Francisco that are at most risk from flooding include portions of nearly all of the bayside fill areas (e.g., Mission Bay, South of Market, Candlestick Point State Recreation Area, Heron’s Head Park, and some areas around the Southeast Water Pollution Control Plant — SEP). For more discussion of flooding see the Stormwater Management section below.

<table>
<thead>
<tr>
<th>Year Built</th>
<th>Age (years)</th>
<th>Length (miles)</th>
<th>Sewers 36 Inches or Less (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860 – 1900</td>
<td>108 – 148</td>
<td>78</td>
<td>10</td>
</tr>
<tr>
<td>1901 – 1940</td>
<td>68 – 107</td>
<td>385</td>
<td>49</td>
</tr>
<tr>
<td>1981 – present</td>
<td>0 – 27</td>
<td>105</td>
<td>14</td>
</tr>
<tr>
<td>Unknown</td>
<td>–</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>–</td>
<td>781</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 3-1. Example of a Sinkhole due to Sewer Pipe Collapse

Figure 3-2. Sewer Ages and Failure Rates
### Sea Level Rise

Rising sea level is already having a noticeable impact on the collection system. During extreme high tide events, bay water overtops some of the CSD weirs (Figure 3-3) and backflows into the collection system. This results in a reduction in T/S system storage capacity and additional flow that must be treated and discharged. If the future sea level rise follows the higher estimates, then the mean higher high water tide will overflow the lowest CSD weirs daily by the year 2050. This will result in upstream flooding during coincident high tides and storm events.

### Design Storm\(^1\) for Collection System Design

Based on the last 30 years of rainfall data, it was decided to retain the currently used design storm intensity-duration-frequency curves for the current Sewer System Master Plan (SSMP) planning period. However, both sea level rise and changes in storm intensity and frequency require an ongoing reevaluation of the City’s design storm. (BCM Joint Venture, 2009a).

### Operational Efficiency

#### Stormwater Management

The design criterion for combined sewer collection systems has generally been to provide sufficient stormwater collection capacity to prevent flooding. Changes in the patterns of city development, such as the addition of newly developed areas in old industrial zones, have resulted in reduced infiltration, with a concomitant increase in runoff. These changes have increased the volume of stormwater that enters the collection system and in many cases, flooding has resulted.

Flooding problems in San Francisco can be caused by either “systemic” or “local” issues. Systemic issues are due to major trunk line constrictions, subsided ground conditions, or higher outlet conditions that cause widespread, severe problems. Local issues are due to sewer line constrictions that affect small areas.

The current collection system design standard, memorialized in the Subdivision Regulations (San Francisco Department of Public Works, 1982), is to provide for drainage below the street level for storms up to the 5-year storm (20% chance of occurring in any year or 0.74 inches per hour). Also, according to this standard, streets should be designed to provide a transport channel for the overland or surface flow in excess of the 5-year storm capacity of the collection system (i.e., street slope design and curb height).

Several factors that influence sewer and street flow capacity could enhance the risk of flooding problems. These include:

- **Changed land use conditions** – San Francisco sewers were designed to accommodate peak flows from undeveloped vegetated upstream areas. However, as the city population grew, these areas were developed and the amount of impervious surface and runoff both increased significantly.

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\(^1\) A design storm is a rainfall event of a specified size and return frequency that is used to calculate the runoff volume and peak discharge for a given area. Design storm information is pertinent to both collection system and treatment plant design and operation and is usually expressed as a storm that has a likelihood of occurrence once every specified number of years.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sewers</strong></td>
<td></td>
</tr>
<tr>
<td>• Vitrified Clay Pipe</td>
<td>50 - 100</td>
</tr>
<tr>
<td>• Reinforced Concrete</td>
<td>50 - 100</td>
</tr>
<tr>
<td>• Cement Lined Ductile Iron</td>
<td>50 - 100</td>
</tr>
<tr>
<td><strong>Force Mains</strong></td>
<td></td>
</tr>
<tr>
<td>• Coated Steel</td>
<td>30 - 50</td>
</tr>
<tr>
<td>• Reinforced Concrete</td>
<td>30 - 50</td>
</tr>
<tr>
<td>• Reinforced Concrete Cylinder</td>
<td>30 - 50</td>
</tr>
</tbody>
</table>

Source: Code of Federal Register 40 CFR Ch.1 (7-1-00 Edition) ft. 35, subpt. E, App A
• **Subsidence** – Structures built in low-lying areas on bay fill have subsided to levels that are below both the City’s official grade and the hydraulic grade of nearby sewers. This makes them susceptible to flooding and drainage problems.

• **Reduction in pipe capacity** – Grit and debris deposition and the accumulation of biological and chemical constituents on the pipe walls have led to decreased sewer capacity in some locations.

• **Blockage of historical overland drainage** – The functional changes to some roadways (i.e., paving, bus/rail public transport and curb/gutter reconfiguration) has resulted in unintentional changes in drainage patterns. These changes can increase risks of stormwater pooling and inundation of properties adjacent to the roadways. A graphic example of this is the effect of the construction of Interstate 280 in the 1960’s. This freeway cut off the natural downstream channel and created a dam that traps the overland flow from the Upper Alemany Drainage Area and causes severe localized flooding.

**Combined Sewer Discharges**

Even though the current collection system performance complies with (and indeed, exceeds) both the City’s long-term CSD control plan and the requirements of the National Combined Sewer Overflow Control Policy (U.S. Environmental Protection Agency, 1994), members of the public (through the public opinion survey and the SFPUC Citizens’ Advisory Committee) and SFPUC Commissioners have expressed a desire to improve the quality and/or reduce the frequency and volume of CSDs. Concerns center on the impact of CSDs on the ecological health, water quality, and recreational uses of the bay and ocean. Significant issues are pollution from bacterial contamination, regulated pollutants, constituents of emerging concern, and trash. In addition to the public concern, the 2009 Oceanside National Pollutant Discharge Elimination System (NPDES) Permit requires the SFPUC to reduce CSDs.
System Permit contains language requiring the City to assess techniques (including green infrastructure and low impact development — LID) that would eliminate CSDs or relocate them from sensitive areas.

Community Impacts

Flood control and odor control are of particular significance to the community.

Flood Control

Incidences of flooding are public nuisances and safety hazards. Changes in land-use patterns over the last several years have resulted in permeable land surfaces becoming more impervious decreasing stormwater infiltration and increasing surface runoff. Areas of subsidence within the system service area are prone to flooding due to various operational efficiency issues. These issues are discussed under stormwater management on page 3-4.

Odor Control

Odors emanating from the collection system impact many neighborhoods throughout the city. Complaints are tracked by the SFPUC and the Bay Area Air Quality Management Board and mitigated by City staff. Current methods of odor remediation include chemical addition, preventative maintenance, operational procedures, and ventilation. Long sewage detention times within the collection system promote the growth of anaerobic bacteria that transforms the organic sulfur compounds in sewage into noxious hydrogen sulfide (H2S) gas. This odorous air is then released when the following conditions are present:

- Turbulence within the sewers and T/S structures
- Damaged catchbasins (i.e., broken or missing odor traps)
- Abrupt change of sewer slope (e.g., differential pipe settlement)
- Debris build-up from restaurant fats, oil, and grease
- Poor initial construction

Recommendations

The challenges identified above will be addressed by the Sewer System Improvement Program through significant investment in the collection system. Taken as a whole, these improvements will make the sewer infrastructure a sustainable city amenity and will meet all of the SSMP goals and objectives for the collection system.

Aging Infrastructure

The current annual rate of expenditure on collection system renewal and replacement provides for a sewer replacement frequency of less than 0.5% per year. With this level of expenditure, sewers, on average, would be required to last for 200 years (an unreasonable expectation). This underfunding has allowed the average age of sewers to rise, leading to an increasingly frequent need for spot repairs and emergency replacement work. If the current rate of expenditure were to continue through the SSMP planning period (to 2030), nearly 78% of the sewers will be at least 100 years old. Without a better funded renewal and replacement program the City will have to endure an increasing number of street sinkholes requiring emergency repair. This will further compound the problem of trying to catch-up on the backlog of scheduled replacement projects.

Collection System Rehabilitation

A key SSMP recommendation includes increased consistent investment in collection system renewal and replacement over the SSMP planning period and beyond.

Structural Integrity/Seismic Reliability

The SSMP collection system rehabilitation recommendations would bring the City’s major sewer lines, brick sewers, tunnels, and T/S structures into a state of good repair, helping to meet SSMP objectives related to system flexibility and reliability and seismic reliability (BCM Joint Venture, 2009b).
System Deficiencies

To address the flooding in low-lying areas impacted by subsidence, small local pumps stations will need to be installed (e.g., Shotwell) (See Stormwater Management section on page 3-8).

As a result of climate change, bay water will eventually flow into the collection system every day on high tides. This will develop into a major collection system deficiency. SSMP recommendations, which rely on adaptive solutions for addressing climate change issues, are given below.

Mitigation of Climate Change Impacts

For the SSMP planning period, the collection system can be protected from sea level rise by installing backflow tide valves at the CSD weirs (Figure 3-4). This will prevent bay water from intruding into the collection system during high tide. If sea level rise predictions are fully realized, a long-term change in infrastructure and operations strategy will be needed.

Impact of Climate Change on the Design Storm

Continued study is needed to determine the extent and impact of predicted changes in precipitation patterns (i.e., intensity and duration of storms) as a result of climate change. The results of these studies will determine whether it is possible to continue using the current design storm intensity-duration-frequency curves for collection system design or whether a change in design storm characteristics is required (see Chapter 6).

Operational Efficiency

SSMP recommendations for stormwater management and the control of combined sewer discharges are presented below. Priority has been given to projects that reduce the risk of impact on public health, public safety, property loss, and property values. Localized flooding problems should be considered when designing system improvements for smaller areas and sewers. Some local flooding problems may be alleviated by the current practice of increasing sewer size when existing sewers are replaced.

Stormwater Management

Implementation of the SSMP stormwater management recommendations will reduce flooding by targeting problem areas, prioritizing flood relief projects, optimizing existing facilities, and modifying existing facilities where needed. In addition to flood control, overall system improvement needs should be evaluated to exploit the City’s investment in its existing infrastructure. Specifically, it is recommended that the collection system should be mapped to determine where inadequacies exist and that street curb design standards should be enforced. The overall approach to stormwater management should include the following approaches.

Figure 3-4. Example of Backflow Prevention Device on Sunnydale Outfall
Identify Projects for Capital Improvement

An expanded capital improvement program for stormwater management projects should be implemented to correct flooding problems that are not currently funded. The information from the flooding hotline should be combined with ongoing collection system modeling to assist the Wastewater Enterprise (WWE) in refining specific areas for implementation of improvement projects. Examples of such projects include small pump stations to relieve flooding in low-lying areas and replacement of “bottlenecks” or flow restrictions. Chronic flooding problems exist in several areas including:

- Upper Alemany Drainage Area
- Sunnydale/Visitacion Drainage Area
- Mission District Drainage Area
- Channel Drainage Area
- Richmond Drainage Area

Low Impact Development

LID is a key component for effective stormwater management due to its efficient use of natural resources, reduced use of chemicals, multifunctional designs, and neighborhood-enhancing qualities.

The recommended collection system replacement projects include an analysis protocol for assessing the opportunity for LID for these projects. Implementation of LID by the WWE requires both capital and management improvements, including an ongoing effort to quantify the costs and benefits of an LID approach and the development of a comprehensive program for flood reduction.

LID can also be used to address some neighborhood flooding and provide neighborhood greening. Implementation of LID by the WWE will achieve flooding relief through:

- Identifying LID opportunities through integrated urban watershed planning
- Providing project review and technical assistance to foster LID implementation in new and redevelopment projects
- Developing demonstration projects within San Francisco to study and monitor the benefits of LID and educate the citizenry
- Encouraging use of LID in both public and private projects
- Providing sufficient funds and staffing for proper operation and maintenance of LID projects
- Developing ordinances and creating incentives for LID

In addition, it may be possible through LID to provide on-site storage of stormwater that could be used for nonpotable uses. This type of rainfall and stormwater harvesting (see Chapter 6) and reuse would provide a local source of nonpotable water as well as reducing stormwater inflow to the collection system.

Routine Sewer Cleaning

Maintaining the full cross-sectional area of the sewer is an important part of flood control. More frequent sewer cleaning will help remove settled grit and solids and maximize the available sewer conveyance volume.

Adequate cleaning efforts are required for compliance with the National Combined Sewer Overflow Control Policy Nine Minimum Controls (U.S. Environmental Protection Agency, 1994). Funds must be provided for cleaning of T/S structures and for the de-rooting and cleaning of easement sewers. These activities will also require additional funding for collection system inspection that is a necessary component of a well-managed cleaning program.

Reduction of Combined Sewer Discharges

The SSMP Project Team recognized the need to plan for reducing CSD impacts on the receiving waters. Depending on the final implementation plan, the following types of improvements may be incorporated:

- Implementing LID techniques to reduce the total quantity and the peak flow rate of
stormwater entering the combined sewer system and desynchronizing the storm peaks

- Increasing storage capacity in upstream sewers, T/S structures, and tunnels through new construction and the increased sewer capacity reclaimed by a robust sewer cleaning program
- Implementing real-time control to better manage stormwater flow and maximize existing system capacity
- Increasing pumping and treatment and discharge capacities at the existing treatment facilities
- Transferring flows from heavily impacted watersheds to existing facilities that have underutilized treatment capacity (e.g., shifting dry-weather flow from the Bayside Watershed to the Oceanside Water Pollution Control Plant for treatment and/or ocean discharge)
- Relocating CSDs from highly sensitive beaches to more remote locations
- Testing of screening systems to improve trash removal from CSDs

Community Impacts

SSMP recommendations for flood control have been given in the previous section on stormwater management. The SSMP recommendations for odor control are presented below.

A vigorous and sustained implementation of the current collection system odor control measures is strongly recommended by the SSMP. These measures include:

- Improving sewer cleaning and inspection schedules, with an emphasis on problem areas to reduce nuisance odors
- Expanding the new fats, oils, and grease reduction program to reduce sewer blockages that can lead to odor production
- Improving management and control practices, including catchbasin and manhole modifications to improve access for cleaning sewers and T/S structures
- Continuing the chemical injection program to address localized problem areas

Overall Collection System Management Improvements

In addition to funding the specific collection system activities mentioned above, it is necessary to also provide adequate funding for the routine support activities of the collection system operations. These support activities include investigation of problems/complaints related to flooding or sewer failure, street cleaning, sewer inspections, data collection, and database maintenance. The last two items are required to support the asset management program (see Chapter 5) and to prioritize sewer system projects.

Future development (and redevelopment) should not exacerbate existing flooding problems. New development should be required to manage stormwater runoff in a fashion that minimizes its impact on the collection system. The SFPUC can achieve these objectives by conducting an early review of development proposals for their impact on the collection system and by working proactively with project planners and developers to accommodate or mitigate project impacts on the collection system and the treatment plant facilities.

Summary of Recommendations

Implementation of the SSMP specific recommendations, along with changes in City policies, will effectively address the major existing vulnerabilities of the SFPUC collection system and will address collection system challenges during the SSMP planning period. A schematic of key collection system improvements is provided in Figure 3-6.
Comparison to Goals and Objectives

All of the collection system component recommendations have been selected to help meet SSMP goals and objectives. New facilities should be designed and built to meet the latest seismic standards so that the seismic reliability of the collection system is improved. System reliability and flexibility will be addressed by replacing sewers that have reached the end of their useful life and by new collection system infrastructure to prevent flooding. Enhanced stormwater and odor control programs, and procedures to minimize flows will reduce the negative community impacts of this ubiquitous City infrastructure.

Figure 3-5. Overview of Collection System Recommended Improvements
Chapter 4

Treatment, Biosolids, and Energy

The City of San Francisco owns and operates three wastewater treatment facilities: (1) the Southeast Water Pollution Control Plant (SEP), (2) the North Point Wet-Weather Facility (NPF), and (3) the Oceanside Water Pollution Control Plant (OSP). Each treatment facility has one or more outfalls for dispersing the treated effluent into San Francisco Bay and the Pacific Ocean. The treatment facilities have received numerous awards including the 2004 U.S. Environmental Protection Agency National Clean Water Act Recognition Award for Operations and Maintenance Excellence at the Oceanside Water Pollution Control Plant. An integral part of treatment of wastewater is the production of biosolids and the utilization and production of energy, both of which are critical elements in the development of the Sewer System Master Plan (SSMP). The challenges and planning recommendations for the treatment facilities, biosolids management, and energy usage and production are presented and discussed in this chapter. The proposed plans for implementing the recommendations presented in this chapter are discussed in Chapter 5.
Wastewater Treatment Facilities

Treatment Facilities Challenges

Both the SEP and the NPF were built over 50 years ago and many of the challenges are related to aging infrastructure. Based on the useful life industry standard estimates for treatment plant components given in Table 4-1, several of the key process units at these facilities are in need of complete replacement. Some of the technology employed by these processes is outdated and the structural integrity of some of the units is compromised. The design standards that governed the construction of the SEP did not take into account current concepts for mitigating negative impacts on the surrounding community. Even the OSP, which is the most recently-constructed treatment facility in the city, is experiencing the effects of deferred maintenance and its operational efficiency and reliability are being impacted.

Southeast Water Pollution Control Plant

The three major challenges at the SEP are: (1) aging infrastructure (especially the digester facility) (Figure 4-1), (2) operational efficiency (anaerobic digester capacity, Class B biosolids compliance, and the biogas system), and (3) community impacts (odors, visual impact). Each of these challenges is considered in the following discussion.

Aging Infrastructure

Most of the components of the current SEP biosolids digester facility have been in service for nearly 60 years which is well beyond their expected mechanical and structural life. This aging infrastructure clearly poses a very significant threat to regulatory compliance.

Operational Efficiency

Operating equipment installed during the expansion of the SEP in the early 1980’s has reached the end of its expected useful life and needs to be replaced within the next five to 10 years. Problems that have surfaced recently include:

- Screenings capture is incomplete and leads to debris accumulation in the anaerobic digesters.
- Grit removal is poor. Grit passes through the grit removal process into the primary sedimentation tanks where it causes excessive wear on process equipment and leads to frequent process stoppages from plugged lines.
- Oxygen-generation equipment, although operating satisfactorily uses energy inefficiently. It is anticipated that its maintenance costs will increase substantially in the near future.
- The antiquated secondary clarification equipment is inefficient, unreliable, and must be replaced soon to ensure continued serviceability of these essential units.
- The existing chlorination/dechlorination system does not allow for the reliable continuous monitoring of final effluent chlorine residual which may be required.

### Table 4-1. Useful Life Industry Standard Treatment Plant Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures</td>
<td></td>
</tr>
<tr>
<td>Plant buildings, concrete process tankage, pump stations</td>
<td>40 - 60</td>
</tr>
<tr>
<td>Process Equipment</td>
<td></td>
</tr>
<tr>
<td>Mechanical equipment (pumps, bar screens etc)</td>
<td>15 - 25</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td></td>
</tr>
<tr>
<td>Motor control center, Substations</td>
<td>15 - 25</td>
</tr>
<tr>
<td>Variable frequency drives</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Auxiliary Equipment</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Outfalls</td>
<td></td>
</tr>
<tr>
<td>Cement-lined ductile iron</td>
<td>50 - 100</td>
</tr>
<tr>
<td>Reinforced concrete</td>
<td>50 - 100</td>
</tr>
</tbody>
</table>

Source: Code of Federal Register: 40 CFR Chapter 1 (7-1-00 Edition) foot 35, subpart E, Appendix A
by the San Francisco Bay Regional Water Quality Control Board (RWQCB) in future National Pollutant Discharge Elimination System (NPDES) permits. Further, the use of chlorine-based disinfectants can result in the formation of disinfection byproducts some of which are known to have negative human and environmental impacts. The costs of sodium hypochlorite and sodium bisulfite, the chemicals used in the disinfection process, have risen significantly and, during the last few years, hypochlorite procurement from local vendors has become less reliable.

- Ensuring fully compliant anaerobic digestion requires constant staff attention and effort. Lack of automation, remote temperature sensing, and the deteriorated state of the mechanical and structural equipment, as well as the frequent need for cleaning, means that operating crews are constantly reacting to crises just to maintain the current modest sludge treatment goals.

- The biosolids centrifuges must be frequently taken off line for maintenance. This, together with the poor reliability of ancillary equipment such as feed pumps, limits the number of operable centrifuges available.

Community Impacts

When the SEP commenced operation in the early 1950’s, the surrounding neighborhood had many more industries, including slaughterhouses and tanneries. The character of the neighborhood was not inappropriate for locating a sewage treatment plant. Today, the SEP is surrounded by a much changed neighborhood consisting of a mixture of light industry and residential development (Figure 4-2). The negative impacts of the SEP are now significant and include:

- Plant odors have a major negative community impact and their control is a major operating issue at the SEP. Odors are the most frequent neighborhood complaint.
• Noise, including plant alarms, the intercom system, and truck traffic has been a source of complaints from the SEP neighbors.

• The main visual impacts from the SEP facilities are from the anaerobic digesters and the flare stack in the biosolids digester facility. These digesters are located directly across the street from houses. The SEP can be seen from nearby hillside neighborhoods and its “industrial appearance” is a constant reminder that there is a sewage treatment plant in the vicinity.

North Point Wet-Weather Facility

The NPF was constructed at about the same time as the SEP and it shares the same problems of aging infrastructure and outdated equipment. The community impacts (e.g., odor, noise, and truck traffic), while similar to the SEP, are limited since the NPF is a wet-weather-only facility, it does not have secondary treatment or solids handling processes, and NPF only operates 30 times per year (450 hours).

Oceanside Water Pollution Control Plant

Even though the OSP is the newest of the City’s treatment facilities, it is beginning to experience condition-related maintenance and operational problems. The OSP is located adjacent to the Pacific Ocean and some of the structures, such as the anaerobic digesters, are exposed to salt-laden marine air. This has caused premature corrosion. Together, a lack of routine preventative maintenance (caused in part by serious underfunding during a 6-year rate freeze), and the harsh marine environment, have started to take their toll on both the mechanical and the electronic equipment. This is making day-to-day plant operation more and more difficult. The OSP was designed to have minimal community impacts and, for the most part, it has performed up to expectations. Odors and noise primarily
impact the health and safety of the on-site employees (San Francisco Public Utilities Commission, 2003).

**Recommendations**

The recommendations for the City’s three treatment facilities include both infrastructure and management improvements. The implementation of these improvements will ensure seismic and operational reliability, adequate redundancy, increased automation, and sustainable operations.

**Southeast Water Pollution Control Plant**

The SSMP recommendations for the SEP center on capital projects that address the aging infrastructure and operational efficiency so that the plant will be returned to a state of good repair. In addition, odor control and architectural improvements will be instituted to address community impacts. By addressing the SEP’s most pressing needs, it is anticipated that the SSMP objectives related to community impacts and aging infrastructure will be met. The recommended upgrades include:

- Replacement of aging major process equipment, which has exceeded its useful life, with modern, more efficient, easily maintainable, and reliable equipment. The oxygen-generation system and the headworks are especially in need of attention.
- Odor control improvements to minimize fugitive odors that can negatively impact the surrounding community.
- Architectural and landscaping improvements to reduce the negative visual impact of the SEP and establish it as a community amenity.
- Evaluation of the replacement of secondary effluent chlorine-based disinfection with ultraviolet radiation disinfection to reduce the use of sodium hypochlorite in the plant and the presence of chlorination byproducts in the dry-weather effluent.
- Seismic and structural upgrades throughout the plant to minimize damage due to an earthquake.

- Electrical upgrades and energy-efficient equipment selection to reduce energy use and increase operational flexibility.
- Upgrades to the SEP biosolids digester facility are described in the Biosolids Management section on page 4-7.

**North Point Wet-Weather Facility**

It is recommended that the NPF should be rehabilitated to ensure its continued service for wet-weather treatment. Recommended improvements to the NPF include:

- Refurbishment of primary clarifiers
- New chemical facilities
- Odor control improvements
- Electrical upgrades and energy efficient equipment selection to reduce energy use and increase operational flexibility
- Seismic and structural upgrades to minimize damage due to an earthquake

**Oceanside Water Pollution Control Plant**

The SSMP recommended improvements to the OSP are needed to maintain the facility and its equipment in a state of good repair and to provide ease of operation. The recommendations include:

- Pretreatment process upgrade to provide additional grit removal so the system can continue to operate at its maximum capacity during wet weather.
- Refurbishment of the oxygen-generation facility.
- Rehabilitation of the gas handling system to ensure continued compliance with the air discharge permit.
- Electrical upgrades and energy efficient equipment selection to reduce energy use and increase operational flexibility.
- Upgrades to the OSP sludge handling facilities are described in Section 4.3.

**Treatment Plant Management Improvements**

Effective treatment plant management requires expenditures for support staff in Operations, Maintenance, Engineering, Labo-
ratory, and Administration. It is very important to provide adequate funding for these activities, since they are essential for an efficient and compliant operation.

Comparison to Goals and Objectives

The treatment facility needs are centered on the rehabilitation of aging and seismically vulnerable infrastructure and the reduction of negative community impacts, especially with respect to odors. The SSMP recommendations address all of the immediate infrastructure needs required to ensure continued compliant and reliable performance of the treatment facilities. Execution of the SSMP recommendations will address the goals and objectives of improving seismic reliability and flexibility and will reduce negative impacts on surrounding communities. The replacement of outdated equipment with modern energy efficient models will reduce facility energy demands and in turn enhance the sustainable use of natural resources and promote environmental stewardship. Key facility improvements will serve to protect worker health and safety by improving indoor air quality, by reducing exposure to treatment chemicals, and by replacing antiquated equipment with models that are easier to maintain. All of these recommendations will help to maximize the use and extend the life of existing facilities so that the financial impact on the ratepayers will be minimized.

Deepwater Outfalls

Deepwater Outfall Challenges

The challenges associated with the effluent outfalls are summarized in this section. Useful life industry standard estimates for the outfalls are presented in Table 4-1.

Southeast Bay Outfall

The Southeast Bay Outfall (SEO) is the main outfall for the SEP and has been in operation since 1969. It was originally designed for an average flow of 20 mgd and a peak flow of 70 mgd. In wet weather, up to 110 mgd (over 1.5 times the design capacity) is discharged through the SEO. Specific concerns with the SEO are:

- By the year 2030, the SEO will be over 60 years old. Based on U.S. Environmental Protection Agency guidelines, the nominal life of a marine outfall is 50 years. With proper maintenance, it has been observed that outfalls can remain in service beyond 50 years (BCM, Joint Venture, 2009c).
- The SEO current condition requires a thorough assessment. Deferring replacement or substantial rehabilitation by an indefinite period beyond 2030 could pose a substantial risk to reliable performance.

North Point Outfalls

The North Point Outfalls (NPOs) are normally used when the NPF is activated during wet weather to discharge primary effluent into the bay. The four outfalls have been in service for over 50 years and their age is an ongoing concern.

Southwest Ocean Outfall

The Southwest Ocean Outfall (SWO) was put into service in 1986. It was sized to allow discharge of effluent from the entire city (590 mgd). The SWO currently is used only for Westside Watershed discharge (maximum flow in wet-weather operations is 175 mgd). Specific concerns with the SWO are:

- The deposition of sediments in the diffuser section of the pipeline (as a result of the lower-than-expected flows) has reduced its capacity.
- Inflow of seawater to the diffuser section has exacerbated the problems of attached marine growth and sediment accumulation.

Recommendations

All of the outfalls should be inspected and evaluated to assess their condition and determine the need for repairs. Specific recommendations to ensure continued function through 2030 include:
• Near-term repair of the existing SEO
• Rehabilitation of NPOs if indicated by inspection
• Installation of backflow prevention devices on the active SWO diffusers to reduce seawater inflow
• Evaluate the rehabilitation or replacement of the SEO capacity near the end of the SSMP planning period

Comparison to Goals and Objectives
Returning the deepwater outfalls to a state of good repair will continue to promote environmental stewardship and maintain system reliability by ensuring deepwater dispersal of treated effluent and will extend the life of existing facilities so that the financial impact on the ratepayers will be minimized.

Biosolids Management
Biosolids are the solid material remaining after anaerobic digestion of the residuals produced by primary and secondary treatment. Currently, most wastewater agencies recycle biosolids through land application. This practice demonstrates the San Francisco Public Utilities Commission commitment to recycling and helps meet the California Integrated Waste Management Board requirements and City goals for diversion of waste from landfills (California Integrated Waste Management Board, 2009; San Francisco Board of Supervisors, 2002). The outlook for the continued use of land application for biosolids recycling is becoming increasingly uncertain, because of social, environmental, and regulatory concerns regarding this practice. The challenges and recommendations inherent to biosolids management are addressed in this section.

Biosolids Management Challenges
San Francisco’s current biosolids recycling practices face several challenges including:
• The anaerobic digesters that serve the SEP facility have been in service for well beyond their expected mechanical and structural life. Because of their condition, the SEP is at risk of not meeting Class B treatment (40 CFR 503) as required by its NPDES permit for reuse.
• As final effluent limits become more stringent, it is possible that the pollutant loading in the biosolids could reach levels that would further limit the options available for its reuse.
• Regulatory and environmental pressures on the practice of applying Class B biosolids to agricultural land application are increasing to the point where it may not be possible to continue current practices through 2030.
• The increasing regulatory pressures on the land application of biosolids will most likely lead to an increased demand for limited landfill space and increased costs.

Recommendations
The underlying principles of an effective and sustainable biosolids management program are to provide reliability and flexibility, to practice environmental stewardship, and to protect the public health and the environment. Implementation of the following recommendations will allow the San Francisco Public Utilities Commission (SFPUC) to achieve such a program:
• Construct a new biosolids digester facility to replace the antiquated SEP facility. This facility would produce high quality biosolids (Class A), enhance energy recovery, and meet the sustainability goal of the SSMP.
• Upgrade the OSP biosolids digester facility to produce Class A biosolids.
• Investigate new opportunities for the reuse of Class B biosolids.
• Increase the flexibility of biosolids disposal/reuse by using advanced biosolids processing methods, such as thermal drying.
• Expand ongoing regulatory compliance, training, and public outreach activities.
• Continue to participate in regional biosolids associations to keep abreast of new technology and innovation.
• Develop and implement a comprehensive Biosolids Environmental Management System.
• Continue to participate in the development of a regional biosolids project that would evaluate a number of different processing methods including some of the more recent waste-to-energy technologies.
• Provide adequate funding for the materials, support staff, and operating costs required to conduct an effective biosolids management program. These areas include operations, maintenance, engineering, laboratory, administration, chemicals, power, hauling, and reuse.

Comparison to Goals and Objectives

Current SFPUC biosolids management strategies are not sustainable. Implementation of the biosolids management recommendations, which include adoption of the management strategy and replacement of the SEP biosolids digester facility, will effectively address all of the major SSMP goals and objectives. A new facility will continue to meet the goals of protecting public health and the environment. It will be consistent with the goal of enhancing environmental stewardship while, at the same time, providing improved system reliability and flexibility and guaranteeing enhanced biosolids processing. A new facility will reduce adverse community impacts through a significant and consistent reduction in odor while replacing the most seismically vulnerable facilities at the SEP. Replacement of the antiquated SEP digesters and ancillary equipment will help protect worker health and safety by reducing the risks associated with the aging facility. Finally, while a new facility will have significant capital costs, prompt implementation of the recommendations and serious consideration of alternative locations for the facility will minimize the impacts on the ratepayers.

Energy and Power Management

The SFPUC Wastewater Enterprise’s (WWE) current energy and power management program consists of maximizing the renewable power produced by cogeneration facilities at the biosolids digester sites, installing solar photovoltaic cells on the roofs of WWE facilities, and implementing energy efficient lighting retrofits throughout all of its facilities.

Current and Future Challenges

The principal power and energy management challenge is to develop a systemwide plan that will minimize the energy use for and maximize the energy production from wastewater treatment.

Recommendations

The SSMP recommends that the WWE develop a comprehensive power and energy management program that builds on the current efforts to save power while exploiting its unique power generation opportunities. The proposed program should have three main components.

1. Maximize on-site renewable energy generation opportunities. The following activities are envisioned for all facilities:
   - Optimize operations to increase the production and use of anaerobic digestion biogas (methane).
   - Formalize a bioenergy subprogram for the development of renewable/alternative energy projects (i.e., Yellow Grease Collection Program, Brown Grease to Biodiesel, Organic Waste Digestion, Alternative/Renewable Energy Sources). This effort will have the added benefit of protecting the collection system infrastructure by retaining its capacity and reducing the frequency of blockages (Chapter 3, Operational Efficiency section on page 3–4).
   - Reduce fossil fuel consumption.
   - Create “green” jobs where possible.
2. Maximize energy efficiency at all facilities, in coordination with the SFPUC Power Enterprise. The principal steps that must be undertaken to implement this program are:
   - Use asset management to identify, prioritize, and replace aging, inefficient equipment at all WWE facilities.
   - Make information on energy consumption available to WWE staff through implementing an energy management system.
   - Employ Best Practices for design decisions and make energy efficiency a priority when evaluating technologies for all projects at WWE facilities. Equipment and lighting designs will balance maintenance, capital, and operating life cycle costs.

3. Use Leadership in Energy and Environmental Design (i.e., LEED) certification for all new buildings constructed and for existing buildings where feasible.

Comparison to Goals and Objectives

Implementation of the Energy and Power Management recommendations will support the SSMP goal of promoting environmental stewardship and enhancing sustainable use of natural resources by minimizing the use of grid power and the associated production of greenhouse gases.
Chapter 5
Implementation

The challenges and planning recommendations for the collection system and the treatment facilities were discussed previously in Chapters 3 and 4, respectively. The purpose of this chapter is to discuss the strategies for the implementation of the recommendations. Implementation of such an ambitious range of recommendations will involve a number of changes from past practices. The most comprehensive change is the adoption of Integrated Urban Watershed Management as the principal tool for planning and decision making. Other changes involve the use of asset management techniques, revisions of the capital improvement program, changes in the Wastewater Enterprise (WWE) management, and policy and code revisions. Each of these subjects is considered in this chapter. In addition, responses to regulatory changes and technological developments are also discussed.
Integrated Urban Watershed Management Approach

After careful consideration of the planning objectives and with the advice and direction of citizen and technical organizations and advisory groups (see Chapter 1), it was concluded that, rather than considering the sewer system in isolation, “Integrated Urban Watershed Management” should be used as the basis for implementing the Sewer System Master Plan (SSMP).

Overview

In Integrated Urban Watershed Management, the drainage basin is the central planning unit. Problems associated with the sewer system are addressed in the context of the entire drainage basin and the whole range of activities and opportunities available within it are examined. For example, if it was demonstrated that a section of the collection system had insufficient hydraulic capacity, the traditional planning approach would be to construct larger sewers. By applying the Integrated Urban Watershed Management approach the need to construct larger sewers would be considered together with evaluating opportunities in the watershed for reducing the quantity and flow rate of water entering the collection system by methods such as capture, storage, treatment, and reuse of stormwater. The use of an Integrated Urban Water Management provides more opportunity for sustainable solutions such as:

- Harvesting stormwater
- Improving water conservation and demand management
- Maximizing stormwater and wastewater reuse
- Increasing the use of Low Impact Development (LID) and green infrastructure
- Increasing the use of pollution prevention
- Maximizing use of renewable power
- Enhancing neighborhoods

Elements of Integrated Urban Watershed Management

The elements of an Integrated Urban Watershed Management approach include the entire sewershed and its management programs. The sewershed consists of:

- The streets and upland areas (including roofs) that contribute stormwater runoff
- The capture and conveyance system (streets, catchbasins and inlets; sewer laterals, trunk sewers, transport/storage (T/S) structures, and pump stations)
- The treatment and discharge system (treatment facilities, outfalls, and combined sewer discharge (CSD) structures)
- The receiving waters of San Francisco Bay and the Pacific Ocean

Management programs consist of activities such as:

- Source control programs that reduce pollutant input to the sewer system
- An LID approach that promotes the storage and detention of stormwater
- A Better Streets Plan that reduces pollutant input to the collection system through unified street design standards and guidelines
- A wastewater reclamation and reuse program that includes stormwater harvesting, water conservation, and groundwater reuse or recharge
- Enhanced public education on pollution prevention programs and stormwater management

Integrated Urban Watershed Management is a paradigm shift for the San Francisco Public Utilities Commission (SFPUC) that will require implementation of the following tactics:

- Build in system resiliency
- Look for opportunities to enhance sustainability. Use the triple bottom line (environmental, economical, and social impacts) to quantify costs, benefits, and risks of technically feasible projects
- Use adaptive learning and management
• Build *multipurpose infrastructure* projects that enhance neighborhoods
• Promote better *interagency cooperation*

**System Resiliency**

The sewer system today is the result of infrastructure choices made 100 years ago and, it is likely that, the decisions made now will also have long-term effects. Because of factors such as seismicity, climate change, and the uncertainty of energy and potable water supplies, it is incumbent upon the SFPUC to build systems that are both resilient and flexible.

**Sustainability and Triple Bottom Line**

Sustainability will be achieved by evaluating all projects that are technically feasible using “triple bottom line” criteria in which environmental costs and social and economic accounting are included.

The SFPUC will:
• Optimize the use of imported resources such as water and energy through conservation, reclamation, reuse, demand management, rainwater harvesting, and groundwater recharge, energy efficiency, alternative energy production, and materials and equipment selection.
• Provide a system that is supported by the ratepayers. Economic planning will include the ability to fund the system during economic downturns and a decrease of ratepayer revenue.

**Adaptive Learning and Management**

Resource management by the WWE should be adaptive and flexible. Adaptive learning involves monitoring the results of decisions and using this information to modify the original decision as necessary (Maimone et al., 2006). Inherent to effective adaptive learning will be ongoing monitoring (e.g., changes to rainfall patterns and sea level rise), determination of project efficacy (e.g., LID), and a robust, proactive WWE research, development and testing program for evaluating advanced treatment technologies for meeting possible future regulatory requirements.

**Multipurpose Infrastructure**

The Integrated Urban Watershed Management approach can provide opportunities for multipurpose infrastructure design that:
• Enhances neighborhoods by adding trees and by providing open space and green space
• Improves the drainage infrastructure performance by reducing runoff
• Provides opportunities for neighborhood involvement
• Enhances habitats
• Increases property values
• Enhances collaboration between City agencies that can result in cost-sharing and creative-problem solving

**Cooperation between SFPUC and City Agencies**

An Integrated Urban Watershed Management approach will require cooperation between the WWE and both internal (i.e., SFPUC Water and Power Enterprises) and external City agencies such as the Better Streets Coordination Team, the Department of Public Works, the Planning Department, the Mayor’s Office on Disability, and the Municipal Transportation Agency.

**Asset Management**

Asset management is a structured program that evaluates both the condition and the risk of failure of existing infrastructure (i.e., the collection system, treatment facilities, and outfalls). The current ad hoc, reactive “system” of responding to crises will be replaced with a formal asset management program that will be designed to reshape the life cycle cost of infrastructure assets by taking into account an acceptable level of risk, while continuously delivering established levels of service. Such a program will assist in project prioritization so that the most pressing needs of the sewer system are met.

A robust asset management program includes the use of:
- Geographical Information Systems to incorporate information about age, condition, and location of infrastructure assets
- System and facility modeling
- Computerized maintenance and operating procedures which include scheduled maintenance, and work plans
- Integrated technology

Effective asset management program implementation includes the use of:
- Investigations, assessments, evaluations, and prioritizations
- Decision-making tools
- Data management and predictive modeling applications

These processes provide for an iterative system whereby capital investments and operations and maintenance protocols are continually refined over time.

The anticipated benefits of implementing asset management include:
- A broader knowledge of WWE assets
- The ability to optimize maintenance activities, mitigate risk, prioritize projects and funding, and predict future demands
- Achieve sustainable system operation by implementing projects that meet the greatest needs of the system

Capital Improvement Program

The major capital projects that are required to make the vision of the SSMP a reality will be implemented through a coordinated capital program — the Sewer System Improvement Program (SSIP). A companion report details the development, level of service goals, and specific projects included in the SSIP.

Renewal and Replacement Program

Renewal and replacement (R&R) identifies those projects that maintain the existing systems and facilities. These projects range from strict replacement to major rehabilitation/redesign of process equipment to enhance performance or to extend the service life of a facility. Such costs tend to be recurring in nature. For successful implementation of the SSMP and to meet the goals and objectives, the renewal and replacement funding must be increased and maintained above current levels. In a manner similar to the capital improvement program, level of service goals will be developed for the R&R program.

Local Employment Opportunities

Implementation of the SSMP recommendations will provide San Francisco residents with a range of opportunities for employment from initial construction jobs through long-term career positions with the WWE for the operation and maintenance of the new treatment facilities. Enhanced investment in sewer replacement will be a steady source of construction work that is projected to continue for at least 30 years. Much of the new “green infrastructure” in upland neighborhoods will require regular maintenance to ensure continued serviceability which will result in new classes of “green jobs.” In addition, many of the bioenergy projects will require staff to ensure adequate collection and handling of non-traditional waste streams that again will be a new source of employment in the WWE.

Wastewater Enterprise Management

The WWE budget is currently aligned along divisional lines (i.e., operations, engineering, etc.). For the implementation of the Integrated Urban Water Management approach, it is recommended that the WWE define program areas, grouping the labor and operations and maintenance efforts, so that the budget can be presented along programmatic or functional lines (i.e., collection system,
treatment, and biosolids) and subdivided by watershed (i.e., Bayside and Westside).

Implementation of this budgeting method will:

- Improve the transparency of the WWE
- Allow ratepayers to readily understand the costs and benefits of the services provided
- Complement the Integrated Urban Watershed Management planning theme
- Facilitate interagency comparison

Policy and Code Revisions

Policy and code changes will be evaluated and developed. These changes will include:

- Re-establishment and enforcement of the “official grade” based on an appropriate hydraulic grade line to help in eliminating sewer backups into buildings during storms.
- Requirement for the use of individual backflow prevention devices where appropriate.
- Establishment of guidelines and requirements for LID.
- Reassessment of the adequacy of the Subdivision Regulations (San Francisco Department of Public Works 1982) in light of possible changes in storm patterns due to climate change to ensure that roads remain serviceable during future rainfall events. Changes to these regulations will lead to revision of sewer and roadway design standards for the entire city.
- Consideration of realigning street and main arterial ratings to ensure that major thoroughfares are not negatively impacted during extreme storm events.

Response to Regulatory Changes

The SSMP recommendations are based on the current and anticipated regulatory landscape. To effectively address regulatory developments, the WWE staff will continue to track pending regulatory changes during implementation of the SSMP recommendations through participation in industry groups (e.g. the Bay Area Clean Water Agencies, Tri-TAC) and through regular communication with regulatory agencies (e.g., the Regional Water Quality Control Board and the U.S. Environmental Protection Agency).

Technology Developments

Since the 1980s, the WWE has had a research program coordinated with the day-to-day plant operations. The WWE will continue to sponsor a robust research and development program for evaluating advanced treatment technologies to meet future regulatory requirements and to enhance the sustainability of the sewer system infrastructure. Thus, as the SSMP recommendations move into the implementation phase, findings from the ongoing research programs will allow the SFPUC and WWE to make timely technological choices with the assurance that performance and compliance goals will be met.

Research Needs

Innovative technologies that have the potential to change wastewater treatment as currently practiced, but are still at an early developmental stage and will require extensive research, include:

- Heat and energy recovery from wastewater, which would allow wastewater treatment facilities to become net exporters of energy.
- Adsorption and non-biological membrane technologies that may prove applicable to provide higher levels of treatment.
- Microbial fuel cells and bio-electrochemically assisted microbial reactors.
- Biosolids drying using the heat recovered from wastewater.
- Low-temperature systems for biosolids drying that are compatible with an urban setting.
Pilot and Demonstration Projects

Some novel and mature treatment technologies that have the potential to become part of wastewater treatment alternatives in the city, if their applicability and effectiveness can be demonstrated, include:

- Ultraviolet radiation (UV) disinfection of SEP secondary effluent
- Effluent pasteurization for disinfection using the heat recovered from wastewater
- Conversion of fats, oils, and grease into biofuel and biodiesel
- Simultaneous nitrification-denitrification-enhanced biological phosphorus removal for nutrient removal
- Ballasted flocculation of wet-weather flows (demonstration scale)
- Improved grit removal

Conclusions

The SSMP recommendations, summarized in Table 5-1, reflect the considered opinion of SFPUC staff, a broad consultant team, and nationally-recognized technical experts. Adoption of these recommendations by the SFPUC and their implementation by the WWE through the SSIP should return the SFPUC collection system and treatment facilities to a state of good repair by the end of the planning period.

The guidance and vision that this SSMP provides will be implemented through both a capital program, the SSIP, and changes in both the day-to-day operations and maintenance and the renewal and replacement program. Taken together these changes will allow the collection system and treatment facilities to serve the citizens of San Francisco and to meet all current and future permit compliance.
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<th>Issue</th>
<th>Recommendations</th>
<th>Comments/Monitoring/Future Needs</th>
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<td><strong>Integrated Urban Watershed Management</strong></td>
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</table>
| Project Implementation | Apply Integrated Urban Watershed Management approach to WWE projects  
Look for opportunities to enhance sustainability in all WWE projects  
Quantify the costs, benefits, and risks of WWE projects using the triple bottom line  
Build multipurpose infrastructure projects that enhance local neighborhoods  
Implement Adaptive Learning and Management  
Promote interagency cooperation to achieve shared goals | Evaluate project efficacy and adopt effective designs  
Support a robust research and development program  
Monitor impacts of climate change  
Implement Asset Management |
| **Collection System** | | |
| Aging Infrastructure | • Increase funding to shorten the replacement cycle of local sewers to about 100 years  
• Inspect and rehabilitate T/S structures  
• Provide redundant conveyance for flows from Channel and North Shore drainage basins to SEP | • Monitor sea level rise  
• Monitor changes in rainfall patterns |
| System Deficiencies | • Install pump stations in low-lying areas (see Stormwater Management)  
• Climate change: Install backflow prevention devices on vulnerable CSD weirs | |
| Operational Efficiency | • Stormwater Management: Sewer replacement program, pump stations in low lying areas, and sewer cleaning  
• Review adequacy of current sewer design standards  
• LID: Capital projects in coordination with sewer replacement projects. Recommend policy and code changes for new developments  
• Address chronic flooding by major capital projects.  
• Reduce CSD volume and events | • Continue modeling efforts to determine impact of climate change on storm patterns and intensities  
• Continue modeling efforts to quantify the impact of LID projects on stormwater run-off |
| Community Impacts | • Well-coordinated collection system odor control program | |
Table 5-1. SSMP Recommendations to Address System Needs to 2030

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<th>Issue</th>
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<td><strong>Treatment Facilities and Outfalls</strong></td>
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| Aging Infrastructure                  | • Capital projects to address the aging infrastructure needs at SEP and NPF and to return the facilities to a state of good repair  
• Address seismic improvements for critical structures |                                                                                                |
| Operational Efficiency                | • Replacement of aging major process equipment with modern, more efficient, more reliable equipment  
• Disinfection: Replace existing chlorine-based system for 20% effluent at SEP with UV  
• Rehabilitation of key unit processes at OSP to maintain a state of good repair | • Conduct further research on treatment technologies, especially technologies that are compact and allow for energy recovery  
• Conduct further research for technology selection if advanced treatment is required  
• Conduct pilot studies on disinfection technologies |
| Community Impacts                     | • Odor control: Ensure no facility odor is detectable beyond fence line of WWE facilities, ensure adequate funding for both chemical addition and for the installation of effective odor control devices to scrub foul process air  
• Architectural improvements to provide appropriate screening | • Commit to ongoing upgrades and continue monitoring program |
| Deepwater Outfalls                    | • Repair existing NPOs and SEO  
• Install backflow prevention on SWO  
• Evaluate the rehabilitation or replacement of SEO | • Evaluate the rehabilitation or replacement of NPOs  
• Evaluate methods to increase the capacities of Westside T/S decant and SWO discharge |
| **Biosolids Management**              |                                                                                                   |                                                                                                |
| Biosolids Management                  | • Retain anaerobic digestion as core process  
• Upgrade to Class A products  
• Produce marketable advanced products for up to 50% of biosolids production | • Evaluate thermal drying for advanced biosolids processing  
• Continue assessment of biosolids reuse technologies and markets |
| Biosolids Digester Improvements at SEP | • Rebuild SEP biosolids digester facility at a site that meets the City’s needs                      |                                                                                                |
| Biosolids Digester Improvements at OSP | • Install of thermal hydrolysis pretreatment                                                        |                                                                                                |

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<th>Issue</th>
<th>Recommendations</th>
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<td><strong>Energy and Power Management</strong></td>
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<tr>
<td>Power Usage</td>
<td>• Maximize energy efficiency at all facilities in coordination with the SFPUC's Power Enterprise</td>
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<td>Onsite Generation</td>
<td>• Maximize current on-site energy generation opportunities at SEP and OSP</td>
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<td></td>
<td>• Formalize a bioenergy subprogram for the development of renewable/alternative energy projects</td>
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<td>Building Efficiency</td>
<td>• LEED certification for all new buildings constructed; LEED certification in existing buildings where feasible</td>
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<td><strong>Implementation</strong></td>
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<td>Capital Program</td>
<td>• Fund the Sewer System Improvement Program</td>
<td>• Revisit SSMP recommendations on a regular basis to recalibrate recommendations</td>
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<tr>
<td>Renewal and Replacement Program</td>
<td>• Maintain adequate funding for R&amp;R Program</td>
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<tr>
<td>Internal Wastewater Enterprise Organization</td>
<td>• Realign budget along functional lines. Change budget organization to allow budgeting by function rather than by division</td>
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<tr>
<td>Policy and Code Revisions</td>
<td>• Re-establishment and enforcement of “official grade”</td>
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<td>• Reassessment of Subdivision Regulations</td>
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<td>• LID guidelines</td>
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<tr>
<td>Respond to Regulatory Changes</td>
<td>Monitor regulatory changes</td>
<td>Research program to pilot test new technologies to determine adequacy and applicability to meet new regulatory limits</td>
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<td>Develop a robust stormwater management program</td>
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<td>Continue with public education and source control</td>
<td>Monitor and manage future regulatory requirements</td>
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Chapter 6
Future Planning Considerations: Beyond 2030

During the Sewer System Master Plan (SSMP) process, several major issues that could impact the sewer system in the future (beyond the SSMP 2030 planning horizon) were identified. These issues — climate change, aging infrastructure, and regulatory changes — are addressed in this chapter. In addition, some peripheral developments and water enterprise and wastewater enterprise related programs that could potentially impact the sewer system are discussed. The San Francisco Public Utilities Commission (SFPUC), in collaboration with other relevant agencies, should continue to monitor and evaluate all of these issues and developments throughout the implementation period of the SSMP and formulate responses as appropriate.
Climate Change

Sea level rise and increased rainfall intensity are the two principal effects related to climate change that could affect the operation and configuration of the sewer system.

Sea Level Rise

Sea level and daily high tides have been monitored continuously since 1854 at Fort Point in the Presidio. Some estimates of sea level rise that will occur by 2100 are as high as 55 inches as compared with 1990 levels (see Figure 3-4) (State of California Resources Agency, 2008; Rahmsdorf, 2007). The change in sea level by 2030 may be as high as 18 inches.

A major effect of sea level rise that may occur during the period of the SSMP is bay-water flow into the collection system at the bayside combined sewer discharge (CSD) structures (Chapter 3, Design Storm for Collection System Design section on page 3-4). This would increase the volume of wastewater requiring treatment at the SEP and could possibly cause some upstream flooding. The near-term response in the SSMP recommendations is to recommend the installation of backflow prevention devices on all bayside CSD structures and to install local pump stations.

If the more extreme rates of sea level rise are realized, bay water will flow into the collection system over bayside CSD weirs every day by 2050 or earlier. This occurrence will require reconfiguration or elimination of the bayside CSD structures. Future planning should consider alternatives that will eliminate or accommodate bay water backflow as well as prevent upstream flooding, such as:

- Comprehensive review of existing CSD structures to determine the feasibility of selectively raising weir height (e.g., Sunnydale, Brannan and Howard Streets)
- Pump stations to lift the flow to CSD structures with higher weir elevations
- Acquisition of property for the installation of additional pump stations
- Increased wastewater pumping to the treatment facilities for treatment and discharge through deepwater outfalls
- Increased collection system storage
- Use of Low Impact Development elements for runoff modification and stormwater retention and infiltration

These measures will be necessary to address the need to provide for adequate wet-weather operation (under the anticipated higher downstream water elevations than for which the current system was designed) while simultaneously preventing upstream flooding.

To deal with the increased volume of combined wastewater that could result from rising sea levels, it is anticipated that both the Southeast Water Pollution Control Plant and the North Point Wet-Weather Facility treatment rates will need to be increased from the current peak flow rate of 250 mgd and 150 mgd to peak flow rate of at least 400 mgd and 300 mgd, respectively. Such increases can be accommodated at the existing sites with new technology, such as ballasted flocculation. In addition, existing pump stations may be expanded to include decant facilities for discharge (e.g., Channel Pump Station). The capacity of the Southeast Bay Outfall and the North Point Outfalls would have to be increased to match the new wet-weather capacities.

There is need to establish a “design tide” for future city projects and new developments that have a connection to the bay or ocean.

Rainfall Intensity

Even though there are no unequivocal supporting data, there is a perception that climate change may cause perturbations in weather patterns that includes increases in rainfall intensity and duration (National Oceanic and Atmospheric Administration, 2008). One prediction is that the current

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1 A 100-year design tide criterion would be the maximum sea level at high tide that is predicted to occur once in one hundred years within the design life of a proposed project.
storm intensity that occurs once every ten years could occur once every five years (BCM Joint Venture, 2009a). It is recommended that rainfall intensity should be evaluated carefully throughout the period of the SSMP with particular attention being paid to the trends of the cumulative five- and ten-year storms. The objective of this evaluation should be to determine whether a new design storm intensity-duration-frequency curve needs to be developed that accommodates the changes in storm patterns.

Aging Infrastructure Issues

Many of the recommendations of the SSMP have dealt with issues related to aging infrastructure. Some of these issues that will not need to be addressed during the time frame of the SSMP will likely become more critical thereafter. These infrastructure issues are considered below.

Collection System

In the future, there will be a continued need to replace and rehabilitate the collection system components beyond the SSMP planning period (2030). The compounding effects of sea level rise, possible changes in storm intensity, and the problems with localized flooding must be assessed and addressed with improvements in infrastructure.

CSD Structures, Pump Stations, and Force Mains

The following elements and structures of the collection system must continue to be maintained and upgraded:

- Continued investment in the program for replacing aging sewers
- Continued inspection and repair of the transport/storage structures, all major sewers (greater than 36 inches in diameter), and tunnels
- Consideration of the impacts of sea level rise for the design and rehabilitation of CSD structures (See Sea Level Rise section on page 6-2)

- Rehabilitation of all pump stations and force mains to ensure continued reliability
- Future flood control projects to address the potential of increased intensity of rainfall and higher water levels at discharge points due to sea level rise

Treatment Facilities

The principal overall issue with each of the wastewater treatment plants is that they will have exceeded their useful life, both structurally and technologically.

Southeast Water Pollution Control Plant

Because many of the structural components of the Southeast Water Pollution Control Plant (SEP) liquid treatment processes will be at least 50 years old at the end of the SSMP planning period, a decision should be made whether to move the dry-weather treatment function of this facility to another location. Factors that could influence this decision include:

- The continued ability to treat wet-weather flows at the SEP location
- The opportunity to incorporate new, more efficient treatment technology and energy-conserving equipment
- Changes in regulations that may make bay discharge infeasible
- Community attitudes to continued wastewater treatment at the SEP location

North Point Wet-Weather Facility

The North Point Wet-Weather Facility (NPF) will have been in operation for about 80 years by the end of the current planning period and significant structural changes will be needed to maintain it in working order. Because of facility age and possible NPF capacity issues caused by climate change, it will be appropriate to review the technology available at that time for providing more efficient, compact wet-weather treatment.

Oceanside Water Pollution Control Plant

By the end of the SSMP, the Oceanside Water Pollution Control Plant (OSP) will have
been in operation for 37 years. With ongoing attention to the requisite structural, mechanical, and electrical upgrades, the facility should be able to function in its present treatment mode for many years beyond the SSMP horizon. Major changes at the OSP would be driven by factors such as:

- The need to treat wet- and dry-weather flows from areas other than the Westside
- The need to treat wastewater solids from treatment plants other than OSP (e.g., NPF or SEP)
- Regulatory changes such as the need to disinfect the effluent or provide some form of advanced treatment

**Deepwater Outfalls**

The infrastructure issues with the deepwater outfalls are similar to those discussed above for the treatment plants.

**Southeast Bay Outfall**

By 2030, the Southeast Bay Outfall (SEO) will have been in operation at flows greatly in excess of its original-rated capacity for more than 60 years (Chapter 4, Southeast Bay Outfall section on page 4-6). The SSMP recommendation is to repair the existing SEO in the near term and conduct a thorough condition assessment to determine if rehabilitation or replacement is warranted. This recommendation will be influenced by factors such as:

- Whether the existing drainage pattern continues to be used for addressing flooding in the Upper Alemany Drainage Area\(^2\)
- Whether bay discharge of dry-weather flows is retained
- Whether the SEP is relocated

**North Point Outfalls**

By 2030, the NPOs will have been in service for over 60 years. Any plans for their replacement or changes in discharge capacity should be coordinated with NPF improvements.

**Southwest Ocean Outfall**

By 2030, the SWO will have been in operation for about 45 years. Beyond the SSMP recommendations to install backflow prevention devices and to conduct an adequate inspection and cleaning program, the WWE should evaluate the feasibility of increasing the Westside Transport/Storage decant capacity that would result in increased discharge through SWO.

**Regulatory Changes**

There are several long-term regulatory actions that require careful monitoring because they could, if promulgated, have major effects throughout the San Francisco sewer system.

- Bay discharge prohibition would require major changes in the sewer system. Although such a prohibition does not seem imminent, it would be prudent to conduct concept-level planning to address such an eventuality.
- Ammonia/nitrogen removal for continued bay discharges would require nitrification (ammonia oxidation to nitrate) and nitrogen removal would additionally require nitrate removal by denitrification. Both of these involve processes that would require significant increases in the size and complexity of the SEP (or its successor facility). Space should be reserved within the bayside dry-weather treatment facilities for such process units.
- In the future, the removal of trace organics including pharmaceuticals and personal care products from dry-weather discharges may be required. This objective, like the ammonia/nitrogen objective discussed above, would require a larger and more sophisticated treatment process at all of the facilities that treat dry-weather flows. Space for advanced treatment processes should be reserved within these facilities.

\(^2\) If an option to direct flow to the west is implemented, the SEO could be repaired in the near-term and revert to a wet-weather only outfall if the dry-weather flows are directed to the west.
Other Wastewater Enterprise Related Programs

The SSMP is a planning and guidance tool that the Wastewater Enterprise (WWE) will update regularly. The SSMP will link into several other systems and plans including:

- The WWE Business Plan which includes initiatives, actions, plans, tasks, assignments, and performance indicators
- Budgetary and financial documentation, which supports the operating and capital budgets and rate evaluation
- Workforce Planning and Development including Staffing and Resource Plans, succession planning, and training functions
- Communications Plans, which will include public information and tracking customer concerns and complaints
- Security and Emergency Response Planning, which addresses planning for future issues such as security breaches, accidents, earthquakes, and other disasters
- Regulatory Compliance Planning including permit renegotiation and participation in the setting of future regulations.
- Other plans and programs including: the Strategic Plan, Health and Safety Management System, the Annual Report, and the SFPUC Sustainability Plan

Peripheral Developments

Several new developments are being built or are proposed in San Francisco. Because these developments could impact the sewer system in the future, they are reviewed below.

Mission Bay and Hunters Point

The estimated dry-weather flows and loads from all of these new developments were accounted for in the SSMP and aligned with the population and water demand in the “Retail Water Demands and Conservation Potential Report” (Hannaford, 2004). The wet-weather flows for these projects were evaluated separately, because they have collection systems made up of a mixture of combined and separate sewers. The proposed Stormwater Guidelines (in draft) and the Green Building Ordinance (San Francisco Building Inspection Commission Codes, 2008) will be applied for reducing stormwater flows into their collection systems.

Treasure Island and Yerba Buena Island

Treasure Island (TI)/Yerba Buena Island (YBI) is owned by the Navy and is currently under the jurisdiction of the Treasure Island Development Authority (a California nonprofit public benefit corporation acting as the redevelopment agency and the trustee of the Tideland Trust for TI/YBI). Ownership is expected to be transferred from the Navy to the City of San Francisco. TI/YBI developments are in the initial stages of planning and their sewers are not connected to the San Francisco collection system because they are on bay islands. If the islands are transferred to the City, the SFPUC will assume ownership and management responsibilities for the stormwater and wastewater systems.

Stormwater Harvesting in New Developments

Harvesting stormwater runoff and rainwater during wet weather can divert large volumes of water from the combined collection system and help reduce peak inflow. If the diverted water can be captured and adequately treated, it can be used during the dry season for irrigation and other nonpotable purposes such as street cleaning/sweeping, vehicle washing, and toilet flushing.

Water Enterprise Related Programs

The Recycled Water Master Plan (RMC Water and Environment, 2006) and the Water
Enterprise have identified recycled water projects. Some of these projects on the west side of the city are currently being developed and implemented by the Water Enterprise. It is anticipated that the Water Enterprise will also take the lead (with WWE staff assistance) in developing and implementing recycled water projects on the bay side.

**Westside Recycled Water**

When fully implemented, the Westside Recycled Water Project will provide recycled water for irrigation of Golden Gate Park, Lincoln Park and Golf Course, and the San Francisco Zoo. In addition, the Harding Park Recycled Water Project (currently being implemented) will use recycled water from the North San Mateo County Sanitation District to irrigate Harding Park.

**Bayside Recycled Water**

The SSMP Project Team performed a conceptual level evaluation of bayside recycled water projects as a supplement to the Recycled Water Master Plan. High salinity caused by bay water intrusion makes recycled water from the SEP unsuitable for irrigation without reverse osmosis treatment. The proposed project could be located at the Bruce Flynn Pump Station, use SEP effluent, and produce recycled water containing less than 100 mg/L chloride. This project would have an average daily demand of 2.1 mgd and would provide recycled water to users in China Basin, Mission Bay, and the nearby Port of San Francisco properties.
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