CHAPTER 7

WASTEWATER

The City of San Francisco's wastewater assets are managed by the San Francisco Public Utilities Commission (SFPUC) Wastewater Enterprise. San Francisco's combined sewer system collects and treats both stormwater and wastewater (see Figure 7.1). This system includes nearly 1,000 miles of sewer pipelines, 26 pump stations, and three treatment plants that collect, convey, and treat stormwater and wastewater before it is discharged through outfalls to San Francisco Bay and the Pacific Ocean.

The sewer system collects approximately 70 million gallons (MG) of water on average dry days and has the capacity to collect and treat up to 575 million gallons per day (mgd) of combined wastewater and stormwater during wet weather. During dry weather, the collection system conveys wastewater flows for treatment at the Southeast Treatment Plant near Islais Creek and the Oceanside Treatment Plant on the westside of the City near the San Francisco Zoo. During wet weather, combined flows are also conveyed for treatment at the North Point Wet-Weather Facility near Fisherman's Wharf.

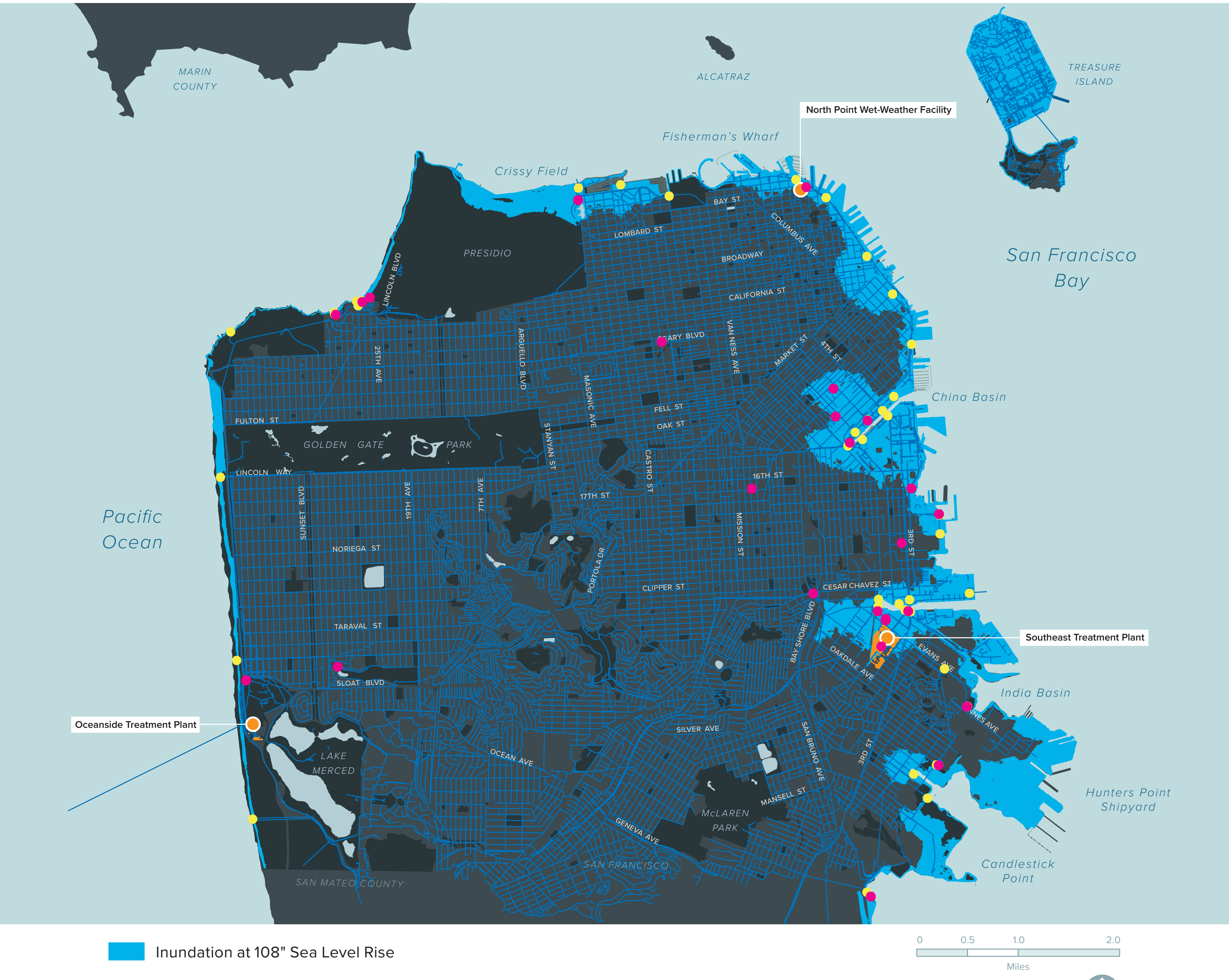
SLR and coastal storm surge will impact the integrity of SFPUC's wastewater infrastructure . Climate change, in particular SLR, is one of many considerations informing SFPUC's Sewer System Improvement Program[1] – a comprehensive program to upgrade the aging sewer infrastructure and ensure the reliability and performance of the City's sewer system. SFPUC completed a Climate Vulnerability and Adaptation Assessment to evaluate the vulnerability of wastewater assets to climate hazards, including SLR, coastal flooding, rising groundwater, and precipitation-driven flooding.[2]

The following sections provide a summary of SFPUC's Climate Vulnerability and Adaptation Assessment, with a focus on how key assets and asset categories may be vulnerable to SLR and extreme tide-related flooding.

1 San Francisco Public Utilities Commission (SFPUC). Sewer System Improvement Program. Available at https://www.sfwater.org/index.aspx?page=116.

2 San Francisco Public Utilities Commission (SFPUC). 2019. Climate Vulnerability and Adaptation Assessment for the Waste Water Enterprise Sewer System Improvement Program.

Figure 7.1 Wastewater System and Assets



Inundation at 108" Sea Level Rise

Treatment Facility

Pump Station

Combined Sewer Discharge

Buried Sewers

7.1 PUMP STATIONS

The wastewater collection sewer system is designed to take advantage of the City's natural topography wherever possible to maximize the benefits of gravity flow; however, pump stations and force mains are required in locations where gravity flow is not feasible. There are 26 pump stations located throughout the City. During dry weather, 14 pump stations transport wastewater to the Southeast and Oceanside treatment plants for treatment. During wet weather, all 26 pump stations transport combined wastewater and stormwater to the City's three treatment plants for treatment and discharge. Continued operation of the pump stations is critical for protecting the environment and public health.

7.1.1 Potentially Vulnerable Assets

Fifteen of SFPUC's 26 wastewater pump stations are located within the SLR Vulnerability Zone, as shown on Figure 7.2.

7.1.1.1 Channel Pump Station

Channel pump station is an abovegrade pump station located at 455 Berry Street near Mission Bay between 6th and 7th Streets in a mixed residential and industrial area directly adjacent to the Mission Bay shoreline (Photo 7.1). Currently, this pump station serves both the Channel and Northshore drainage basins. Constructed in 1979 and upgraded in 2010, Channel pump station has a pumping capacity of 103 mgd and operates continuously in both dry and wet weather. In dry weather, Channel pump station receives and transports wastewater pumped from the North Shore pump station and flows from the Channel drainage area. The pump station conveys wastewater through the Channel force main to the Southeast Treatment Plant. In wet weather, combined flows are conveyed from the local drainage area to the Southeast Treatment Plant. The pump motor, electrical equipment, and controls are located at grade. This station could be exposed to floodwaters under 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6).

Photo 7.1 Channel Pump Station (above grade). Sergio Ruiz

Figure 7.2 Wastewater Pump Stations and the SLRVZ

PUMP STATIONS

1. Channel Pump Station
2. Bruce Flynn Pump Station
3. Northshore Pump Station
4. Griffith Pump Station
5. Sunnydale Pump Station
6. Mariposa Pump Station
7. Palace of Fine Arts Pump Station
8. Davidson Pump Station
9. Rankin Pump Station
10. Merlin Morris Pump Station
11. Harriet-Lucerne Pump Station
12. Twentieth Street Pump Station
13. Berry Street Pump Station
14. Booster Pump Station
15. Southeast Lift Station

Inundation at 108" Sea Level Rise

7.1.1.2 Bruce Flynn Pump Station

Bruce Flynn pump station is an above grade pump station located in an industrial area at the intersection of Rankin Street and Davidson Avenue, approximately 500 feet from the Bay shoreline. This wet-weather pump station was constructed in 1996, is presently being upgraded, and will have a pumping capacity of 150 mgd. In wet weather, the pump station receives combined flows from the Islais Creek transport / storage box and pumps to the Southeast Treatment Plant. This pump station serves the Islais Creek, Yosemite, Sunnydale, and Mariposa drainage areas in wet weather. Electrical equipment and controls are located at grade, and the pump motor is located below grade.

This station could be exposed to floodwaters under 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). Pathways for flooding at this asset include roll-up doors at ground level and open ground-level areas with equipment. There are several access points to below grade rooms and water-sensitive equipment inside the station.

7.1.1.3 North Shore Pump Station

North Shore pump station is an abovegrade pump station located at 2001 Kearny Street at the intersection of Bay Street and Kearny Street. The pump station is in a mixed commercial and industrial area, approximately 300 feet from the Bay shoreline.

Constructed in 1982, North Shore pump station serves the Northshore drainage basin during both dry and wet weather. This pump station operates continuously in dry weather and conveys 30 mgd of wastewater to the Channel pump station, which transports wastewater to the Southeast Treatment Plant. During wet weather, the pump station can convey 150 mgd to the North Point Wet-Weather Facility. Electrical equipment and controls are located over 3.5 feet above grade, and the pump motor is located below grade.

7.1.1.4 Griffith Pump Station

Griffith pump station is an abovegrade pump station located in an industrial area at the intersection of Griffith Street and Thomas Avenue, approximately 400 feet from the Bay shoreline. Constructed in 1989 and upgraded in 1998 and 2018, this pump station serves the lower Yosemite and Sunnydale drainage basins with a pumping capacity of 120 mgd. In dry and wet weather, the Griffith pump station conveys wastewater and/or combined flows to the Hunters Point tunnel via two force mains. Electrical equipment and controls are located at grade.

This station could be exposed to floodwaters with 66 inches of SLR coupled with a 100-year extreme tide (Scenario 10). Pathways for flooding at this asset include the north door approximately one foot above ground level and louvers approximately 1.5 feet above ground level.

7.1.1.5 Sunnydale Pump Station

Sunnydale pump station is a belowgrade pump station located on Harney Way between US 101 and the Bay. The pump station is located near an industrial area but is isolated because of its location directly adjacent to the Bay shoreline. Sunnydale pump station currently experiences intermittent coastal flooding, although the impacts thus far have been negligible. Repairs and flood-proofing measures are planned.

Constructed in 1991, Sunnydale pump station serves the Sunnydale drainage basin during wet weather with a pumping capacity of 50 mgd. In wet weather, the pump station conveys flows from the Sunnydale transport / storage box and overflow from the Sunnydale tunnel to the Candlestick tunnel via a force main. Wet weather flows eventually reach Griffith pump station. The pump motor, electrical equipment, and controls are located below grade. This station could be exposed to floodwaters during a 2-year annual extreme high tide today. With 12 inches of SLR, this pump station could be exposed with a 1-year annual extreme high tide, and with 24 inches of SLR, this pump station could experience daily impacts (Scenario 2). Pathways for flooding at this asset include an air intake structure and multiple floor hatches that lead into the station. Once floodwaters enter the station, there are several access points to belowgrade rooms and water-sensitive equipment inside the station. Because this station is located directly along the shoreline, it is also at risk to wave hazards, including wave runup and overtopping over the station structure. Wave hazards may also increase with SLR.

7.1.1.6 Mariposa Pump Station

Mariposa pump station is an abovegrade pump station located in an industrial area on Terry Francois Boulevard, approximately 200 feet from the Bay shoreline. The pump station serves the Mariposa drainage basin. The existing dry weather pump station is in the process of being demolished and replaced and will provide an overall pumping capacity of 15 mgd. In dry and wet weather, the pump station conveys combined flows from the Mariposa transport / storage box to the gravity sewer located at 21st Street and Illinois Street, which then flows to the Southeast Treatment Plant. The original dry-weather pump station was constructed in 1954 and expanded to wet-weather capabilities in 1993.

This station could be exposed to floodwaters with 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). Existing electrical equipment and controls are located approximately one foot above grade, and the pump motor is located below grade. Pathways for flooding at the existing pump station include several hatches, doorways, and ventilation openings at or near ground level. There are louver openings at the control room located four feet above ground level. There are several access points to belowgrade rooms and water-sensitive equipment inside the station. Floodwaters can also reach the wet-weather and dewatering pump equipment in the yard through the ground-level hatches. The new pump station is being designed to accommodate anticipated SLR by raising grades and limiting potential flood pathways into the pump station.

7.1.1.7 Palace of Fine Arts Pump Station

The Palace of Fine Arts Pump Station consists of two facilities, which serve a two-acre drainage area that includes the Palace of Fine Arts and its surrounding lagoon and landscaped areas. The facilities are located in a mixed residential and commercial area at Lyon Street near the Palace of Fine Arts Theatre and Presidio Park, approximately 850 feet from the Bay shoreline. The pump station serves a small area in the North Shore drainage basin with a pumping capacity of 0.43 mgd. The wet-weather pump station was constructed in 1967, and the dry-weather pump station was constructed in 1994. It receives wastewater from the Palace of Fine Arts building, and storm runoff and drainage from the adjacent lagoon. Dry- and wet-weather flow is transported to the Marina transport / storage box. The controls are located at grade and the wet well is located below grade.

This station could be exposed to floodwaters with 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). Pathways for flooding at this asset include several access hatches and manholes at ground level. Once floodwaters enter through these openings, belowgrade rooms and water-sensitive equipment can be affected. The at-grade electrical controls are also at risk from shallow flooding.

7.1.1.8 Davidson Pump Station

Davidson pump station is a belowgrade pump station located on Davidson Avenue in a mixed industrial and commercial area, approximately 250 feet from the Bay shoreline. This pump station was constructed in 1996 and serves a small area adjacent to I-280 near Islais Creek with a pumping capacity of one mgd. Davidson pump station conveys wet-weather flows to an adjacent sewer. Electrical equipment and controls are located approximately 0.5 feet above grade, and the pump motor is located below grade.

This station could be exposed to floodwaters with 52 inches of SLR, or 12 inches of SLR coupled with a 100-year extreme tide (Scenario 5). Pathways for flooding at this asset include hatches at ground level and open areas with equipment at or near ground level.

7.1.1.9 Rankin Pump Station

Rankin pump station is a belowgrade pump station located at the intersection of Rankin Street and Davidson Avenue. This pump station was constructed in 1998 and serves a local area of the Islais Creek drainage basin with a pumping capacity of three mgd. In wet weather, the pump station conveys combined flows into the three-chamber basin dry-weather compartments of the Rankin / Custer sewer. Electrical equipment and controls are located at grade, and the wet well and pump motor are located below grade (on Rankin Street, north of the controls structure).

This station could be exposed to floodwaters with 52 inches of SLR, or 12 inches of SLR coupled with a 100-year extreme tide (Scenario 5). Pathways for flooding at this asset include hatches at ground level and an electrical cabinet on the sidewalk. The at-grade electrical controls are also at risk from shallow flooding.

7.1.1.10 Merlin Morris Pump Station

Merlin Morris pump station is a belowgrade pump station located on Merlin Street (near Harrison Street) in a mixed residential and commercial area, approximately 1,600 feet from the San Francisco Bay shoreline. The pump station serves a local area of the Channel drainage basin with a pumping capacity of 9.2 mgd. This wet-weather pump station was constructed in 1988. The electrical equipment and controls are located at grade and the wet-well is located below grade.

This station could be exposed to floodwaters with 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). Pathways for flooding at this asset include several hatches, doorways, and ventilation openings at or near ground level. There are louver openings at the control room located four feet above ground level and there are several access points to belowgrade rooms and equipment inside the station. Floodwaters can also reach the wet-weather and dewatering pump equipment in the yard through the ground-level hatches.

7.1.1.11 Harriet-Lucerne Pump Station

Harriet-Lucerne pump station is a belowgrade pump station located in a mixed residential and commercial area on Harriet Street, approximately 1,600 feet from the San Francisco Bay shoreline. This pump station was constructed in 2005 and serves a local area of the Channel drainage basin with a pumping capacity of 7.3 mgd. Electrical equipment and controls are located approximately 1.5 feet above grade, and the pump motor is located below grade.

This station could be exposed to floodwaters with 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). Pathways for flooding at this asset include hatches and manholes at ground level that would allow water to reach the equipment.

7.1.1.12 Twentieth Street Pump Station

The Twentieth Street pump station is a belowgrade pump station located in a mixed residential and commercial area on 20th Street, approximately 100 feet from the San Francisco Bay shoreline. This pump station serves the eastern end of Twentieth Street and the old Todd Shipyard in the Mariposa drainage basin with a pumping capacity of three mgd. The pump station conveys dry- and wet-weather flows to the Twentieth Street gravity sewer connection structure. This pump station was constructed in 1993 and last upgraded in 2010. Electrical equipment and controls are located at grade and below grade, and the pump motor is located below grade. The main power is located at grade west of the station.

This station could be exposed to floodwaters with 66 inches of SLR, or 24 inches of SLR coupled a 100-year extreme tide (Scenario 6). Pathways for flooding at this asset include the access hatch and the air exhaust at ground level that can lead to water reaching belowgrade rooms and equipment. This pump station will be placed as part of the Pier 70 development project.

7.1.1.13 Berry Street Pump Station

Berry Street pump station is a belowgrade pump station located at the corner of Berry Street and 5th Street in a mixed residential and industrial area adjacent to Mission Creek, approximately 200 feet from the San Francisco Bay shoreline. This pump station was constructed in 1997 and serves the Berry Street drainage area in the Channel drainage basin with a pumping capacity of 9.2 mgd. During wet weather, this pump station conveys combined flows from the Berry Street drainage area to a sewer on 5th Street. Electrical equipment and controls are located at and below grade.

This station could be exposed to floodwaters with 52 inches of SLR, or 12 inches of SLR coupled with a 100-year extreme tide (Scenario 5). Pathways for flooding at this asset include several access hatches and manholes at ground level. Once floodwaters enter through these openings, belowgrade rooms and equipment can be affected. The at-grade electrical controls are also at risk from shallow flooding.

7.1.1.14 Booster Pump Station

Booster pump station is an abovegrade pump station located in an industrial and commercial area near the 3rd Street bridge crossing, directly adjacent to the San Francisco Bay shoreline. This pump station serves the Southeast Treatment Plant, conveying treated effluent from the plant to the Bay through the Southeast Bay Outfall with a pumping capacity of 110 mgd. During wet weather, treated flows beyond the capacity of the pump station discharge directly to Islais Creek. This dry- and wet-weather effluent pump station was constructed in 1967 and last upgraded in 2002. Electrical equipment and controls are located above grade.

This station could be exposed to floodwaters during 52 inches of SLR, or 12 inches of SLR coupled with a 100-year extreme tide (Scenario 5). Pathways for flooding at this asset include several hatches, doorways, and ventilation openings at or near ground level. The louver openings in the control room are located four feet above ground level. There are several access points to belowgrade rooms and equipment inside the station. Floodwaters can also reach the wet-weather and dewatering pump equipment in the yard through the ground-level hatches.

7.1.1.15 Southeast Lift Station

Southeast lift station is an abovegrade pump station located adjacent to Islais Creek in an industrial and commercial area near the Southeast Treatment Plant Headworks Facility, approximately 750 feet from the Bay shoreline. The original pump station at this location was constructed in 1981. However, this pump station is being demolished and will be replaced with a new pump station designed to accommodate anticipated SLR by raising grades and limiting potential flood pathways into the pump station once the upgrades to the Bruce Flynn pump station are complete. When complete, the new pump station will serve the Islais Creek, Yosemite, Sunnydale, and Mariposa drainage areas with a pumping capacity of 50 mgd. The dry- and wet-weather pump station will convey gravity flows from the Islais Creek, Yosemite, and Sunnydale drainage areas to the Southeast Treatment Plant Headworks Facility for preliminary treatment.

While the original pump station is still in operation, it could be exposed to floodwaters with 52 inches of SLR, or 12 inches of SLR coupled with a 100-year extreme tide (Scenario 5). Pathways for flooding at this asset include several hatches, doorways, and ventilation openings at or near ground level. There are several access points to belowgrade rooms and equipment inside the station. The new pump station will be located just inland of the original facility, and could potentially be impacted under Scenario 6.

7.1.2 Exposure Assessment

The exposure of the pump stations was evaluated relative to the 10 SLR scenarios (see Chapter 2) to assess when each pump station is first exposed to potential inundation. The pump stations located within the SLR Vulnerability Zone are presented in Table 7.1.

Of the 26 pump stations that help convey combined wastewater and stormwater to the City's three treatment plants for treatment and discharge, only one, Sunnydale, could be exposed to temporary flooding from a 100-year extreme tide today, with no SLR (Scenarios 1-3). Sunnydale pump station is located directly adjacent to the shoreline and can also be exposed to coastal wave hazards. Five additional pump stations could be exposed with 52 inches of SLR, or 12 inches of SLR coupled with a 100-year extreme tide (Scenario 5). With 66 inches of SLR coupled with a 100-year extreme tide (Scenario 10), a total of 15 pump stations could be exposed to temporary flooding. As pump station upgrades are planned, or as new pump stations are constructed as part of the Sewer System Improvement Program, SFPUC is addressing potential SLR flooding risks.

Table 7.1 Pump Station Exposure Summary

Pump Station	Pumping Capacity (mgd)	Wet or All Weather	Pump Stations within Each Sea Level Rise Scenario (Y/-)									
			1	2	3	4	5	6	7	8	9	10
Channel	103	All	-	-	-	-	-	Y	Y	Y	Y	Y
Bruce Flynn	(old 110) new 150	Wet	-	-	-	-	-	Y	Y	Y	Y	Y
North Shore	150	All	-	-	-	-	-	-	Y	Y	Y	Y
Griffith	120	All	-	-	-	-	-	-	-	-	-	Y
Sunnydale	50	Wet	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mariposa*	15	All	-	-	-	-	-	Y	Y	Y	Y	Y
Palace of Fine Arts	0.43	All	-	-	-	-	-	Y	Y	Y	Y	Y
Davidson	1	Wet	-	-	-	-	Y	Y	Y	Y	Y	Y
Rankin	3	Wet	-	-	-	-	Y	Y	Y	Y	Y	Y
Merlin Morris	9.2	Wet	-	-	-	-	-	Y	Y	Y	Y	Y
Harriet-Lucerne	7.3	Wet	-	-	-	-	-	Y	Y	Y	Y	Y
Twentieth Street	3	All	-	-	-	-	-	Y	Y	Y	Y	Y
Berry Street	9.2	Wet	-	-	-	-	Y	Y	Y	Y	Y	Y
Booster	110	All	-	-	-	-	Y	Y	Y	Y	Y	Y
Southeast Lift Station*	50	All	-	-	-	-	Y	Y	Y	Y	Y	Y

* Mariposa pump station and Southeast lift station are currently being demolished and replaced with new pump stations as part of the Sewer System Improvement Program. The new pump stations are designed to accommodate anticipated SLR by raising grades and limiting potential flood pathways into the structures.

7.1.3 Consequence Summary

The consequences that could occur to society and equity, the economy, environment, and governance (see Chapter 3) were evaluated assuming no action is taken to address the impacts associated with SLR or extreme tide flooding. However, some actions are currently planned or in progress to address the noted impacts.

KEY ISSUE: Wastewater pump stations are generally located in areas of the City where flows cannot be transported to the treatment plant by gravity alone. These areas are often associated with a higher risk of flooding. Properly functioning pump stations are critical for conveying combined flows to the three treatment plants. Pump station failure could result in localized flooding. The scale of the potential impact may be related to the pumping capacity of the pump station, the average dry weather flows observed at the pump station, and/or the drainage area served by the pump station. Smaller pump stations with localized drainage areas will have fewer cascading impacts than large pump stations that operate 24 hours a day, seven days a week in all weather conditions. The larger pump stations that are connected to transport / storage boxes have some storage capacity during dry weather to mitigate impacts, as well as the potential to discharge excess flows to the Bay through combined sewer discharge outfalls during wet weather (see Section 7.3).

Society and Equity: Pump station operations can impact residences, businesses, schools, hospitals, and healthcare facilities that are within the pump station's service area. Short-term downtime could impact localized flooding during wet weather operations and result in the release of untreated sewage on City streets or to the Bay. Longer-term downtime could impact wastewater service during all weather, potentially resulting in a lack of wastewater services within the pump station's service area or insufficient flows into the treatment plants, which can compromise the biological treatment processes. Vulnerable populations that cannot temporarily relocate during an extreme event may suffer the greatest impact. A lack of wastewater service could also have significant health impacts, particularly on vulnerable populations, including the elderly, medically infirm, and young children.

Economy: If a long-term wastewater outage occurs, it could impact revenue collected by SFPUC for providing services. Providing temporary services (e.g., portable toilets and washing stations) and the cost of repairs would also have economic impacts on SFPUC. If a pump station is inundated, a portable pump will be required to remove floodwater from the pump station itself; many of the pump stations extend one or more floors below grade. After removing floodwaters, electrical equipment will require repair and replacement. Saltwater may also corrode and damage exposed metal surfaces, including pump blades. Pumping bypasses may be installed to provide temporary service to mitigate impacts. Local businesses may be forced to close temporarily until pumping bypasses are installed and wastewater services can resume. Any impacts to local business could result in economic consequences to the greater community, including lost business revenue, lost tourist revenue, and lost work days for local residents and commuters.

Environment: Localized flooding that could occur on City streets during wet weather is likely to be dilute (e.g., the wastewater contribution to the localized flooding is likely to be small relative to the stormwater contribution). However, health and environmental hazards may still exist. Localized flooding in vulnerable communities pose the greatest health risk. Combined wastewater and stormwater flows may also flow directly to the Bay; however, the SFPUC wastewater system includes large underground transport / storage boxes that are capable of holding approximately 200 MG of combined flows for later treatment at one of the three treatment plants, and these boxes help prevent direct overflows to the Bay.

Governance: A large-scale failure or disruption of the City's wastewater system due to flooding has not happened to date in San Francisco. Responding to a flood event that could impact multiple pump stations located throughout the City will require multi-agency coordination. Repair work may need to be coordinated with SFMTA and Public Works in tandem with roadway clearing and other City cleanup efforts, as needed.

7.2 TREATMENT FACILITIES

SFPUC operates three wastewater treatment plants in San Francisco (Figure 7.3). Each treatment plant has an integral role in treating wastewater and stormwater before it is discharged into the Bay or the Pacific Ocean. The Southeast Treatment Plant is located near Islais Creek and serves the City's Bayside, while the Oceanside Treatment Plant, located near the San Francisco Zoo, serves the City's Westside neighborhood. Both operate 24 hours a day, 365 days a year. During large rain events, the North Point Wet-Weather Facility is activated to reduce the demand on the Southeast Treatment Plant to treat Bayside flows. The treatment plants are highly complex facilities, with multiple structures, treatment processes, and infrastructure that collectively process the combined wastewater and stormwater for the City and County of San Francisco.

7.2.1 Potentially Vulnerable Assets

7.2.1.1 Southeast Treatment Plant

The Southeast Treatment Plant operates 24 hours a day, 365 days a year, serving the Bayside of the City. It is located in the mixed industrial, commercial, and residential area of Bayview/Hunters Point, with the northern corner located approximately 750 feet from the Bay shoreline (see Photo 7.2). The Southeast Treatment Plant is San Francisco's largest wastewater facility, responsible for treating flows from the City's Bayside in addition to minor flows from Daly City and Brisbane. The treatment plant serves about two-thirds of San Francisco residents, or over 580,000 people as of 2016. The service areas include the Marina, Financial District, South of Market Area, Mission, Hunters Point, and Visitacion Valley, which generate more than 80 percent of the total annual wastewater flow from the City. Wastewater and stormwater are

Photo 7.2 Southeast Treatment Plant. Marcin Wichary

transported through a network of transport and storage facilities, sewers, and five high-capacity pump stations prior to the Southeast Treatment Plant. Treated effluent is then discharged to the Bay.

The treatment plant treats, on average, 57 mgd of wastewater during dry weather, including handling 160 wet tons of biosolids each day. It has the capacity to treat up to 250 mgd during heavy precipitation. The Southeast Treatment Plant includes the following processes: pretreatment, primary, secondary, disinfection, and sludge stabilization and dewatering. These processes occur over numerous facilities both above and below ground. Most facilities have a unique configuration of mechanical and electrical equipment and are interconnected to other facilities through a network of conduits or tunnels.

Several facilities at the Southeast Treatment Plant could be exposed to coastal floodwaters with 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). Flooding is limited to the northern corner of the plant, which includes the Southeast Lift Station, Headworks Facilities, and Primary Sedimentation Facilities. New facilities are currently under construction in this area, including the new Headworks Facility and Lift Station and Biosolids Digester Facilities, as part of the Sewer System Improvement Program. The new facilities are designed to accommodate anticipated SLR by raising grades and limiting potential flood pathways into the structures. The existing facilities have several entryways or pathways that could allow flooding to reach sensitive components, including doorways, tunnels and tunnel entrances, vents and louvers, open areas, utility holes, or ground-level entrances. Many tunnel entrances are at grade and could allow water to reach belowground equipment and regions of the treatment facility further inland.

If a large flood event occurs that impacts the treatment facilities, it may take several days to restore full service. The subterranean location of many treatment system components makes it challenging to modify or retrofit facilities to accommodate temporary flooding. Although some facilities have backup components onsite for redundancy, they are often at the same elevation as other station components and will likely be impacted at the same time.

Photo 7.3 North Point Wet-Weather Facility

7.2.1.2 North Point Wet-Weather Facility

Located on Bay Street approximately 300 feet from the Bay shoreline, the North Point Wet-Weather Facility is the City's oldest wastewater treatment facility, originally built in 1951, and was the main treatment facility until 1983 (see Photo 7.3). As part of the 1972 Clean Water Act upgrades, the North Point facility was converted to a wet-weather-only treatment facility. During wet weather, this facility provides pretreatment and primary treatment with disinfection of combined wastewater and stormwater flows collected in the northeast part of the City. The treatment plant is only brought online during wet weather when the Southeast Treatment Plant approaches capacity (i.e., approximately 250 mgd). With the North Point facility online, an additional 150 mgd of capacity is added to the citywide treatment capabilities.

The treatment processes at the North Point facility occur over numerous facilities both above and below ground. Most facilities have a unique configuration of mechanical and electrical equipment and are interconnected to other facilities through a network of conduits or tunnels. Many of these facilities have both belowground and aboveground components that could potentially be exposed to floodwaters or convey floodwaters to other areas. While the treatment facilities will likely recover after repairs, it may take several days to restore full function.

Figure 7.3 Treatment Facilities

Oceanside Treatment Plant

Built in 1993

Receives 20% of the City's flows

Treats 13 MGD and up to 175 MGD during rain storms

Located off the Great Highway between Lake Merced and San Francisco Zoo

North Point Wet Weather Facility

Built in 1951

Only active during wet weather

Treats up to 150 MGD during rain storms

Located at Bay Street and The Embarcadero

Southeast Treatment Plant

Built in 1952

Receives 80% of the City's flows

Treats 57 MGD and up to 250 MGD during rain storms

Located on Phelps Street near Third and Evans streets in the Bayview District

Source: San Francisco's Wastewater Treatment Facilities, SFPUC. https://sfwater.org/modules/showdocument.aspx?documentid=5801

Several individual North Point facility structures could be exposed to coastal floodwaters with 66 inches of SLR, or 24 inches of SLR coupled with a 100-year extreme tide (Scenario 6). This flooding is limited to the northern edge of treatment plant, which includes the Sedimentation Building No. 1 and the Materials Testing Laboratory (which has recently been vacated). There are several entryways at the North Point facility that could allow flooding to reach sensitive components, including doorways, tunnels and tunnel entrances, vents and louvers, open areas, utility holes, or ground level entrances. However, because the potential for flooding is limited, the treatment plant is likely to retain most of its operational capacity during a flood event that occurs when this facility is in operation.

Photo 7.4 Oceanside Treatment Plant

7.2.1.3 Oceanside Treatment Plant

The Oceanside Treatment Plant operates 24 hours a day, 365 days a year serving the City's Westside. It is located on the Great Highway near the San Francisco Zoo, approximately 100 feet from the edge of the Great Highway and 250 feet from the Pacific Ocean (see Photo 7.4). Built almost entirely underground, the Oceanside Treatment Plant is the City's newest wastewater facility, providing all-weather wastewater collection and treatment for approximately 20 percent of the City's wastewater and combined stormwater flows. Wastewater and stormwater from the Westside service areas is routed through the Richmond tunnel, Westside transport / storage box, and the Lake Merced Tunnel to the Westside pump station, where it is pumped to the Oceanside Treatment Plant through a 48-inch force main. On an average day, the plant treats 13 mgd. During rain storms, the wet-weather treatment capacity is 65 mgd. The Oceanside Treatment Plant discharges to a deep-water ocean outfall located more than three miles offshore.

The Oceanside Treatment Plant is located outside of the SLR Vulnerability Zone, and no flooding hazards are expected under current SLR projections. However, the large wave hazards on the open Pacific coast have caused shoreline erosion along Ocean Beach, and the potential for shoreline erosion is likely to increase over time with SLR.

The Lake Merced Tunnel, a critical component of the wastewater collection system that carries wastewater and combined storm water and wastewater to the treatment plant via a 14-foot-diameter pipe, is within the SLR Vulnerability Zone. SFPUC is coordinating with other agencies on the implementation of the Ocean Beach Master Plan,[3] a comprehensive vision to address SLR and coastal erosion, protect critical wastewater and transportation infrastructure, restore coastal ecosystems, and improve public access.

7.2.2 Exposure Assessment

The exposure of the treatment plants was evaluated relative to the 10 SLR scenarios (see Chapter 2). The assessment considered the exposure of individual treatment plant facilities, calculating the percent of each facility's building footprint within the SLR Vulnerability Zone and within each scenario, as shown in Table 7.2. This exposure assessment does not include individual facility floodproofing that may exist, including raised grades for new facilities such as the new Headworks and Biosolids Digester Facilities to minimize the potential for flooding impacts on sensitive infrastructure.

3 San Francisco Bay Area Planning and Urban Research Association (SPUR). 2012. Ocean Beach Master Plan. Available at https://www.spur.org/featured-project/ocean-beach-master-plan.

Table 7.2 Treatment Plant Exposure Summary

	Treatment Plant Inundated (Y/N) within each Sea Level Rise Scenario Building % inundated in each Sea Level Rise Scenario									
	1	2	3	4	5	6	7	8	9	10
Southeast Treatment Plant	-	-	-	-	Y	Y	Y	Y	Y	Y
Southeast Lift Station **	-	-	-	-	1	75	100	100	100	100
New Headworks Facilities *	-	-	-	-	-	20	50	85	95	95
Wet-Weather Headworks **	-	-	-	-	-	2	40	80	90	95
Headworks **	-	-	-	-	-	55	90	100	100	100
New Biosolids Digester Facilities*	-	-	-	-	-	-	5	20	60	90
Oxygen Plant*	-	-	-	-	-	-	10	70	100	100
Primary Sedimentation	-	-	-	-	-	-	40	90	100	100
Primary Clarifiers	-	-	-	-	-	-	10	20	50	70
Secondary Sludge Control Building	-	-	-	-	-	-	-	1	20	100
Engineering Annex	-	-	-	-	-	-	-	70	100	100
Primary Effluent Pump Station	-	-	-	-	-	-	-	-	1	20
Grease Handling Facility	-	-	-	-	-	-	-	-	10	75
Gravity Belt Thickeners**	-	-	-	-	-	-	-	-	45	51
Sodium Hypochlorite Tanks*	-	-	-	-	-	-	-	-	70	95
Primary Power Switching Station*	-	-	-	-	-	-	-	-	90	100
Secondary Sludge Thickening	-	-	-	-	-	-	-	-	90	95
Wet-Weather Primary Clarifiers	-	-	-	-	-	-	-	-	-	1
Sludge Filtration Building**	-	-	-	-	-	-	-	-	-	5
Water Pump Station **	-	-	-	-	-	-	-	-	-	10
Secondary Clarifiers	-	-	-	-	-	-	-	-	-	15
Dryer Building	-	-	-	-	-	-	-	-	-	20
Post Chlorination Building	-	-	-	-	-	-	-	-	-	95
North Point Treatment Facility	-	-	-	-	-	Y	Y	Y	Y	Y
Primary Clarifiers	-	-	-	-	-	2	10	15	20	25
Materials Testing Laboratory ***	-	-	-	-	-	25	60	95	100	100
North Shore Pump Station	-	-	-	-	-	-	5	50	75	85
Water Pump Station, Garage, Machine Shop, Polymer Room	-	-	-	-	-	-	-	5	15	25
Pre-Treatment and Grit Removal Building	-	-	-	-	-	-	-	-	55	75
Sodium Bisulfite Tanks	-	-	-	-	-	-	-	-	85	100
Storage Yard	-	-	-	-	-	-	-	-	100	100
Oceanside Treatment Plant	-	-	-	-	-	-	-	-	-	-

* Although the footprint of the new facilities remains within the SLR Vulnerability Zone, the facilities are designed and being constructed to address anticipated SLR by raising grades and limiting potential flood pathways into the structures.

** These facilities will be demolished once the new facilities are brought online.

*** This facility has been vacated and is not currently in use.

7.2.3 Consequence Summary

The consequences that could occur to society and equity, the economy, environment, and governance (see Chapter 3) were evaluated assuming no action is taken to address the impacts associated with SLR or extreme tide flooding. However, some actions are currently planned or in progress to address the noted impacts. For a list of the current SFPUC projects, see Section 7.5.

KEY ISSUE: Wastewater treatment is a critical service provided by the City. Without sufficient wastewater treatment, water-borne pathogens and microorganisms can spread, resulting in health hazards to human and animal populations and degradation of receiving water bodies. Although the risk of complete loss of wastewater treatment facilities is small in San Francisco, a reduction in wastewater treatment capacity is possible.

Society and Equity: A lack of wastewater treatment services can increase human health risks and result in the spread of water-borne diseases. Vulnerable populations, particular the elderly, medically infirm, and young children are most at risk. Populations at low-lying elevations that cannot discharge wastewater by gravity to the transport / storage boxes are most at risk of potential adverse health and environmental impacts.

Economy: Any flooding impacts to one of the three treatment facilities could result in significant repair and rehabilitation costs. A priority would likely be placed on preventing the direct discharge of untreated wastewater to the Bay and the prevention of sewer backups. Local businesses within impacted service areas may be forced to close temporarily until wastewater services can resume, resulting in economic consequences to the community, including lost business revenue, lost tourist revenue, and lost work days for local residents and commuters.

Environment: Localized flooding that could occur on City streets during wet weather is likely to be dilute (e.g., the wastewater contribution to the localized flooding is likely to be small relative to the stormwater contribution). However, health and environmental hazards will still exist. Localized flooding in vulnerable communities pose the greatest health risk. Combined wastewater and stormwater flows may also flow directly to the Bay; however, the SFPUC wastewater system includes large underground transport / storage boxes that are capable of holding approximately 200 MG of combined flows for later treatment at one of the three treatment plants, and these boxes help prevent direct overflows to receiving waters.

Governance: A large-scale failure or disruption of the City's wastewater system due to flooding has not happened to date in San Francisco. Responding to a coastal flood event that impacts wastewater treatment plant operations may require multi-agency coordination.

7.3 COMBINED SEWER DISCHARGES

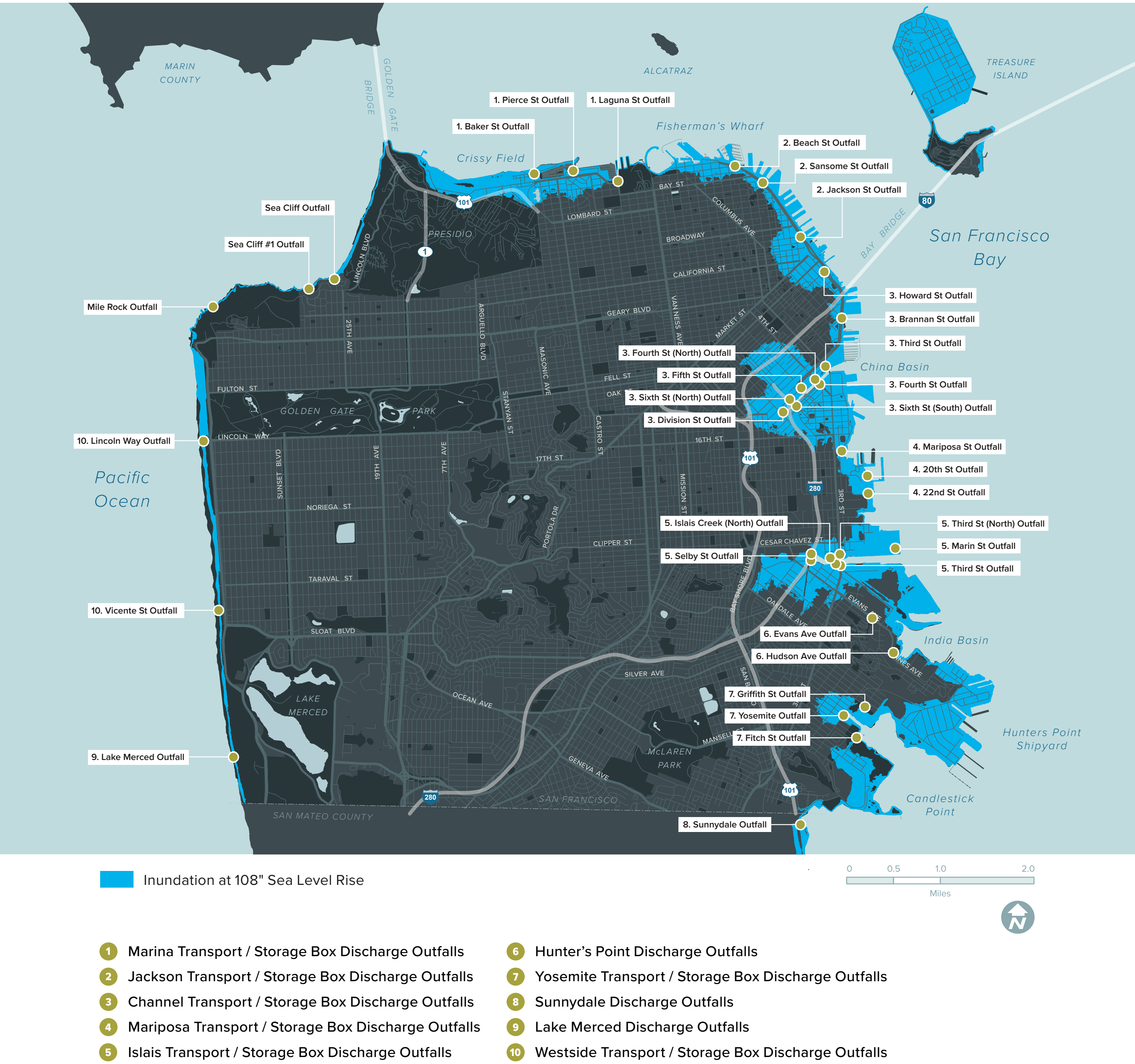
During rainstorms that exceed the capacity of the transport / storage boxes and treatment plants, combined stormwater and wastewater can be discharged through 36 combined sewer discharge outfalls to the Bay and Pacific Ocean (Photo 7.5). Combined sewer discharges include mostly stormwater but may also include wastewater flows in concentrations that vary depending on the intensity and duration of the rainstorm (see Figure 7.4). Twenty-nine of the discharge outfalls are located on the Bayside shoreline, and seven are located on the City's Westside. The physical configurations of the discharge structures vary based on location, but they are most often associated with a transport / storage box, with either an overflow weir or outfall pipe conveying excess flows from a transport / storage box to the Bay. A typical transport / storage box may be associated with more than one outfall to receiving waters; therefore, to consolidate the assessment findings, the discharge structures are grouped by their associated transport / storage box. If the overflow weir of a discharge outfall is not overtopped under any of the SLR scenarios assessed, it was not included in the assessment (i.e., four combined sewer discharge outfall weirs on the City's Westside are not included; however, these structures may still experience impacts related to wave hazards and coastal erosion).

The transport / storage boxes capture combined wastewater and stormwater from the sewer system before it reaches the Bay or Pacific Ocean shoreline.[4] In total, the boxes can hold approximately 200 MG of combined flows for later treatment at one of the three treatment plants. The transport/ storage boxes provide settling and baffling of floatable materials. During prolonged and intense rainstorms, the transport / storage boxes may fill completely.

4 https://sfwater.org/index.aspx?page=399

Photo 7.5 Division Combined Sewer Discharge. SFPUC

Figure 7.4 Combined Sewer Discharges



7.3.1 Potentially Vulnerable Assets

All combined sewer discharge outfalls are located along the shoreline and were engineered to withstand exposure to tides, wave hazard, storm surge, and saltwater. These shoreline structures are generally not sensitive to coastal flooding. However, the structures experience corrosion from the saltwater environment and weakened condition from continued exposure to wave hazards. As sea levels rise, the discharge capacity of each outfall may be reduced, particularly during extreme high tides and prolonged storm surge conditions. In the near term, the impacts to discharge capacity are temporary (e.g., one to four hours) while Bay water levels are elevated above the outfall weir. The ability to discharge through the outfall will resume as the tides fall. Over the longer term with higher SLR projections, the discharge capacity of the outfalls would be substantially reduced. Discharge outfalls that are submerged would not be able to maintain their function as currently designed.

Adaptive measures, such as backflow prevention, are currently being installed to prevent the inflow of Bay water into the discharge structures during periods of elevated water levels. However, maintaining outflow capacity during extreme wet-weather events as sea levels rise will require the addition of pumps in the future.

7.3.1.1 Marina Transport / Storage Box Discharge Outfalls

The Baker Street, Pierce Street, and the Laguna Street combined sewer discharge outfalls convey overflow from the Marina transport / storage box to the Bay. The Marina transport / storage box has a capacity of 8.3 MG and drains combined wastewater and stormwater runoff from the North Shore drainage area. Wet-weather flow is pumped downstream via the North Shore pump station, but excess flows (if they occur) are discharged through the outfalls. Of the three Marina transport / storage outfalls, currently only the Baker Street outfall has backflow prevention installed to mitigate saltwater intrusion into the collection and treatment system. The Pierce Street outfall is being closed, and Laguna Street outfall has a high elevation.

7.3.1.2 Jackson Transport / Storage Box Discharge Outfalls

The Beach Street, Sansome Street, and Jackson Street combined sewer discharge outfalls convey overflow from the Jackson transport / storage box to the Bay. The Jackson transport / storage box has a capacity of 10.4 MG and drains combined wastewater and stormwater runoff from the North Shore drainage area. Wet-weather flow is pumped downstream via the North Shore pump station, but excess flows (if they occur) are discharged through the outfalls. All three of these discharge outfalls will have backflow protection installed as part of the Sewer System Improvement Program.

7.3.1.3 Channel Transport / Storage Box Discharge Outfalls

The Howard Street, Brannan Street, 3rd Street, 4th Street (deactivated), 5th Street, 6th Street North, Division Street, 6th Street South, and 4th Street North combined sewer discharge outfalls convey overflow from the Channel transport / storage box to Mission Creek, China Basin, and the Bay. The Channel transport / storage box has a capacity of 38 MG and drains dry weather flow from the North Shore drainage areas, and dry and wet weather flow from the Channel drainage areas. Wet-weather flow is pumped downstream via the Channel pump station, but excess flows (if they occur) are discharged through the outfalls. The Brannan Street discharge outfall currently has a hydraulic gate that offers an ancillary benefit of mitigating saltwater intrusion into the collection and treatment system. The 5th Street and 6th Street North outfalls will have backflow protection installed as part of the Sewer System Improvement Program.

7.3.1.4 Mariposa Transport / Storage Box Discharge Outfalls

The Mariposa Street, 20th Street, and 22nd Street combined sewer discharge outfalls convey overflow from the Mariposa transport / storage box to the Central Basin in the Bay. The Mariposa transport / storage box has a capacity of 0.9 MG and drains combined wastewater and stormwater runoff from the Mariposa drainage areas. Wet-weather flow is pumped downstream via the Mariposa pump station, but excess flows (if they occur) are discharged through the outfalls.

7.3.1.5 Islais Transport / Storage Box Discharge Outfalls

The Third Street North, Islais Creek North, Marin Street, Selby Street, and Third Street combined sewer discharge outfalls convey overflow from the Islais transport / storage box to Islais Creek and the Bay. The Islais transport / storage box has a capacity of 45.1 MG and drains combined wastewater and stormwater runoff from the Mariposa and Islais Creek drainage areas. Wet-weather flow is pumped downstream via the Bruce Flynn pump station, but excess flows (if they occur) are discharged through the outfalls.

Photo 7.6 Yosemite Street Combined Sewer Discharge

7.3.1.6 Hunter's Point Discharge Outfalls

The Evans Street and Hudson Street combined sewer discharge outfalls convey overflow to the Bay. The Hunter's Point tunnel carries combined wastewater and stormwater runoff from the Yosemite/Sunnydale drainage areas. Excess flows (if they occur) are discharged through the outfalls.

7.3.1.7 Yosemite Transport / Storage Box Discharge Outfalls

The Griffith, Yosemite, and Fitch combined sewer discharge outfalls convey overflow from the Yosemite transport / storage box to the South Basin and the Bay (see Photo 7.6). The Yosemite transport / storage box has a capacity of 11.5 MG and drains combined wastewater and stormwater runoff from the Yosemite and Sunnydale drainage areas. Wet-weather flow is pumped downstream via the Griffith pump station, but excess flows (if they occur) are discharged through the outfalls. The Griffith outfall will have backflow protection installed as part of the Sewer System Improvement Program.

7.3.1.8 Sunnydale Discharge Outfalls

The Sunnydale combined sewer discharge outfall conveys overflow from the Sunnydale transport / storage box to Candlestick Cove and the Bay. The Sunnydale transport / storage box has a capacity of 6.2 MG and drains combined wastewater and stormwater runoff from the Sunnydale drainage areas. Wet-weather flow is pumped downstream via the Sunnydale pump station, but excess flows (if they occur) are discharged through the outfalls.

7.3.1.9 Lake Merced Discharge Outfall

The Lake Merced combined sewer discharge outfall conveys overflow from the Lake Merced Tunnel to the Pacific Ocean. Combined wastewater and stormwater runoff that reaches the Lake Merced Tunnel is conveyed from the Lake Merced drainage areas.

7.3.1.10 Westside Transport / Storage Box Discharge Outfalls

The Vicente Street and Lincoln Way combined sewer discharge outfalls convey overflow from the Westside transport / storage box to the Pacific Ocean. The Westside transport / storage box has a capacity of 49 MG and drains wastewater and stormwater runoff from the Westside and Richmond drainage areas.

7.3.2 Exposure Assessment

The combined sewer discharge outfalls were evaluated to assess when each outfall would be first exposed to potential inundation. The outfall is exposed when tide levels exceed the elevation of an outfall weir structure.

We used different methodologies to assess high water levels along the Bayside and Westside shorelines. Along the Bayside, the elevation of the outfall weir was evaluated relative to the 10 SLR scenarios

Table 7.3 Combined Sewer Discharge Exposure Summary (Bayside CSDs)

Transport / Storage Box	CSD	CSD Inundated (Y/N) within Each Sea Level Rise Scenario 1	2	3	4	5	6	7	8	9	10
Marina	Baker Street *	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Pierce Street ****	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Laguna Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jackson	Beach Street **	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Sansome Street **	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Jackson Street **	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
Channel	Howard Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Brannan Street ***	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Street ****	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5th Street **	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Street North **	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Division Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Street South	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Street South	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mariposa	Mariposa Street	-	-	Y	Y	Y	Y	Y	Y	Y	Y
	20th Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	22nd Street	-	-	Y	Y	Y	Y	Y	Y	Y	Y
Islais	3rd Street North	-	-	Y	Y	Y	Y	Y	Y	Y	Y
	Islais Creek North	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Marin Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Selby Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Street South	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hunter's Point	Evans Street	-	-	-	-	-	-	Y	Y	Y	Y
	Hudson Street	-	-	-	-	-	-	-	-	-	-
Yosemite	Griffith **	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Yosemite Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fitch Street	-	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sunnydale	Sunnydale	-	-	Y	Y	Y	Y	Y	Y	Y	Y

* This outfall was used as a pilot for assessing backflow prevention measures. Backflow prevention is currently installed to mitigate saltwater intrusion.

** Backflow prevention is installed, or will be installed under the Sewer System Improvement Program.

*** This outfall has a hydraulic gate that also mitigates saltwater intrusion.

**** This outfall will be closed or deactivated.

Table 7.4 Combined Sewer Discharge Exposure Summary (Westside CSDs)

Transport / Storage Box	CSD	CSD Inundated (Y/N) within Each 100-Year Dynamic Water Level* 1	2	3	4	5 DWL 12	6 DWL 24	7 DWL36	8 DWL 48	9	10 DWL 66
Lake Merced Tunnel	Lake Merced	-	-	-	-	Y	Y	Y	Y	-	Y
Westside	Vicente Street	-	-	-	-	Y	Y	Y	Y	-	Y
	Lincoln Way	-	-	-	-	-	Y	Y	Y	-	Y

* The Westside's Dynamic Water Level scenarios are mapped to corresponding Bayside SLR scenario. There is no corresponding Westside scenario for Bayside scenario's 1, 2, 3, 4, or 9.

(see Chapter 2). The discharge outfalls along the Westside are located at higher elevations. The high water levels most likely to exceed the outfall weir elevations incorporate additional coastal processes, including wave setup. As waves break offshore and across the surf zone, they drive water onshore and "set up" the water level at the shoreline.

Temporary flooding at Westside combined sewer discharge outfalls was evaluated relative to the Dynamic Water Level (DWL), which includes wave setup. Five DWL plus SLR scenarios were evaluated, and Table 7.3 maps those scenarios to the most similar Bayside SLR scenario for ease of comparison.

The majority of the Bayside combined sewer discharge outfalls (i.e., 23 of 29) are impacted under Scenario 2, or 24 inches of SLR. Under Scenario 3, or 36 inches of SLR, 27 of the 29 Bayside outfalls are impacted (see Table 7.3). Therefore, before the end of the century, and likely between mid-century and the end of the century, the combined sewer discharge outfalls will no longer function as intended.

Although backflow prevention will prevent saltwater intrusion into the collection system, the higher Bay water levels may impede the gravity-driven flow of excess combined wastewater and stormwater from the transport / storage boxes to the Bay through the outfalls and pumping would be required.

Although SLR alone is not anticipated to raise Bay water levels this high until after mid-century, water levels in the Bay may reach this level (24 to 36 inches above existing high tides) temporarily during King Tides, El Niño conditions, or during a coastal storm surge event today. Therefore, for short durations (i.e., six hours or less), discharge through the outfalls could be impacted under existing conditions. As sea levels rise, the frequency of these short-term high Bay water level conditions may increase.

On the Westside, the outfall weirs are generally located at higher elevations. Only the Lake Merced discharge outfall (Lake Merced Tunnel) could be temporarily exposed to water levels above its weir elevation during a 100-year extreme tide (with wave setup) and no SLR (see Table 7.4). During a 100-year extreme tide with 12 inches of SLR, the Vicente outfall weir could be temporrarily overtopped, and during a 100-year extreme tide with 24 inches of SLR, the Lincoln outfall weir could be temporarily overtopped. The remaining combined sewer discharge outfalls on the Westside are not overtopped under the SLR scenarios that were evaluated in this assessment.

7.3.3 Consequence Summary

The consequences that could occur to society and equity, the economy, environment, and governance (see Chapter 3) were evaluated assuming no action is taken to address the impacts associated with SLR or extreme tide flooding. However, installation of backflow prevention is currently planned for multiple discharge outfalls under the Sewer System Improvement Program.

KEY ISSUE: As sea levels rise, the combined sewer discharge outfalls that currently help mitigate localized flooding during prolonged and intense rainfall events will be impacted. When an outfall weir is submerged, either temporarily during a coastal storm surge event or permanently due to SLR, the ability of the outfall to discharge excess combined wastewater and stormwater will decrease. With 24 inches of SLR, the overall functioning of the combined sewer discharge system would be impaired and could result in increasing instances of localized flooding, particularly in low-lying areas.

Society and Equity: Localized flooding will impact residences, businesses, and human health. Vulnerable populations in the low-lying areas of the City are most at risk of potential adverse health and environmental impacts.

Economy: Localized flooding could result in damage to buildings and structures, requiring repairs. Environmental cleanup efforts will also be required to help mitigate potential adverse health impacts. The extent of damage and the impact to the local economy from business closures will depend on the intensity and length of the rainstorm, and the amount of time that Bay water levels are impeding discharge through the combined sewer discharge outfall.

Environment: Localized flooding that could occur on City streets during wet weather is likely to be dilute (e.g., the wastewater contribution to the localized flooding is expected to be small relative to the stormwater contribution). However, health and environmental hazards will still exist. Localized flooding in vulnerable communities pose the greatest health risk. Combined wastewater and stormwater flows may also flow directly to the Bay if discharge through the combined sewer discharge outfalls is feasible; however, the SFPUC wastewater system includes large underground transport / storage boxes that are capable of holding approximately 200 MG of combined flows for later treatment at one of the three treatment plants, and these boxes help prevent direct overflows to the Bay.

Governance: In the near term, backflow prevention is being installed on the combined sewer discharge outfalls to prevent intrusion of saltwater into the system. In the long term (i.e., between mid-century and end of the century), a more substantial modification of the transport / storage boxes and the combined sewer discharge outfalls may be required. As large-scale shoreline adaptation projects are planned, coordination with the SFPUC will be required to allow for continued functioning of the combined sewer discharge outfalls.

7.4 BURIED SEWERS

SFPUC's wastewater system relies on a network of more than 1,000 miles of force mains, tunnels, sewers, and transport / storage boxes to transport and discharge wastewater and stormwater flows. Each type of buried sewer has a unique configuration and purpose, but ultimately serves to convey or store wastewater and/or stormwater as needed for treatment prior discharge into the Bay or Pacific Ocean. Since the buried sewers have similar physical characteristics and function, they are evaluated as a group, rather than by individual type or asset (Photo 7.7).

- **Gravity sewers** – The primary collection and conveyance features in the sewer system that carry storm and sanitary flows downstream by gravity flow;
- **Force mains** – Typically, buried conduits that link pump stations to other parts of the conveyance system or deliver combined wastewater to treatment facilities;
- **Tunnels** – Typically, deeper sewers that convey flows via gravity; and
- **Transport / storage boxes** – Large interconnected underground structures buried along the perimeter of the City that intercept, temporarily store, and transport combined wastewater to treatment facilities and/or combined sewer discharge outfalls.

Photo 7.7 New installation of concrete sewer pipes. Robert J. Pierce, SFMTA

Figure 7.5 Vulnerable Buried Sewers

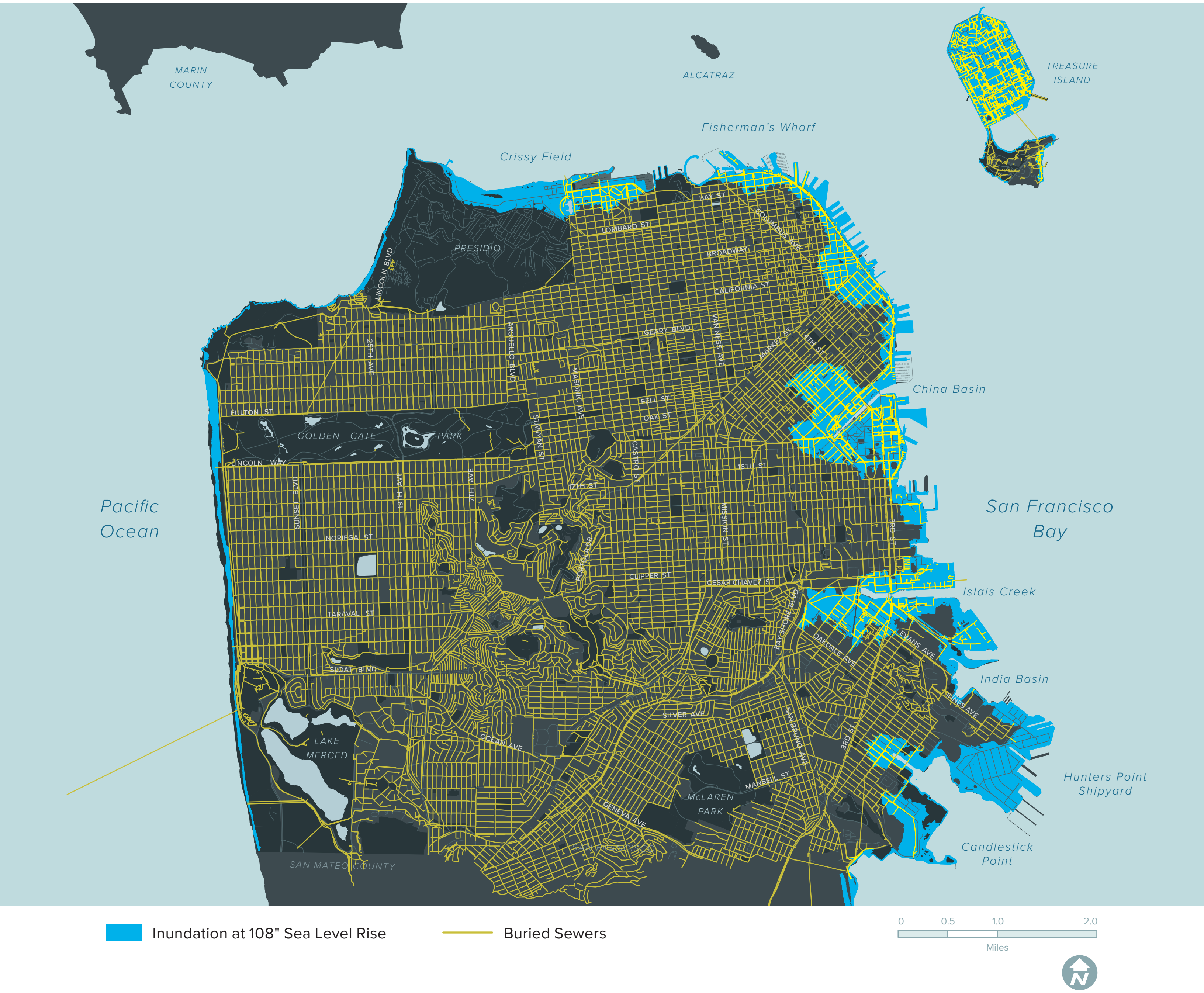


Table 7.5 Buried Sewers (Bayside) Exposure Summary

	Miles Inundated within Each Sea Level Rise Scenario									
	1	2	3	4	5	6	7	8	9	10
					DWL 12	DWL 24	DWL36	DWL 48		DWL 66
Sewers (< 18")	-	-	5.1	11.1	16.9	34.7	43.2	46.8	51.7	57.1
Sewers (18-36")	-	-	1.1	3.3	5.1	11.7	14.6	16.9	18.4	20.5
Gravity Sewers (>36")	-	-	-	-	-	-	-	14.8	17.9	20.6
Tunnels	-	-	-	-	-	-	-	-	-	-
Transport/Storage Facilities	-	-	0.2	0.7	1.9	4.6	5.9	6.5	7.1	7.6
Force Mains	-	-	0.6	2.5	3.4	6.9	8.6	8.9	9.5	9.8
Catch Basins (# in SLRVZ)	2	7	30	92	319	1,222	1,535	1,750	2,052	2,345

* The Westside's Dynamic Water Level scenarios are mapped to corresponding Bayside SLR scenario. There is no corresponding Westside scenario for Bayside scenario's 1, 2, 3, 4, or 9.

7.4.1 Potentially Vulnerable Assets

The majority of these sewers are buried beneath the City and are not directly exposed to overland flooding due to SLR in the same manner as the pump stations and treatment facilities. However, buried sewers are susceptible to overland inflow and infiltration into the collection system (see Photo 7.8). Water can enter sewers, tunnels, and transport / storage boxes through joints and connections, cracks, catch basins, or through utility hole covers. This can reduce the overall storage capacity of the collection system. Pressurized force mains are less susceptible to inflow and infiltration. As water levels continue to rise, the potential for infiltration into the system will also increase. The increasing frequency of exposure to saltwater may result in accelerated corrosion of materials sensitive to saltwater, reducing the lifespan of some sewers.

Catch basins within the SLR Vulnerability Zone could also be inundated during a coastal flood event, providing another mechanism for saltwater inflow to the system. Sewer components made of materials sensitive to saltwater (e.g., iron), regardless of physical condition, could corrode and compromise the integrity of the asset. Maintenance and access to sewers could also be impacted, and subsurface soils may erode around the sewers, which could result in sewer breaks, operational impacts, and sink holes.

7.4.2 Exposure Assessment

The exposure of the buried sewers was evaluated relative to the 10 SLR scenarios (see Chapter 2) to assess when either the Bay or Pacific Ocean floodwaters cover the ground above each sewer segment (see Table 7.5). Areas that can be exposed to permanent inundation by SLR are the most likely to be exposed to rising saline groundwaters. The exposure of the catch basins was also evaluated, as the catch basins represent a significant pathway for floodwaters to enter the sewer system.

7.4.3 Consequence Summary

The consequences that could occur to society and equity, the economy, environment, and governance (see Chapter 3) were evaluated assuming no action is taken to address the impacts associated with SLR or extreme tide flooding. However, some actions are currently planned or in progress to address the noted impacts. For a list of the current SFPUC projects, see Section 7.5.

KEY ISSUE: In general, buried infrastructure is less sensitive to coastal flooding and SLR; however, as sea levels rise, frequency of exposure to saltwater will increase, both internally due to saltwater intrusion, and externally due to more saline groundwater. This will result in accelerated corrosion of materials sensitive to saltwater, reducing the lifespan of some sewers.

Society and Equity: The possibility of localized sewer failures associated with saltwater intrusion, infiltration, and corrosion are most likely to occur in the low-lying areas of the City along the shoreline. A sewer failure could result in localized flooding of wastewater, creating potential adverse health and environmental impacts. The vulnerable populations within the low-lying areas are at greatest risk. Sewer failures can also cause sink holes and roadway disruption, and impact wastewater services at nearby residences and businesses. Smaller-scale, localized sewer failures can be contained, mitigated, and repaired quickly to minimize adverse consequences.

Economy: As sewer lifespans decrease, the cost to maintain and rehabilitate the overall sewer system will increase. Localized sewer failures will also require prompt repair. Roadway damage, and any associated building and/or structure damage will also need to be addressed. Local businesses may be forced to close temporarily until wastewater services can resume, resulting in economic consequences to the local community, including potential lost business revenue, tourist revenue, and lost work days for local residents and commuters, depending on the area impacted by the sewer failure.

Environment: Localized flooding that occurs on City streets during wet weather is likely to be dilute (e.g., the wastewater contribution to the localized flooding is likely to be small relative to the stormwater contribution). However, health and environmental hazards will still exist. Localized flooding in vulnerable communities pose the greatest health risk. Combined wastewater and stormwater flows may also flow directly to the Bay if some form of containment is not put in place promptly.

Governance: SFPUC has an ongoing program for rehabilitation and replacement of existing sewers. As sea level rises and functional lifespans decrease, this program may require modifications.

7.5 PLANNED ADAPTATION ACTIONS

SFPUC's planned adaptation actions include general adaptation strategies, as well as specific planned projects. These various strategies are listed below.

7.5.1 General Adaptation Strategies

Flood proofing with external barriers, such as flood gates, can be implemented to protect buildings from temporary flooding. Additionally, access points such as vents, and electrical gear can be raised to a higher elevation to reduce the likelihood of water entering a building or damaging electrical equipment. If needed, external barriers could be used to adapt the facility to higher levels of flooding.

In general, switchgear and electrical equipment can be placed on the second floor of buildings. Flood proofing of belowground conduits can be incorporated. New facilities can place critical elements (e.g., electrical gear and transformers) above the flood risk elevation.

7.5.2 Planned Projects

Community Center

Electrical elements will be placed at or above the elevation reached by a 100-year extreme tide with 33 inches of SLR. Flood-proofing strategies will also be implemented for belowgrade structures. To increase the adaptive capacity of the community center to accommodate larger potential flood events or higher amounts of SLR, temporary barriers (e.g., removable floodwall) or permanent perimeter flood protection (e.g., levees or floodwalls) could be implemented over time, as needed.

Griffith Pump Station

The lowest ground elevation at the Griffith pump station project location is already above the 100-year extreme tide elevation plus 23 inches of SLR for the planning horizon year 2049. Any access points to belowgrade infrastructure (e.g., maintenance access to electrical conduits) could be flood proofed to prevent floodwaters from reaching belowgrade equipment.

Photo 7.8 Rendering of Mariposa Pump Station. San Francisco Public Works

Photo 7.9 Rendering of Biosolids Digester facilities. SFPUC

Photo 7.10 Rendering of Headworks Facility and Lift Station. SFPUC

Mariposa Pump Station

Building openings will be placed above the elevation of the 100-year extreme tide plus 20 inches of SLR (Photo 7.8). Abovegrade electrical and mechanical elements will also be placed at or above this elevation. Flood-proofing strategies will be implemented for belowgrade structures. Adaptive capacity to reach higher elevations of temporary inundation could be achieved with temporary barriers (e.g., removable flood gate) or permanent perimeter flood protection (e.g., levees or floodwall). Electrical equipment can be raised in the future if necessary, if the roof level will accommodate.

Treasure Island

The new Treasure Island wastewater treatment plant will be built at an elevation that provides six inches of freeboard above the 100-year extreme tide elevation with 39 inches of SLR.

Flood-proofing strategies will be implemented for belowgrade structures. To increase the adaptive capacity of the new wastewater treatment plant to larger potential flood events, temporary barriers (e.g., removable floodwall) or permanent perimeter flood protection (e.g., levees or floodwalls) are being considered and will be implemented as needed.

Biosolids Digester Facilities

Abovegrade facilities for the new Biosolids Digester Facilities at the Southeast Treatment Plant are being constructed with an elevated grade that will provide 12 inches of freeboard above the 100-year extreme tide elevation with 36 inches of SLR (Photo 7.9). Abovegrade electrical and mechanical elements will also be placed at or above this elevation, and flood-proofing strategies will be implemented for below-grade structures. Adaptive capacity for larger flood events or higher SLR scenarios could be achieved with temporary barriers (e.g., removable flood gate) or permanent perimeter flood protection (e.g., levees or floodwalls).

Headworks Facility and Southeast Lift Station

The new Headworks Facility and Lift Station at the Southeast Treatment Plant is being constructed with raised grades that provide six inches of freeboard above the 100-year extreme tide elevation with 36 inches of SLR (Photo 7.10). Above grade electrical and mechanical elements will also be placed at or above this elevation, and flood-proofing strategies will be implemented for below grade equipment. Adaptive capacity to larger flood events and higher SLR scenarios could be achieved with either temporary barriers (e.g., removable flood gate) or permanent perimeter flood protection (e.g., levees or floodwalls).

Combined Sewer Discharge Outfalls

Vulnerable combined sewer discharge outfalls will be outfitted with backflow preventers to reduce the potential for inflow into the collection system by rising Bay. The backflow prevention mechanism for each combined sewer discharge outfall will be designed individually as each discharge structure is slightly different.

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