San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

Southeast Water Pollution Control Plant, North Point Wet Weather Facility and Bayside Wet Weather Facilities (NPDES No. CA0037664)

Oceanside Water Pollution Control Plant and Collection System, and the Westside Wet Weather Facilities (NPDES No. CA0037681)

San Francisco Wastewater Long Term Control Plan Synthesis

March 30, 2018

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Acronyms

1971 Master Plan	1971 San Francisco Master Plan for Waste Water Management
Bay	San Francisco Bay
Bayside Permit	Southeast Water Pollution Control Plant, North Point Wet Weather Facility, and Bayside Wet Weather Facilities, NPDES Permit No. CA0037664
City	City of San Francisco
CSD	Combined Sewer Discharge
CSO	Combined Sewer Overflow
CSO Control Policy	Combined Sewer Overflow Control Policy
CSO Report	*Characterization and Treatment of Combined Sewer Overflows Report*
CWA	Clean Water Act
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FIB	fecal indicator bacteria
GI	Green infrastructure
H&H	Hydrologic and Hydraulic
LTCP	Long Term Control Plan
Master Plan	*San Francisco Master Plan for Waste Water Management*
MG	million gallons
MGD	million gallons per day
NEPA	National Environmental Policy Act
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPF	North Point Wet Weather Facility
Ocean Plan	*Water Quality Control Plan for Ocean Water of California*
OSP	Oceanside Water Pollution Control Plant
PAA	peracetic acid
Regional Water Board	San Francisco Bay Regional Water Quality Control Board
San Francisco	City and County of San Francisco
SEP	Southeast Water Pollution Control Plant
SFPUC	San Francisco Public Utilities Commission
SMR	Self-monitoring report
SWOO	Southwest Ocean Outfall
Synthesis	Long Term Control Plan Synthesis
T/S	transport/storage
USGS	United States Geological Survey
UV	Ultraviolet light
WQS	Water quality standards

1. Introduction

The San Francisco Public Utilities Commission (SFPUC) submits this Long Term Control Plan Synthesis (Synthesis) consistent with Section VI.C.5.c.v. of the Southeast Water Pollution Control Plant, North Point Wet Weather Facility, and Bayside Wet Weather Facilities (National Pollutant Discharge Elimination System [NPDES] No. CA0037664) (Bayside Permit). Section VI.C.5.c.v requires that the SFPUC "synthesize and update its Long-Term Control Plan … [to] reflect current circumstances."[1] The permit further clarifies that the document should:

1) Continue to reflect the historical long-term average annual design goals for combined sewer discharges (CSDs);

2) Set forth operational requirements similar to those in the existing permit to optimize system operations so as to maximize pollutant removal and minimize CSDs;

3) Set forth additional measures, to the extent technically and economically feasible, to maximize pollutant removal and minimize CSDs (e.g., implementing and promoting green infrastructure);

4) Develop and propose a metric to evaluate the performance of wet weather disinfection systems for Discharge Points No. 001 through 006, and

5) Propose a plan for post-construction compliance monitoring of all wet weather discharges consistent with the *Combined Sewer Overflow Control Policy*.

While each of the elements specified in the Bayside Permit is addressed in subsequent sections of this report, the primary objective of this report is to describe the historical planning efforts undertaken by the City of San Francisco (City) to minimize and control wet weather discharges from the combined sewer system. San Francisco developed and began implementation of capital plans for its combined sewer overflow control plan prior to the adoption of the federal Combined Sewer Overflow Control Policy (CSO Control Policy) in April of 1994. The process of planning for, designing, and constructing projects to minimize and control wet weather discharge was iterative and extended for nearly two decades. As a result of this early effort, no single report describes the analyses and assumptions underlying the construction of the City's current facilities. This is in contrast to other municipalities with combined systems that initiated wet weather planning and construction after adoption of the CSO Control Policy.

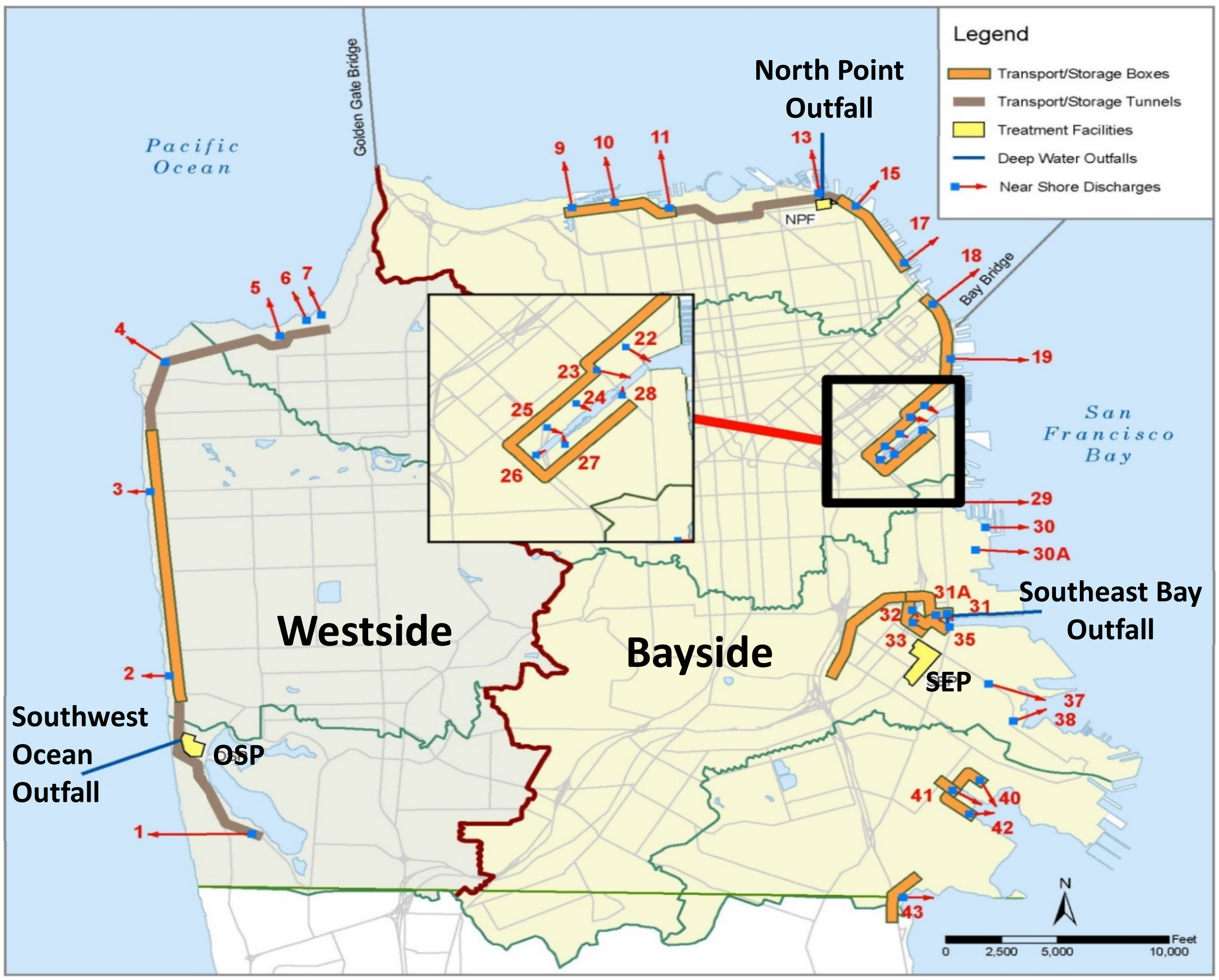
This report synthesizes the various documents that make up the City's long term control plan (LTCP) for wet weather controls and that resulted in the construction of existing wet weather facilities. Although the Bayside Permit requirement is limited to the Bayside facilities, planning for Bayside and Westside wet weather facilities occurred simultaneously. This report, therefore, addresses the City's entire combined sewer system.

[1] Bayside Permit (Order No. R2-2013-0029) at p. 25.

2. Overview of Existing Facilities

A schematic of the City's combined sewer system, including its storage and treatment facilities and outfalls, is provided in **Figure 1**. These facilities include two all-weather treatment plants, the Southeast Water Pollution Control Plant (SEP) and Oceanside Water Pollution Control Plant (OSP), and one wet-weather treatment facility, the North Point Wet Weather Facility (NPF). Collectively, these facilities treat all dry weather flows and the majority of wet weather flows. As of 2017, the SEP has dry weather flows of 51 million gallons per day (MGD)[2] and a peak wet weather capacity of 250 MGD. The OSP has dry weather flows of 13 MGD and a peak wet weather capacity of 65 MGD. The NPF provides treatment for up to 150 MGD of wet weather flows. In addition to these treatment facilities, the Westside Pump Station has the capacity to pump up to 120 MGD of wet weather flows from the Westside Transport and Storage to the Southwest Ocean Outfall (SWOO).

Figure 1: Map of San Francisco Combined Sewer System Infrastructure



2 Dry weather flows are calculated using the average flows from July, August, and September as reported in the 2017 Annual Self-Monitoring Reports, submitted in February 2018.

The City's wet weather facilities also include approximately 160 million gallons (MG) of storage on the Bayside and 71 MG of storage on the Westside. This storage exists primarily in the form of large transport/storage (T/S) structures that were constructed in the 1980s and 1990s. When wet weather flows exceed the combined treatment and storage capacity of the system, flows are discharged through one or more of the 29 Bayside and seven Westside CSD outfalls. All but seven of these CSD outfalls are connected to a T/S structure to facilitate solids removal.[3] Most outfalls also include baffles to reduce floatables. Additional control of solids and floatables is provided through source control measures, such as catch basin cleaning and street sweeping, as described in the SFPUC's 2017 Pollution Prevention Report.

Prior to the City's substantial investment in wet weather treatment and storage facilities, historical documents indicate that the City's wet weather combined sewer outfalls discharged when rainfall exceeded 0.02 inches, for an average of 82 discharges a year. As shown below in **Table 1**, the average annual number of storm events resulting in a discharge from one of the 36 CSD outfalls has decreased substantially since completing construction of the existing facilities in 1997.

In addition to monitoring CSD events within each basin, the SFPUC uses a hydraulic and hydrologic (H&H) model to understand system performance in wet weather. System performance is characterized by simulating a "typical year" of rainfall in the H&H model. The storms in a typical year represent a statistical average of actual storms from a 30-year period in terms of storm depth and intensities. The City's typical year consists of 32 storm events, each with a total rainfall depth greater than 0.1 inches. **Table 2** summarizes the results of the typical year modeling simulation by individual outfall. Other information about system performance provided by the typical year simulation includes:

- 26 of the 32 typical year storm events do not result in any CSDs because all stormwater runoff is captured and treated.
- The Westside CSD outfalls discharge in six storms but result in seven CSD events because one long-duration storm event results in two discharges separated by six hours.
- The Northshore Basin CSD outfalls discharge in three storms.
- The Central Basin CSD outfalls discharge in 12 storms. Two of the storms result in very small (0.1 and 0.03 MGD) discharges. One of these small volume CSD events is the result of a discharge only from CSD No. 030 (20th Street) which has a small catchment driven by local conditions rather than basin-wide conditions or capacity.
- A single CSD outfall, CSD 037 (Evans Avenue) discharges once within the Southeast Basin.

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[3] The CSD outfalls not connected to T/S structures are Nos. 005 (Sea Cliff #1), 006 (Sea Cliff Sewer), 007 (Sea Cliff #2), 030 (20th Street), 030A (22nd Street), 037 (Evans Avenue), and 38 (Hudson Avenue). Discharges from these CSDs are small in volume because they typically have small catchments and are driven by local conditions, such as local pump station capacity, rather than basin-wide conditions or capacity.

Table 1. Frequency of San Francisco CSD Events on the Bayside, 1998 - 2017

Year	Annual Rainfall Total (inches)[a]	Number of Combined Sewer Discharge Events[b]			
		Westside Basin[c]	North Shore Basin	Central Basin	Southeast Basin
1998-1999	23.5	7	1	13	0
1999-2000	24.9	7	3	12	1
2000-2001	19.5	3	0	8	0
2001-2002	25.1	6	2	9	2
2002-2003	23.9	9	3	14	4
2003-2004	20.5	8	4	8	2
2004-2005	31.9	12	4	15	1
2005-2006	34.4	13	3	16	2
2006-2007	16.9	3	1	5	1
2007-2008	17.5	4	3	7	2
2008-2009	18.1	4	3	4	1
2009-2010	24.1	7	5	11	3
2010-2011	28.9	7	6	21	0
2011-2012	15.8	6	2	8	1
2012-2013	16.6	8	3	8	1
2013-2014	12.5	5	1	8	0
2014-2015	18.2	9	5	10	2
2015-2016	23.2	9	7	11	2
2016-2017	32.4	18	9	19	2

Footnotes:

a. As measured at NOAA's downtown San Francisco rain gauge (SFOC1).

b. A CSD event is a wet weather event that results in an authorized discharge from one or more approved combined sewer discharge points. A discrete combined sewer discharge event is separated by at least six hours from any other combined sewer discharge event (as defined in Order Nos. R2-2013-0029 and R2-2009-0062, Attachment A).

c. Includes CSD events in which a discharge occurred either from the Westside Wet Weather facilities CSD outfalls (Nos. 001-003) and/or from the Sea Cliff CSD outfalls (Nos. 005 – 007). Discharges from the Sea Cliff CSD outfalls are driven by local conditions within the small tributary catchment and may discharge independently of the other Westside outfalls.

Table 2: SFPUC Model - CSD Counts and Volume Results for a Typical Year Simulation

CSD Name By Receiving Water Drainage Basin	CSD ID	EHY17_200 (Bayside) EHY17_200 (Westside)	
		Count	Volume (MG)
Lake Merced	1	8	10.6
Vicente	2	7	55.4
Lincoln	3	7	115.9
Mile Rock	4A	6	14.4
Mile Rock 2	4B	0	0.0
Seacliff 1	5	1	0.0003
6' Brick	6	1	0.0041
Seacliff 2	7	2	0.0125
WESTSIDE		7	196.3
Baker	9	3	6.1
Pierce	10	3	7.4
Laguna	11	0	0.0
Beach	13	3	2.2
Sansome	15	3	18.6
Jackson	17	1	0.0
NORTH SHORE		3	34.3
Howard	18	9	71.1
Brannan	19	10	198.4
3rd Street	22	0	0.0
4th Street (N)	23	0	0.0
5th Street	24	4	5.3
6th Street (N)	25	5	16.4
Division Street	26	9	253.8
6th Street (S)	27	0	0.0
4th Street (S)	28	0	0.0
Mariposa	29	3	0.8
20th Street	30	12	4.2
22nd Street	30A	2	0.013
3rd Street (N)	31	10	2.0
Islais North	31A	11	426.7
Marin Street	32	11	51.0
Selby Street	33	11	99.0
3rd Street (S)	35	11	92.6
CENTRAL		12	1221.2
Evans Street	37	1	0.011
Hudson Street	38	0	0.0
Griffith	40	0	0.0
Yosemite	41	0	0.0
Fitch	42	0	0.0
Sunnydale	43	0	0.0
SOUTH EAST		1	0.011

3. Historical Long Term Control Planning and Implementation

The federal CSO Control Policy, adopted in 1994, lists nine elements relevant to developing a LTCP:[4]

1. Characterization, monitoring, and modeling activities to support combined sewer overflow (CSO) control selection and design.
2. A public participation process to involve the affected public.
3. Prioritization of controls in sensitive areas.
4. Evaluation of alternatives that will enable the permittee, in consultation with the NPDES permitting authority, water quality standards (WQS) authority, and the public, to select appropriate CSO controls.
5. Cost/performance considerations to demonstrate the relationships among a comprehensive set of reasonable control alternatives.
6. Operational plan revisions to include agreed-upon long term CSO controls.
7. Maximization of wet weather treatment at treatment plants.
8. An implementation schedule.
9. A post-construction compliance monitoring program adequate to verify compliance with water quality-based Clean Water Act (CWA) requirements and ascertain the effectiveness of CSO controls.

The City's current combined sewer system is the outcome of a more than 20-year design, engineering, and construction process that included activities related to each of the nine elements. As described in more detail below, extensive monitoring and modeling efforts performed in the late 1960s and 1970s served as the basis for the final selection of the design criteria. Alternatives evaluated during the City's design phase included increased treatment, decentralized storage, outfall consolidation, outfall relocation, and a T/S system. Key elements of the system's operational plan to maximize storage and treatment and requirements for post-construction monitoring were ultimately incorporated into NPDES permits. There is no single report or study documenting the relevant decision-making for all elements of the City's system as the planning process began in the late 1960s and construction continued into the 1990s. Appendix A, however, lists the key documents prepared during the development of the City's LTCP efforts and identifies the CSO Control Policy's LTCP nine elements addressed by each document. All documents listed in Appendix A that comprise the SFPUC LTCP can be found in Appendix C.

[4] At the time that EPA adopted the CSO Control Policy in 1994, the agency recognized the "extensive work" already done by some municipalities to abate CSOs. As such, EPA noted that "portions of [the CSO Control Policy] may already have been addressed by permittees' previous efforts to control CSOs" and, as a result, portions of the CSO Control Policy "may not apply, as determined on a case-by-case basis. 59 Fed. Reg. at 18690.

3.1 Chronology of Long Term Control Planning Efforts

Official construction of San Francisco's sewer system began in the late 1850s.[5] By 1935, the City had developed two sewer master plans (completed in 1899 and 1935) focused on recommendations to address public health and nuisance concerns posed by the uncontrolled discharge of sanitary waste during the summer months.[6]

The two sewer master plans resulted in the construction of three treatment plants: the Richmond-Sunset Treatment Plant in 1939, the North Point Treatment Plant (later converted to the North Point Wet Weather Facility in 1983) in 1951, and the Southeast Treatment Plant (later converted to secondary treatment in 1982) in 1951. Although these treatment plants were built as the result of concerns about untreated sanitary flows, combining the City's sewer pipes meant the plants also provided some treatment to wet weather flows.

The City's first documented efforts to characterize CSOs and recommend improvements are described in the 1967 *Characterization and Treatment of Combined Sewer Overflows Report* (CSO Report), which was supported with a grant from the Federal Water Pollution Control Administration (Grant No. WPD-112-01-66). The City's CSO Report was one of the first efforts in the nation to characterize CSOs. This extensive study included an initial characterization of drainage districts and their relationship to major CSO outfalls, CSO flow monitoring, dry and wet weather discharge sampling, bioassays, and shoreline bacteria sampling. The report concluded that sewer separation was not advised because it was anticipated to only provide reductions of some constituents, namely in biological oxygen demand and nutrients, whereas treatment of combined flows would provide greater pollution control. Recommendations from this report were used to continue characterizing the system, the system's response to rainfall, and CSOs, and to pilot CSO treatment at the Baker Street outfall.

Findings from the CSO Report were used by the City to support the development of a master plan in 1971 to meet the requirements of the San Francisco Bay Regional Water Quality Control Board's (Regional Water Board) 1968 plan for waters inland of the Golden Gate. As part of the master planning effort, the City initiated automated monitoring of rainfall and sewer levels, created its first computational model of the sewer system, and undertook effluent studies and modeling to analyze water quality, currents, drift, and mass water movement.

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[5] William P. Humphreys. 1876. *Report on a System of Sewerage for the City of San Francisco.*

[6] A 1935 report described the conditions on San Francisco beaches as follows: "The people of San Francisco, as a community, are an out-of-door, recreation-seeking group. On fine days, during the seven-month period, April to October, they flock to all available beaches and shores for various types of recreation, including swimming. On warm days in the other months of the year the beaches are frequented, but swimming is not largely indulged in.

The presence of sewage is shown by fecal matter and other litter along the beaches and is demonstrable in the coastal waters at nearly all points by laboratory tests. This pollution has its public health implications in that it is dangerous to swim in such heavily polluted waters or to use beaches fouled with fecal matter. The esthetic implications likewise are not to be overlooked or condoned." (Grunsky, 1935)

As with the 1967 report, the 1971 *San Francisco Master Plan for Waste Water Management* (Master Plan) concluded that sewer separation would be costly and result in little or no water quality benefits. The Master Plan recommended a system-wide approach to minimize overflows by maximizing system capacity and flexibility. Although predating the CSO Control Policy by almost 20 years, the monitoring, modeling, and analyses undertaken to develop the 1971 Master Plan and subsequent analyses are consistent with the requirements later adopted by Environmental Protection Agency (EPA) in the CSO Control Policy to characterize a combined system and determine the infrastructure requirements for long term control. Scenarios described in the 1971 Master Plan attempted to balance system storage and treatment to reduce the number of wet weather discharges at the lowest cost, using a combination of pumps, pipes, storage reservoirs, treatment plants, and outfalls. The levels of control analyzed were based on system capacity scenarios using different long term annual average discharges and long term rainfall records from the United States Weather Bureau.

The 1971 Master Plan developed alternatives to control approximately 90% of overflows by providing physical and chemical treatment prior to discharge to reduce the total number of overflows from 82 to eight per year. Alternative levels of control were evaluated based on the extent of control, treatment, operational feasibility, acceptability of discharge locations, and costs. Each alternative was divided into three construction phases: one for the western and northern beaches, one for the northeastern waterfront areas, and one for the remainder of the eastern shoreline. To accomplish the reduction in overflows, the 1971 Master Plan recommended the construction of 45 retention basins spread around the City, a wastewater transport system, a major wet weather treatment facility in the Southwest area of the City (Lake Merced Plant), an ocean outfall, and high level (secondary) dry weather treatment facilities at the existing Richmond-Sunset and Southeast treatment plants.

Following completion of the 1971 Master Plan, the CWA was passed in 1972 and established the Construction Grant Program, which provided significant funding for the San Francisco wastewater facilities. Through the grant program, the EPA provided federal grants up to 75% of the construction costs for municipalities which had submitted a Facility Plan and that complied with the National Environmental Policy Act (NEPA)[7] to the State and EPA. The 1971 Master Plan was modified in 1974 to become eligible for grant funding to support the City's construction costs. The revised planning documents were accompanied by an Environmental Impact Report (EIR) and Environmental Impact Statement (EIS) issued in 1974, both prepared by EPA and the San Francisco Department of Planning.

The 1974 programmatic EIR/EIS described the environmental impacts of the alternatives included in the Master Plan and subsequent planning documents. The EIR/EIS for the Master Plan detailed how the scenarios in the Master Plan (including storage, transport, upgraded treatment, and disposal) were acceptable solutions to mitigate wet weather overflows in San Francisco. The EIR/EIS included dispersed combined sewage storage tanks and envisioned transporting all wastewater to the Westside for additional wet weather treatment and ocean disposal.

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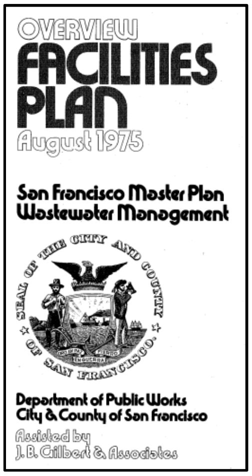
7 USEPA Office of Water Program Operations, *Guidance for Preparing a Facility Plan*, EPA-430/9-76-015 (May 1975).



The 1975 Overview Facilities Plan furthered plans for wet weather wastewater facilities.

The programmatic EIR/EIS was followed by a planning period that included extensive surveys of beach recreational use, and the monitoring and modeling of potential impacts on receiving waters from wet weather discharges. In 1975, the City issued the *Overview Facilities Plan*, which used the 1971 Master Plan recommendations to further develop plans for stormwater and wastewater collection, transport, and treatment facilities. The 1975 Overview Facilities Plan replaced the previously proposed underground basins with the concept of T/S structures lining the perimeter of the City and further developed plans to construct the Southwest Treatment Plant in the Lake Merced area. The Overview Facilities Plan also incorporated the results of monitoring efforts and studies that were initiated as part of the master planning process, such as stormwater data collection and modeling, updated financial plans, a citywide seismic study, and solids handling studies.

After the Regional Water Board's adoption of the first comprehensive Basin Plan for the San Francisco Bay Region in 1975, and consistent with later-adopted *CSO Control Policy's* Phase II[8] permitting approach, the Regional Water Board issued a series of permits and orders that included enforceable schedules for implementing the City's selected wet weather controls (e.g., milestones for planning, design, and construction). In 1976, the Master Plan and programmatic EIR/EIS became the basis of three Regional Water Board orders issued to the City: Order Nos. 76-22, 76-23, and 76-24 for the Southeast, Westside, and North Shore Zones, respectively. These orders required the City to construct facilities to achieve long term annual average CSO frequencies of one overflow per year for diversion structures No. 1-8 (Westside), one overflow per year for diversion structures No. 9-17 (North Shore Basin), four overflows per year for diversion structures No. 18-28 per year (Central Basin), and four overflows per year for diversion structures No. 34-35 (Southeast Basin).

The orders also noted that complying with the newly adopted Basin Plan's prohibition against discharges of untreated waste presented a challenge because of the high cost of achieving compliance and the need for a cost-benefit analysis as recommended by the Basin Plan. The orders directed the City to undertake cost-benefit analysis and submit a study recommending the appropriate frequency of overflows based on several considerations, including the Basin Plan's water quality objectives and an evaluation of "cost-effective combinations of storage, outfall location and length, and treatment."

In response to these orders, the City undertook field studies to evaluate the effects of wet weather overflows to ocean and San Francisco Bay (Bay) waters. These studies quantified the potential impacts of untreated overflows on the receiving waters, including on water quality, sediments and benthos, shellfish, fish and game populations, beach use, public health, and the potential impacts on these factors if overflows were relocated. The results of these field studies were used to conduct a cost-benefit analysis of providing varying levels of CSO control as described in the

[8] USEPA Office of Water, *Combined Sewer Overflows, Guidance for Long-Term Control Plan*, EPA 832-B-95-002 (September 1995).

Westside Wet Weather Revised Overflow Control Study (1978), the *Bayside Wet Weather Facilities Overflow Control Study* (1979), and the *Report for CCSF Bayside Overflows* (1979).

The field studies ultimately led to the Regional Water Board's adoption of Order Nos. 79-67 (Bayside) and 79-12 (Westside), which established the following long-term average annual discharge criteria that the City used to design and construct storage pipes and boxes, pump stations, treatment facilities, and outfall structures deemed necessary by the Regional Water Board to protect beneficial uses during wet weather events:

- Westside Drainage Basin Facilities – eight discharges,
- North Shore Drainage Basin Facilities – four discharges,
- Central Drainage Basin Facilities – ten discharges, and
- Southeast Drainage Basin Facilities – one discharge.

The frequencies were not specific limitations but rather intended to provide the criteria upon which the City's wet weather storage and treatment facilities would be designed. Order Nos. 79-67 and 79-12 specifically noted that "these long term overflow frequencies shall not be used to determine compliance or noncompliance with the exception [to water quality objectives specified in the Basin Plan]."

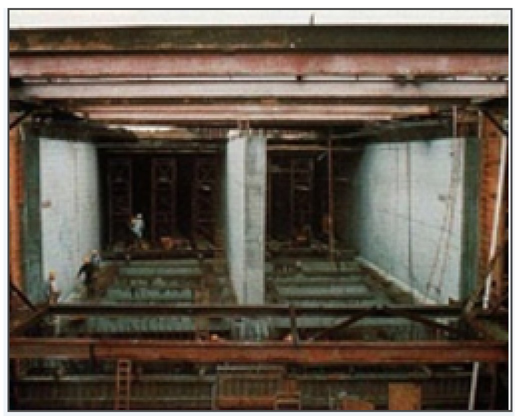
Regional Water Board Order No. 79-12, which established the Westside design criteria, was later amended in 1979 by Order No. 79-16. Order No. 79-16 incorporated Order No. 79-12 plus the results from the *Westside Wet Weather Revised Overflow Study* and concluded the Westside facilities met the requirements to obtain an exception to the numeric water quality objectives in the 1978 *Water Quality Control Plan for Ocean Water of California* (Ocean Plan). Specifically, Order No. 79-16 granted the City's future CSDs an exception to the Ocean Plan because the Regional Water Board deemed it "inappropriate to apply Ocean Plan standards strictly to combined waste and stormwater discharges." Order No. 79-16 became the basis for all subsequent planning, design, and construction of Westside's wet weather control facilities.

In 1980, the Master Plan was approved by the Board of Supervisors and subsequently, San Francisco applied for an amendment to the Regional Water Board ordered compliance schedule. In the amendment request, San Francisco sought new compliance dates and included a detailed comparison of the original and proposed compliance dates, descriptions of all the physical modifications needed to achieve implementation of the Master Plan, and a detailed cash flow analysis. The amendment request described the three stages of the plan, which were prioritized to address areas of higher priority first:

- **Stage I** included all work completed at the Southeast Treatment Plant, North Shore, and Channel Transport boxes required to make facilities operational.
- **Stage II** encompassed the Westside hydraulic core, two of the three barrels at the Ocean Outfall, and Phase I of the Southwest plant.
- **Stage III** continued the work from Stage II but was separate from Stage II due to significant concerns about cost and the availability of adequate funding. Stage III work included enlarging Stage II facilities (e.g., Southwest Treatment Plant), and constructing remaining elements necessary to transport, treat, and discharge all effluent before discharge to the ocean.

The request for a modified compliance schedule was granted by the Regional Water Board through a series of letters and negotiations during the summer of 1980. Upon approval, the construction commenced. Construction of the Bayside facilities commenced with the Channel and Marina T/S structures in the late 1970s, followed by construction of the Islais T/S structure in the early 1980s. Upgrades to the SEP, including to secondary treatment and the conversion of the North Point treatment plant to a wet weather facility, were completed by 1983. Construction of the Westside facilities began with the Westside T/S box in the early 1980s. The OSP was completed in 1993, around the same time that construction began on the Lake Merced Transport Tunnel and the Richmond Transport Tunnel.

In 1996, upon substantial completion of the planned wet weather facilities for the Bayside, the City requested that the Regional Water Board authorize treated wet weather discharges from SEP to Islais Creek. Due to its near-shore location, the Quint Street discharge was inconsistent with the Basin Plan's prohibition on discharges that receive less than a 10:1 dilution. At the time, SEP had a total wet weather capacity of 210 MGD and discharged a mix of primary and secondary treated effluent to Islais Creek via the Quint Street outfall during wet weather. A project was underway to increase the total SEP capacity to 250 MGD and ensure only secondary treated effluent discharged from the Quint Street Outfall. In response to the City's request, the Regional Water Board issued Order 96-116, finding that the City had demonstrated compliance with the Basin Plan's two criteria for an exception. First, an inordinate burden would be placed on the discharger because of the high cost of alternatives evaluated, which included construction of a new and larger Bay outfall. Second, an equivalent level of environmental protection was being achieved by increasing the total wet weather capacity of SEP and eliminating discharges of primary effluent through the Quint Street outfall.



Construction of the Bayside and Westside Wet Weather Facilities was completed in 1997.

Implementation of the Master Plan was completed in 1997, at a cost of approximately $1.4 billion in 1997 dollars ($2.4 billion in 2017 dollars). In addition to wet weather controls focused on storage, the City undertook extensive treatment plant and pumping improvements to provide higher levels of treatment and reliability for both dry weather and wet weather flows.

3.2 Evaluation of Consistency with CSO Control Policy

After the adoption of the CSO Control Policy in April of 1994, EPA engaged a consultant to analyze whether the City's completed and planned wet weather controls were consistent with the Policy. In August 1994 the Cadmus Group, an environmental and public health consulting firm, submitted a report noting that the program "focused from the outset on CSO controls that would protect beneficial uses of receiving waters," and concluding that San Francisco's controls met all three criteria of the CSO Control Policy's "Presumption Approach"[9]

The findings of this report are reflected in the Phase I permit, Order No. 94-149 for the Southeast Water Pollution Control Plant, issued by the Regional Water Board after EPA's adoption of the CSO Control Policy. The order explicitly recognized that San Francisco's efforts were consistent with CSO Control Policy requirements and goals:

> "The discharger is served almost 100% by combined sewers and this is directly affected by the Policy. This Order implements the Policy in Section B.; Effluent Limitations and Section E.; Provisions. Based on the Board's preliminary evaluation, the CSO control requirements in this permit and the NPDES Permit for the Wet Weather Diversions Structures (CA0038610) are in compliance with the policy."

Shortly after San Francisco completed implementation of its Master Plan, the first Phase II NPDES permit[10] in the country was issued; Order No. 97-044, a joint state and federal permit which included all the Westside Wet Weather Facilities and the OSP. Subsequent permits for the SEP, NPF, Bayside Wet Weather Facilities, OSP, and Westside Wet Weather Facilities reiterated that San Francisco's efforts were consistent with CSO Control Policy requirements and goals.

In 2002, the Regional Water Board issued the first post-Phase II permit (Order No. R2-2002-0073) for the SEP, and NPF and Bayside facilities. Findings 30-34 in Order No. R2-2002-0073 state that San Francisco had implemented the NMCs as required by the CSO Control Policy and developed a LTCP based on the "Presumption Approach" in the CSO Control Policy because San Francisco provides treatment to 100% of combined sewer flows. The 2008 permit (Order No. R2-2008-0007) also explicitly recognized these findings:

> "The Discharger's program exceeds the specifications of the USEPA *Combined Sewer Overflow Control Policy* Presumption Approach. The Discharger captures and provides treatment to 100% of the combined sewer flows rather than the 85% identified in option ii in the USEPA *Combined Sewer Overflow Control Policy.* As defined in the USEPA *Combined Sewer Overflow Policy,* the Discharger has no remaining untreated overflow events*;* the overflows that occur in San Francisco receive treatment (within the storage/transports) consisting of removal of floatables and settable solids."

In 2003, the following year, the Regional Water Board issued a subsequent post-Phase II permit (Order No. R2-2003-0073) for the OSP and Westside Wet Weather Facilities. Order No. R2-2003-0073 again explicitly recognized and reiterated that San Francisco's efforts were consistent with CSO Control Policy requirements and goals:

> "The Discharger is served almost 100% by combined sewers and thus is directly affected by the CSO Control Policy. In 1997, U.S. EPA and the Board reviewed this Policy together with documentation submitted by the Discharger and have made the following determinations:
>
> a. The Discharger has demonstrated implementation of the nine minimum control technologies as specified in the Policy.

---

[9] One of two approaches must be used to ensure water quality standards are being met; the Presumption Approach or the Demonstration Approach. The Presumption Approach implements a minimum level of treatment that is presumed to meet water quality standards whereas the Demonstration Approach demonstrates that water quality standards are being met even though the program does not meet designated criteria.

[10] As described in the CSO Control Policy, a Phase II NPDES permit requires continued implementation of the nine minimum controls and a LTCP.

b. The Discharger has completed its Master Plan CSO control program and has otherwise demonstrated compliance with section I.C.1 of the CSO Control Policy. Therefore, the Discharger is not required to complete a (new) CSO long-term plan.

c. The Discharger has demonstrated compliance with the "Presumption" Approach for compliance during wet weather with water quality standards. (See Finding 38 for a discussion of the "Presumption" Approach.)

d. The Discharger's implementation of its wastewater Master Plan appropriately considered sensitive areas as required in the CSO Control Policy.

e. During wet weather, the Discharger operates its Oceanside WPCP [Water Pollution Control Plant] at the maximum capacity compatible with safe operation and thus is in compliance with the CSO Control Policy provisions which allow for the discharge during wet weather of combined sewer flows which have received primary-only treatment."

4. Operational Requirements to Maximize Treatment and Storage

The Bayside and Westside NPDES permits each contain specific requirements for operations during wet weather that are intended to "optimize operations to minimize combined sewer discharges and maximize pollutant removal during wet weather."[11] These requirements generally require maximizing pumping within the system and to each of the treatment plants before any CSD occurs and, after a storm, ensuring that T/S structures are quickly pumped down to make capacity available if more rain is forecast. The specific numeric requirements are based on the design capacity of different treatment and pumping facilities, such as the 250 MGD wet weather capacity at SEP, or the 175 MGD capacity of the Westside Pump Station.

In 2013 the City used its H&H model to evaluate the Bayside system's wet weather operational strategies. The purpose of the evaluation was to determine whether modification to the operation of the existing system could reduce CSD frequency or volume, increase utilization of storage capacity, or increase wet weather flows receiving secondary treatment. The analyses found that storage in the Sunnydale and Yosemite T/S structures could be better utilized by reducing the rates at which the Sunnydale and Griffith Pump Stations send flows to the Islais T/S structure. The modeled effect of this change on CSD volume, however, was small because of the relatively small size of the Southeast Basin catchment as compared to the Central Basin catchment.

This effort also identified the possibility of improved rainfall forecasting as a means of further optimizing wet weather performance. With a perfect rainfall forecasting system, pumping could be adjusted dynamically during the storm. Model simulations indicated that perfect forecasting could enable a small increase the typical year volumes receiving secondary treatment. SFPUC engaged the National Oceanographic and Atmospheric Administration (NOAA) to explore providing financial support for technical services to improve local forecasting. The small improvements in local forecasting predicted, however, did not justify the significant investment needed.

[11] See, e.g., SEP Permit (NPDES Permit No. R2-2013-0029), p. 23.

5. Additional Measures to Maximize Pollutant Removal and CSD Strategies

Past and planned improvements to manage wet weather flows are briefly summarized here and in the SFPUC's 2018 *Bayside Sensitive Areas Report*, submitted concurrently with this report. Consideration of further measures to maximize pollutant removal and reduce CSDs must be viewed in the context of the substantial initial investment in the system in 1997. A timeline of key planning and construction activities from 1967 to the present is shown in **Figure 2**Error! Reference source not found. and demonstrates how the City continues to invest in wet weather facilities. That investment has resulted in substantial wet weather treatment and storage capacity and reduced the number of CSDs from the historical average of 82 by nearly an order of magnitude. As a result of this substantial capital improvement program, over two decades, limited opportunities exist to significantly and cost-effectively reduce CSD volume further. As described in the following sections, however, the City continues to take incremental steps, via both grey and green infrastructure projects, to reduce overall CSD volume.

5.1 Grey Infrastructure

Since completion of the City's wet weather facilities in 1997, additional system improvements have been made that benefit the system performance. In 2012, SFPUC completed construction of the New Sunnydale Tunnel. The primary project driver was to reduce flooding in the Visitacion Valley neighborhood, but an ancillary benefit was an approximate 3.4 MG increase in storage capacity in Southeast Basin. Additionally, the recently completed rehabilitation of the Marin (CSD No. 032) and Selby (CSD No. 033) outfalls included installation of an additional set of baffles to further improve pollutant removal prior to discharge.

Improvements to the wet weather facilities continue to be evaluated as part of the SFPUC's ongoing capital planning process. Specifically, in 2012, the SFPUC undertook a planning exercise to generate conceptual strategies and planning-level cost estimates for higher levels of CSD control. The objectives of this effort included identifying opportunities to cost-effectively provide higher control of CSD frequency or volume in conjunction with addressing other capital needs (such as pump station or CSD outfall rehabilitation); ensuring that other planned projects will not foreclose optimal CSD reduction opportunities; and ensuring that CSD control opportunities were considered and prioritized along with all other capital needs in future capital planning efforts. Select Bayside CSD reduction scenarios identified in 2012 have been updated and are summarized in the 2018 *Bayside Sensitive Areas Report* that is submitted concurrently with this report.

Some of the projects identified in the 2012 exercise and that are completed or continue to be investigated include:

- Increasing capacity of the force main discharging from the Sea Cliff Pump Station No. 2 when the force main is replaced to reduce CSDs from outfall no. 007;
- Optimizing sewer system improvements tributary to the Mariposa Pump Station to reduce CSDs from outfall no. 029;

- Coordinating with the redevelopment of Pier 70 to explore reducing CSDs from outfall no. 030 at full build-out when the 20th Street Pump Station and force main are replaced; and
- Evaluating the potential for reducing CSDs from the Central Basin as part of the planning for the Central Bayside Improvement Project, which is intended to provide redundancy to the Channel Force Main.

5.2 Green Infrastructure

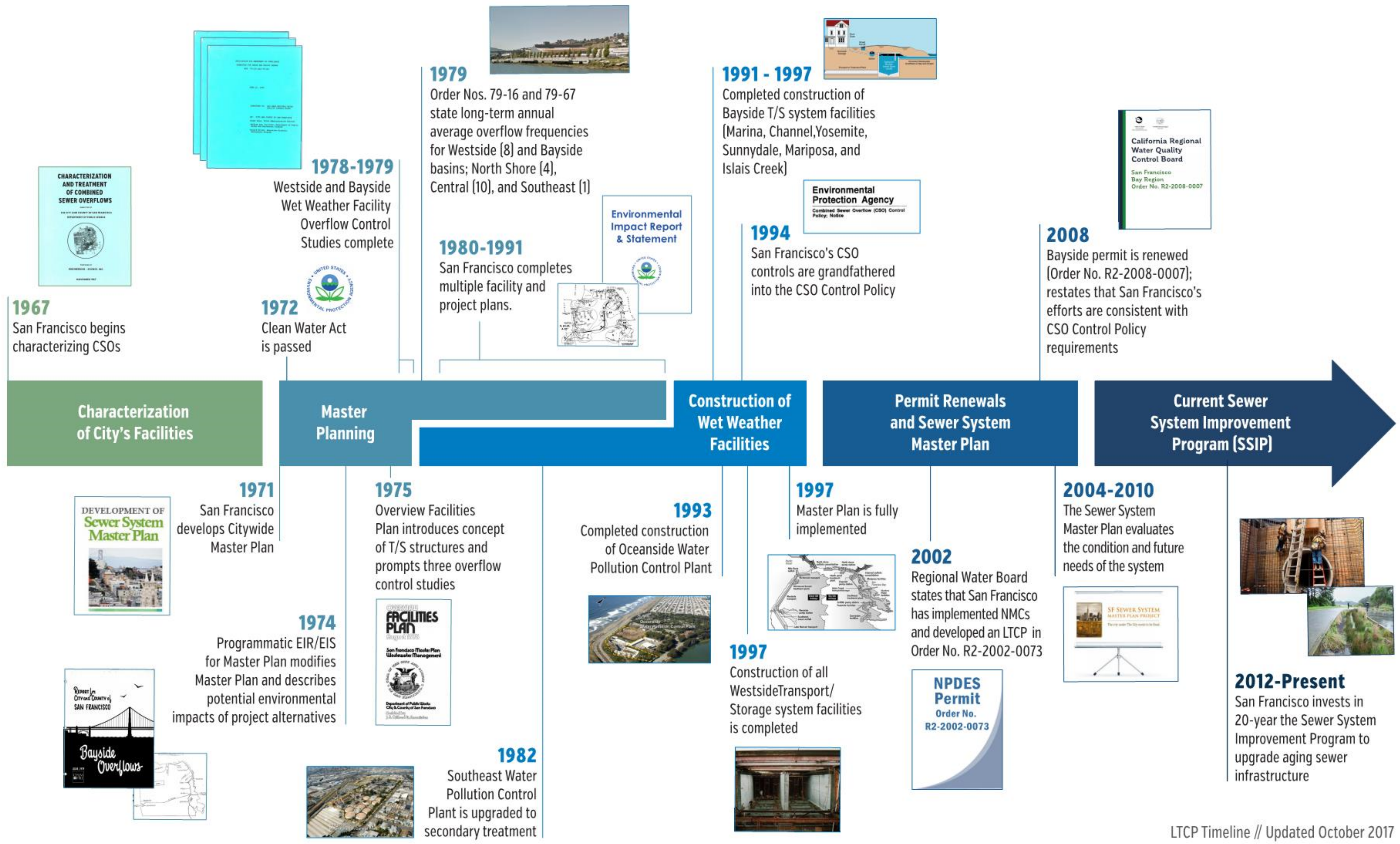
The effectiveness of green infrastructure (GI) in reducing CSD frequency and volume is limited in San Francisco's system because GI is most effective with low- to medium-intensity storms. Following decades of large-scale collection system and treatment plant improvements, the few storms that still cause CSDs are larger, more intense storms, making GI a less suitable approach for CSD reduction. GI can, however, provide system and other public and environmental benefits when implemented on a citywide scale over the long term. The City's strategy for large-scale, long term implementation includes the following:

- **Stormwater Management Ordinance:** In 2010 the City adopted a Stormwater Management Ordinance that requires all new construction and redevelopments that disturb 5,000 square feet or more to meet performance measures for controlling stormwater runoff. The SFPUC led other city agencies in the development of the San Francisco Better Streets Plan which provides guidelines for incorporating stormwater management elements into street design and offers challenge grants for green infrastructure implementation.
- **Capital projects:** Since 2009, the City has constructed several green infrastructure projects, including the following:
    - Cesar Chavez Streetscape Improvement
    - Newcomb Avenue Green Street
    - San Francisco State University Bioswale
    - San Francisco State University Infiltration Basin
    - Sunset Circle
    - Leland Avenue Streetscape Improvement Project
    - Sunset Boulevard Greenway Pilot Block
    - Mission-Valencia Green Gateway
    - Fell-Oak Green Infrastructure
    - Holloway Green Street
    - Sunset Boulevard Greenway Phase 1 Block

The Cesar Chavez Streetscape Improvement project included 18 rain gardens along more than a half mile of impervious street.

Additional projects will be identified, evaluated, and prioritized as capital planning for the collection system continues.

Figure 2: Series of Events Leading to Establishment of San Francisco's LTCP



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6. Alternative Metrics for Evaluating Wet Weather Disinfection System Performance

While not an element of the CSO Control Policy, the Bayside Permit requirements for this report include developing and proposing a metric to evaluate the performance of the wet weather disinfection systems for discharges from the SEP and the NPF. This requirement was included at the request of the SFPUC to facilitate an evaluation of opportunities to reduce the use of disinfection chemicals. The SEP final effluent discharges to San Francisco Bay approximately 800 feet downstream of the point at which samples to determine compliance with bacteria and chlorine residual effluent limitation are collected. Taking into account chlorine decay that can occur in outfall pipes has the potential to reduce the use of sodium bisulfite for dechlorination. Other utilities in the country have successfully reduced their chemical use through the implementation of NPDES permit limits for total chlorine residual that account for the chlorine decay within the outfall pipe.

A technical report, the *Total Residual Chlorine Report* (Appendix B), was completed in 2018 by the wastewater engineering firm Hazen and Sawyer to evaluate the City's current chemical dosing strategies, the potential for chlorine decay in outfall pipes downstream of compliance monitoring locations, and the potential effectiveness of using ultraviolet light (UV) and peracetic acid (PAA) as disinfection alternatives. The report concluded that current SFPUC dosing is effective at optimizing chemical usage, that the residence time in the outfalls had an insignificant effect on reducing chlorine residual concentrations, and that UV and PAA disinfection were likely to be less reliable disinfection methods than chlorination and dechlorination.

7. Post-Construction Monitoring

No single document encompasses all the post-construction monitoring performed by the City. Some elements are specified as requirements in past and current NPDES permits, whereas other elements have been voluntarily implemented to better understand system performance. Generally, current monitoring falls into three categories: (1) system performance, (2) wet weather discharge monitoring, and (3) receiving water monitoring and modeling.

7.1 System Performance

Actual system performance is monitored consistent with the current NPDES permits, which require monitoring and reporting the frequency and estimated volume of CSDs from the following specific outfalls: 001, 002, 003, 004, 005, 006, 007, 010, 025, 029, 031A, 041, and 043. In addition to these locations, the SFPUC has installed level sensors and similar devices at locations within the wet weather facilities that enable reporting of the estimated volume from all CSDs on the Bayside. This system evolved over time and is now reflected in the monthly self-monitoring reports (SMRs) submitted by the SFPUC.

As briefly described in Section 2, long term performance of the system is evaluated using the City's H&H model, which was first developed in 2006 and has been regularly updated. A more detailed description of the model is included in the 2018 *Sensitive Areas Report.*

7.2 Wet Weather Discharge Monitoring

The SFPUC's wet weather discharge monitoring has been incorporated into the Bayside and Westside NPDES permits. These permits require the collection of samples at locations representative of the discharges from specific CSD outfalls as well as sampling of wet weather effluent at each of the three treatment plants. The results of the CSD analytical monitoring have been summarized in three reports submitted to the Regional Water Board to fulfill the nine guidance elements in each permit to characterize wet weather discharge impacts and the efficacy of controls. Reports include the *Bayside Operations Evaluation Study* (2013), *Characterization of Westside Wet Weather Discharges and the Efficacy of Combined Sewer Discharge Controls* (2014), and the *Overflow Impacts and Efficacy of Combined Sewer Overflow Controls for the San Francisco Bayside System, Southeast Water Pollution Control Plant, North Point Facility, and Bayside Wet Weather Facilities* (2017). Analyses of the CSD samples for metals and other constituents indicate that copper and zinc concentrations are elevated, but within the range of concentrations typically found in urban stormwater runoff.

7.3 Receiving Water Monitoring & Modeling

The Bayside and Westside NPDES permits identify specific shoreline locations that must be monitored for fecal indicator bacteria (FIB) at a frequency sufficient to characterize ambient conditions and after CSDs occur. The SFPUC's shoreline monitoring program is jointly administered with the San Francisco Department of Public Health. The program samples the specific shoreline locations identified in the permits and includes additional locations beyond the requirements in the permits. The results of this shoreline sampling are reported in monthly SMRs.

Receiving water monitoring on the Westside also includes an offshore monitoring program designed to identify any effect on receiving water from SWOO discharge. The results of this program are reported in the 2016 SWOO Data Report.

In 2014, the SFPUC began development of a three-dimensional receiving water model to simulate the fate and transport of wet weather discharges and to inform capital planning efforts. The model was based on a two-dimensional Delft3D model developed by the United States Geological Survey (USGS) Pacific Coastal and Marine Science Center. The USGS model was converted to Delft3d Flexible mesh, the shoreline around San Francisco and the vicinity of SWOO was refined, and the model was calibrated using field monitoring data collected in 2016 and 2017. The model has been used to evaluate conceptual CSD reduction projects for the 2018 *Sensitive Areas Report*, inform potential capital project development such as evaluating the potential for closing certain CSD outfalls as a cost-effective alternative to rehabilitation or replacement.

The SFPUC proposes to continue all above-mentioned elements of the current post-construction monitoring program, with modifications to be discussed with the Regional Water Board during the permit re-issuance processes for the Westside and Bayside Permits.

Appendix A - Summary Table of Documents that Comprise the SFPUC Wastewater LTCP

Table of Documents that Comprise the SFPUC Wastewater LTCP[12]

Document Name	Applicable System	Year Issued	Brief Description	LTCP Guidance Element(s)[13] Satisfied								
				1. Characterization, Monitoring & Modeling	2.Public Participation	3. Sensitive Areas	4.Evaluation Alternatives	5.Cost/ Performance	6. Operations Plan	7. Max Treatment at POTW	8. Implement. Schedule	9. Post Construction Monitoring
Characterization and Treatment of Combined Sewer Overflows; FWPCA Grant WPC 112-01-66	Bayside	Nov 1967	First characterization of the City's combined sewer system.	X			X					
San Francisco Master Plan for Waste Water Management	Bayside & Westside	Sep 1971	The City's first master plan to comprehensively address wet weather discharges. The 1971 Master Plan included a Recommended Alternative.	X	X	X	X	X	X	X		
Environmental Impact Report/Environmental Impact Statement (EIR/EIS) – San Francisco Wastewater Master Plan	Bayside & Westside	May 1974	Programmatic EIR/EIS for the 1971 Master Plan.	X	X	X	X	X	X	X	X	
Overview Facilities Plan	Bayside & Westside	Aug 1975	Plan that reviewed the 1971 Master Plan and recommended alternatives including proposed financing and construction phasing.				X	X				
North Shore Outfall Consolidation Revised Overflow Control Level Abstract Report	Bayside	Nov 1978	Petition to the Regional Water Board to revise the overflow frequency in Order No. 76-24 from an average of one overflow per year to four overflows per year.	X	X	X	X	X		X	X	
Westside Wet Weather Facilities Overflow Control Study	Bayside & Westside	Dec 1978	Modeling and a cost-benefit analysis to support the City's petition for an increase in the Westside design criteria to a long term annual average discharge frequency of eight.	X	X	X	X	X		X	X	X
Bayside Wet Weather Facilities Overflow Control Study	Bayside	May 1979	Modeling and cost-benefit analysis to support the City's petition for an increase in the design criteria to a long-term annual average discharge frequency of eight for the Channel Basin and an exception to the prohibition of an initial dilution less than 10:1.	X	X	X	X	X				X
Report for CCSF Bayside Overflows	Bayside	Jun 1979	Quantification of impacts of untreated overflows on the Bay to support proposed design criteria.	X	X	X		X				X
Bayside Facilities Plan, NPDES Permit Prohibitions Analysis Report	Bayside	Mar 1980	Detailed plan demonstrating careful planning and cost-effectiveness of pollution control technique to comply with Order No. 75-34. Also discussed the Basin Plan's 10:1 dilution ratio and the discharge into dead-end sloughs.	X		X	X	X				
Application for Amendment of Compliance Schedules	Bayside & Westside	Jun 1980	Application for amendment to CDO 79-119. The application analyzed the financial strategy for staged implementation of the Master Plan, including analysis of facility structures and proposed compliance dates. Also known as the "blue book".		X			X		X	X	
Letter to Regional Board and State Board	Bayside & Westside	Oct 1980	Additional information on cost/funding scenarios for Master Plan implementation.				X	X	X	X		

[12] All documents comprising the SFPUC wastewater LTCP listed in this table can be found in Appendix C.

[13] USEPA Office of Water, *Combined Sewer Overflows, Guidance for Long-Term Control Plan*, EPA 832-B-95-002 (September 1995), p. 1-8.

Document Name	Applicable System	Year Issued	Brief Description	LTCP Guidance Element(s)[13] Satisfied								
				1. Characterization, Monitoring & Modeling	2.Public Participation	3. Sensitive Areas	4.Evaluation Alternatives	5.Cost/ Performance	6. Operations Plan	7. Max Treatment at POTW	8. Implement. Schedule	9. Post Construction Monitoring
Bayside Facilities Plan, Citywide Control System Report	Bayside	Feb 1981	Presentation of results for the citywide control system alternatives and provided best apparent alternatives for the Bayside distributed control system to support full compliance with Order No. 79-67.	X			X	X	X	X	X	X
Bayside Facilities Plan Southeast Bayside Project Report	Bayside	Mar 1982	Detailed description of the recommended best alternatives and summary recommendations for the Southeast Bayside Project, including Sunnydale-Yosemite Transport/Storage and Hunters Point Transport/Storage.	X	X	X	X	X	X	X	X	
Crosstown Project Report, Bayside Facilities Plan	Bayside	Mar 1982	Description of alternatives for pumping facilities and transport tunnels for disposing of Bayside dry and wet weather effluent to the ocean.	X			X	X				
Bayside Treatment and Disposal Study	Bayside	Oct 1984	Examination of treatment and disposal options such as wet weather treatment facilities, disposal alternatives, and outfall capacity to handle future bayside wet weather effluent.	X		X	X	X	X			
Sunnydale Facilities Project Report; Amendment to the Bayside Facilities Plan	Bayside	Dec 1986	Analysis of Sunnydale Facilities by screening 17 options and reducing them down to five; the report provides analyses of the five and identifies best apparent alternative.	X	X	X	X	X	X	X	X	
Westside Operation Plan	Westside	1988 (revised Jan 1990)	Evaluation of alternatives for siting and sizing the OSP; the plan included an updated wet weather treatment capacity and operational strategy for the Westside facilities.	X			X	X	X	X		X
Lake Merced and Richmond Transport Storage Facilities Plan	Westside	1988 (revised Jul 1990)	Description of long term design criteria that provides detailed plans for the Lake Merced and Richmond transport/storage structures.	X	X	X	X	X	X	X	X	
Islais Creek Transport/Storage Facilities Amendment to the Crosstown Project Report Bayside	Bayside	Jul 1988	Analysis alternatives for Islais Creek transport and storage.	X	X		X	X	X	X		
Mariposa Transport/Storage Facilities Project Report Amendment to Bayside Facilities Plan	Bayside	Sep 1988	Analysis of alternatives to reduce overflows, including tunnels and in-line storage. Recommended an apparent best alternative.	X	X		X	X	X	X		
Bayside Facilities Planning Phase 3, Islais Creek Pump Station and Southeast Water Pollution Control Plant Improvements	Bayside	Jan 1991	Amendment to the Crosstown Project Report, Bayside Facilities Plan that includes plans for Islais Creek Transport/Storage and pump station and geotechnical analyses.	X	X		X	X	X	X	X	
NPDES Permit Program Attachment #2 (PRC000234)	Bayside	Mar 1994	Application to be grandfathered into the CSO Control Policy by showing how the City is in compliance with section I.C.1 of the CSO Control Policy.						X		X	
NPDES Permit Program Attachment #4 (PRC000235)	Bayside	Mar 1994	Application to be grandfathered into the CSO Control Policy by comparing the performance of wet weather controls with the “presumption approach” requirement in the CSO Control Policy.					X		X		

Appendix B - Total Residual Chlorine Report

Hazen

Total Residual Chlorine Report

Order No. R2-2013-0029 (NPDES No. CA0037664) Section IV.C.5.c.v(d)
DRAFT

Table of Contents

1. Introduction

The San Francisco Public Utilities Commission owns and operates the Southeast Water Pollution Control Plant (SEP). The SEP treats approximately 80% of San Francisco's wastewater and discharges treated wastewater effluent to the San Francisco Bay via the Pier 80 and Islais Creek (during wet weather only) outfalls. SEP discharges wastewater effluent that receives secondary treatment (during dry and wet weather) and wastewater that receives primary and secondary treatment (during wet weather only) per the following:

- Dry weather: Secondary effluent via the Pier 80 outfall (discharge point 001)
- Wet weather:
    - Secondary effluent via the Islais Creek outfall (discharge point 002)
    - Blend of secondary effluent and primary effluent via the Pier 80 outfall (discharge point 001)

Both the secondary effluent and primary effluent are chlorinated and subsequently dechlorinated such that the total residual chlorine (TRC) is 0.00 mg/L per permit Order No. R2-2013-0029 (NPDES No. CA0037664).

1.1 NPDES Permit Requirement

The SFPUC SEP discharge permit contains the following requirement as part of the permit's combined sewer system long-term control plan provisions described in Section IV.C.5.c::

> "(d) The Discharger shall develop and propose a metric to evaluate the performance of its wet weather disinfection systems for Discharge Point Nos. 001 through 006".

1.2 Purpose of this Report

SFPUC retained Hazen and Sawyer to work with SFPUC staff to analyze both the dry and wet weather disinfection systems at the SEP and its discharge points 001 and 002 to determine whether an alternative metric to the TRC 0.00 could be proposed. The study focused on strategies that could be used to reduce the amount of sodium hypochlorite (NaOCl) and sodium bisulfite ($NaHSO_3$) added to the primary and secondary effluent and alternative disinfection systems that would reduce or eliminate sodium hypochlorite and sodium bisulfite discharge to the bay which still assuring adequate disinfection for public health.

2. Evaluation

The following four options were evaluated for their potential to reduce sodium hypochlorite and sodium bisulfite dosages.

1. Optimization of the current sodium hypochlorite and sodium bisulfite dosing systems
2. Decrease chemical usage by taking credit for chlorine decay in the SEP outfall
3. Alternative disinfection by ultraviolet (UV) disinfection of the secondary effluent
4. Alternative disinfection by peracetic acid (PAA) of the secondary effluent

High-level evaluations were performed for each alternative, including field investigations and pilot scale testing.

2.1 Optimization of Current Sodium Hypochlorite and Sodium Bisulfite Dosing Strategies

An evaluation of the current sodium hypochlorite and sodium bisulfite dosing system and strategies was undertaken from 2015 to 2017. This evaluation included analysis of chemical usage, dosing strategies, stoichiometric ratios for sodium hypochlorite and sodium bisulfite application, jar testing and sampling during wet weather conditions.

Results showed that the current operational dosing strategies and stoichiometric ratios for the applied chemicals at the SEP are within the accepted ranges for plants having to meet the coliform standard and the strict TRC standard. The need to meet the current TRC standard of 0.00 mg/L does not allow for significant innovation in the dosing strategy.

Wet weather testing of the primary and secondary disinfection systems was conducted during the period of February 2017 through April 2017 using a bench-test approach. The goal of the testing was to understand the hourly initial chlorine demand throughout a storm period and investigate if potential reductions in chemical dosing could be obtained. Hourly grab samples of primary and secondary effluent were analyzed for TRC after chlorine dose to the sample and after estimated wet weather detention time had elapsed. **Figure 2-1** secondary effluent and **Figure 2-2** primary effluent present the results from one of the wet weather testing days.

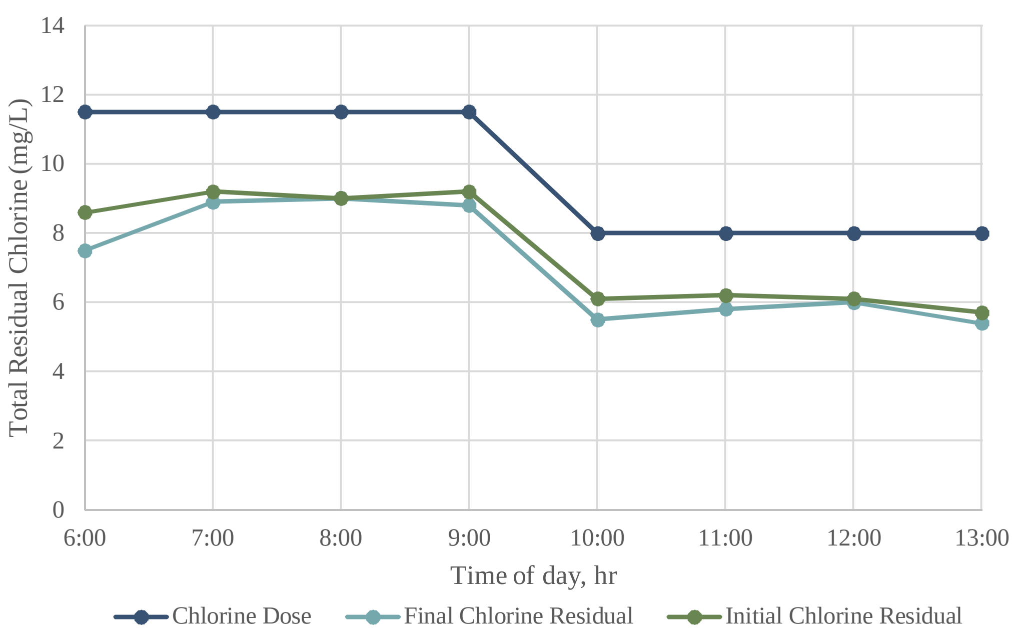

Figure 2-1: Secondary Effluent Wet Weather Bench-Scale Testing Results (February 2017)

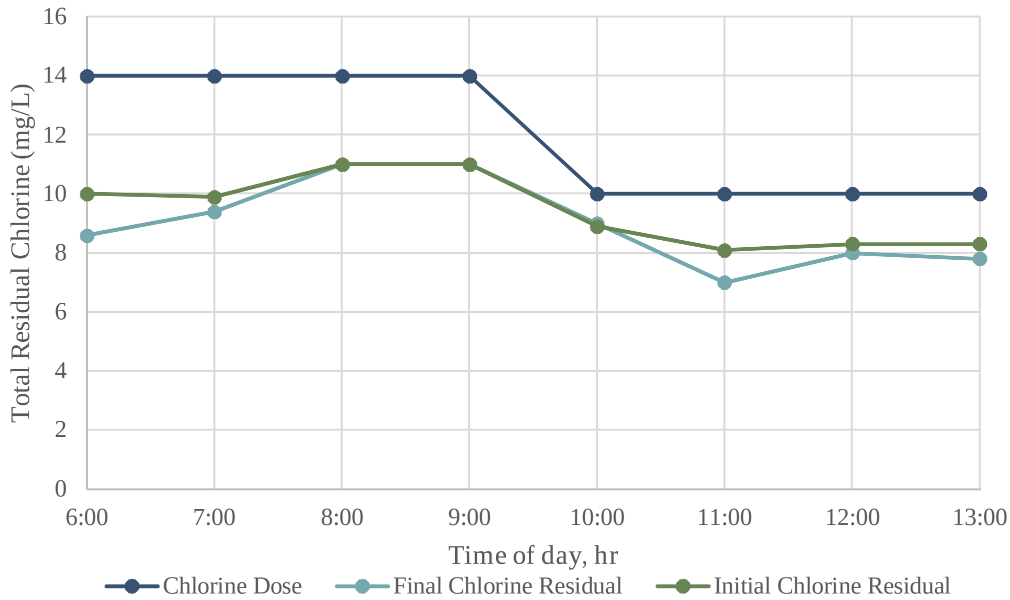

Figure 2-2: Primary Effluent Wet Weather Bench-Scale Testing Results (February 2017)

Secondary effluent initial chlorine uptake was consistent for the duration of the storm event at approximately 2 mg/L and the TRC did not decrease significantly over the chlorine contact tank hydraulic residence time. Primary effluent initial chlorine uptake decreased over the duration of the storm event, however TRC did not decrease significantly over the chlorine contact tank hydraulic residence time.

The SEP staff do have a proactive procedure to reduce chemical addition through the reduction of the pre-dechlorination residual after three hours of a storm event.

- 0-3 hrs: 5-6 mg/L pre-dechlorination TRC
- After 3 hrs: 3-4 mg/L pre-dechlorination TRC

The SEP wet weather chemical dosing strategy takes advantage of the decrease in initial chlorine uptake after the first few ours of the storm as observed during testing. It is therefore concluded that the current wet weather dosing strategy is effective at optimizing chemicals and does allow for a reduction in chemical usage as the wet weather event continues. SEP staff continue to work on optimization of the chemical dosing systems at the SEP. In 2017 the installation of the Water Champ® mixer system was completed, which improves the efficiency of the mixing and diffusion of sodium hypochlorite

2.2 Chlorine Decay in Outfall Pipes

One strategy that has been successfully used in other states to deal with low level TRC limits is to account for the chlorine decay in outfall pipes when determining the NPDES TRC permit limits. Research has shown that the organic and inorganic constituents in outfall pipes contribute to a decay constant that is on average an order of magnitude greater than the static chlorine decay constant. Chlorine decay rates in outfall pipes have varied from 0.0018 to 0.0136 min^{-1} although the rate is site specific. Florida facilities with outfall pipes that ranged from 5,200 to 18,800 feet were able to negotiate with the Florida

Department of Environmental Protection to increase their NPDES permit TRC levels to account for chlorine decay in the outfall pipe. This strategy is typically used for non-zero TRC limits such as 0.5 mg/L.

Final effluent water quality compliance samples at the SEP are taken at the plant site, while the Discharge Point 001 is over 800 feet downstream. The degree of chlorine decay in the outfall pipe is dependent mainly on HRT. **Table 2-1** presents estimated residence time downstream of the SEP effluent structure during high and low secondary effluent flows.

Bench scale testing was performed to simulate chlorine decay downstream of the SEP effluent structure. Tests were conducted at low initial TRC values, and decay was observed over the course of one hour. The results indicate that decay rate is proportional to the initial TRC concentration. For example, at a relatively low initial TRC concentration of 0.15 mg/L, it required approximately 60 minutes detention time for a 0.05 mg/L reduction in TRC. **Figure 2-3** compares the decay over 60 minutes at various initial TRC concentrations. Considering that the estimated residence times in the outfall pipe range from 10 to 20 minutes (**Table 2-1**), the potential TRC decay associated with the transport to the outfall would not be sufficient to offset small excursions of TRC leaving the facility.

Table 2-1: Estimated SEP Outfall Residence Time Before Discharge at 001 Pier 80 Outfall

	Flow (mgd)	HRT (min)
Average	57	18.4
Maximum	110	9.5

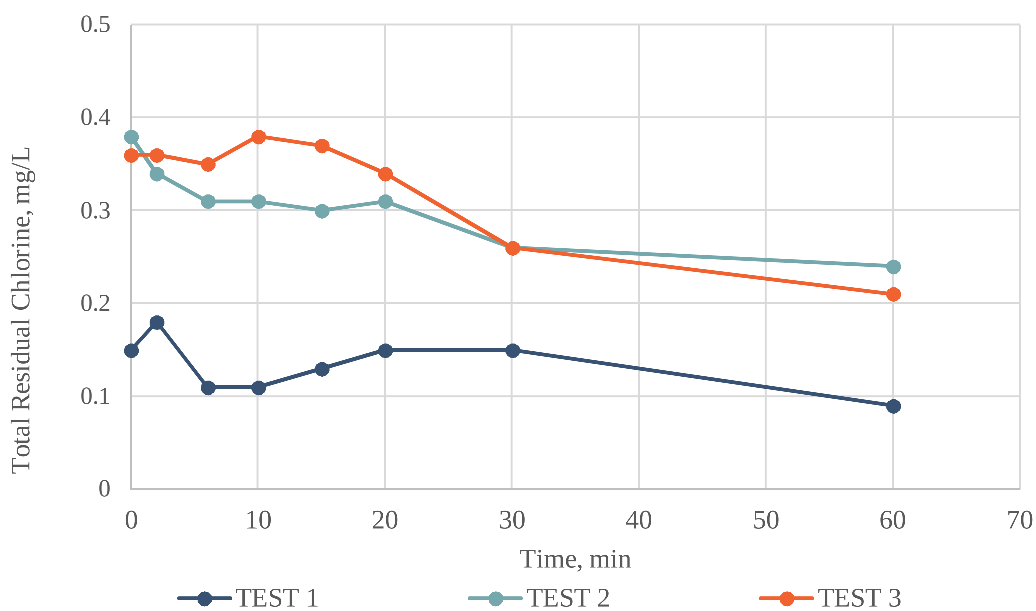

Figure 2-3: Chlorine Decay Batch Testing

Based on the short residence time and minimal decay observed during the bench scale testing, it was concluded that this alternative does not have significant potential to reduce chemical usage at the SEP plant.

2.3 UV Disinfection

Secondary effluent samples were collected by SEP staff twice per day and tested for UV transmittance (UVT) at 254 nm for two weeks during April 2016. The average UVT of these 25 samples was 48% and the 10th percentile of the UVT data was 43%. Generally, the 10th percentile UVT value is used for UV system design to ensure adequate disinfection capacity. The 10th percentile value observed at SEP is outside the range where UV disinfection is typically applied for secondary effluent. As a result of this testing, UV disinfection is currently not recommended for further evaluation at the SEP.

2.4 Peracetic Acid Testing

Peracetic acid (PAA) has been used as a disinfectant in the food and medical industries and has been used in Europe and Canada as a wastewater disinfectant. Advantages of disinfection by PAA include strong oxidation potential, lack of chlorinated disinfection by-products (DBPs), low freezing point, long shelf life, and the lack of residual quenching (typically).

On May 2, 2016, a sample from the south combined secondary effluent channel was sent to PeroxyChem, a local chemical vendor, for PAA demand testing. PAA was dosed at 1.0, 1.5, 2.0, and 3.0 mg/L as PAA, and samples were collected after 20, 30 and, 70 minutes of contact time. The samples were analyzed for fecal coliform, *Enterococcus*, PAA residual, pH, cBOD, TSS, and ammonia.

Overall PAA was shown to be effective in reducing both fecal coliform and *Enterococcus*, and PAA was more effective at meeting the fecal coliform permit limits than meeting the *Enterococcus* permit limits. A dose of 1.0 mg/L PAA resulted in a 2.4-log reduction of fecal coliform (down to 326 MPN/100 mL) in 20 minutes. A dose of 2.0 mg/L PAA resulted in *Enterococcus* levels below 35 MPN/100 mL in 70 minutes, and below 35 MPN/100 mL with 3.0 mg/L PAA in 35 minutes. At ADWF with a typical dry weather configuration in the disinfection channels, SEP has approximately 37 minutes of contact time. At peak secondary flow, the contact time is around 24 minutes. **Table 2-2** shows the available detention time with different disinfection channel configurations. Preliminary results indicate that while PAA effectively inactivates fecal coliform and *Enterococcus* at the available secondary effluent detention times during ADWF, additional dosing above the concentrations tested may be required during peak secondary flows.

Table 2-2: Secondary Disinfection System Available Hydraulic Residence Time

Channels in Service	ADWF (57 mgd) HRT (min)	Peak Secondary Flow (150 mgd) HRT (min)
1	37	14
1.5	55	21
2	75	28

For PAA disinfection, the effluent residual limit is set in a site-specific manner based on a dilution factor. Typically, the PAA residual is set at 1 mg/L for facilities that discharge into effluent dominated streams. Nevertheless, SEP has a TRC limit of 0.00 mg/L and would also likely have a similar residual requirement for PAA. Based on this bench scale testing, quenching of the PAA residual would be required to meet a residual of 0.00 mg/L.

Further testing of PAA was undertaken at SEP as part of an ongoing WE&RF study evaluating the feasibility of peracetic acid. Results from the pilot study confirmed the results of the bench scale testing, concluding that PAA was not feasible for SEP based on the low reduction of *Enterococcus* (at typical doses and contact times), the resulting PAA residual that would require quenching, and the higher costs associated with PAA.

Capital changes required to implement PAA at SEP would include retrofit of storage, pumping, and piping and dose points. Safety improvements to accommodate the concentrated PAA would need to be implemented as well. PAA requires 316L stainless steel for piping and storage with PTFE/PVDF gaskets. Capital costs, while not developed as part of this evaluation, would be significant for a conversion to PAA.

With a preliminary budgetary supply cost of $5.40 per lb active PAA and an estimated average dose of 2.0 mg/L PAA, the monthly operational costs will be approximately $156,000 per month. The price of PAA is currently in flux, and changes would significantly affect the economics behind a conversion to PAA. **Table 2-3** compares the current PAA chemical costs with the cost for disinfection and quenching with sodium hypochlorite and sodium bisulfite. The PAA costs are approximately 35% higher based on current chemical costs.

Table 2-3: Peracetic Chemical Costs

	Monthly Costs ($)	Yearly Costs (M$)
Hypochlorite	75,000	0.9
Sodium Bisulfite	41,000	0.4
Total (Chlorination/Dechlorination)	**115,000**	**1.4**
Peracetic Acid	156,000	1.9

In summary, based on the low reduction of *Enterococcus* with PAA at typical doses and contact times, the potential for residual quenching, and the high costs associated with PAA, PAA is not recommended for further evaluation at the SEP.

3. Changing the TRC Standard for the Bay

The Bay Area Clean Water Agencies (BACWA) is studying the impact of adopting the federal TRC standards for discharges to the San Francisco Bay, which could result in raising the TRC standard of 0.00 mg/L TRC. This is the most promising path for reducing the chemical load currently utilized in disinfection and dechlorination of the SFPUC's effluent as adoption of the federal TRC standard, and applied to the SFPUC based on its dilution, could allow for significant reductions in sodium hypochlorite and sodium bisulfite dosing.

4. Conclusions

To comply with one of the requirements of the SEP discharge permit, the SFPUC undertook an investigation to determine if there was a viable “metric for the SEP wet weather disinfection system” it could propose which would reduce or eliminate the sodium hypochlorite and sodium bisulfite loads currently used to meet the TRC 0.00 standard. None of the avenues investigated yielded such a metric:

- A comprehensive review of the current chemical dosing strategies for sodium hypochlorite and sodium bisulfite showed the current system operates within acceptable industry ranges. During wet weather conditions a reduction in chemical usage is obtained through a reduction in the target pre-dechlorination residual, implemented after a three-hour period. Efforts to optimize the disinfection systems at the SEP are ongoing.
- The residence time in the discharge system and outfall piping was not significant enough to allow decay of a positive chlorine residual and still meet the current TRC standard.
- UV disinfection testing indicated poor UV transmittance and UV disinfection is not recommended for further evaluation at the SEP.
- PAA disinfection is not recommended due to the low reduction of *Enterococcus* at typical doses and contact times. The PAA residual that would require quenching, and the high costs associated with dosing sufficient PAA to meet the *Enterococcus* discharge limits.

The SFPUC has concluded that the BACWA effort currently underway to study and consider adoption of the federal TRC standard for discharge to San Francisco Bay is the most likely path to allow a significant reduction in chemicals dosed to the plant effluent.

Appendix C - Documents that Comprise the SFPUC Wastewater LTCP