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

SEWER SYSTEM IMPROVEMENT PROGRAM

BAYSIDE DRAINAGE BASIN URBAN WATERSHED CHARACTERIZATION

FINAL DRAFT TECHNICAL MEMORANDUM

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PROGRAM QUALITY ASSURANCE AND QUALITY CONTROL REVIEW:

Reviewers listed in the table below have completed an internal quality review check and approval process that is consistent with procedures and directives previously identified by the PMC. The table below outlines the corresponding reviewers for each deliverable document.

Table 1: Identification of Technical and Administrative Reviewers

Subtask	Deliverable *Bayside Drainage Basin Urban Watershed Characterization*	Technical Reviewer	Complete	Administrative Reviewer	Complete	PCTA Reviewer	Complete
	FINAL DRAFT	Karen Kubick Rosey Jencks John Roddy David Wood Don Walker Geoff Grant	x	Kara Baker Scott Lowry	x	Dan Donahue	x
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Quality Assurance and Quality Control Review Complete:

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ACRONYMS / ABBREVIATIONS

Acronym / Abbreviation	Definition
AB	Assembly Bill
AWSS	Auxiliary water supply system
BMP	Best management practice
BOD	Biochemical oxygen demand
BRT	Bus rapid transit
BSM	Bureau of Street Use and Mapping
BU	Beneficial uses
CAC	Citizen Advisory Committee
CBSIP	Central Bayside System Improvement Project
CCSF H&H Model	City and County of San Francisco Hydrologic and Hydraulic Model
CIP	Capital Improvement Program
COD	Chemical oxygen demand
CSAMP	Collection System Asset Management Program
CSD	Combined sewer discharge
CSS	Combined sewer system
CULCOP	Committee for Utility Liaison on Construction and Other Projects
DBI	Department of Building Inspections
DCS	Distributed control system
DCYFS	Department of Children, Youth and Their Families
DDF	Depth-duration-frequency
DDMP	Detailed Drainage Modeling Plan
DPH	Department of Public Health
DSS	Decision support systems
DT	Department of Technology
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EIR	Environmental impact report
EIS	Environmental impact statement
EN TRIPS	Eastern Neighborhoods Transportation Implementation Planning Study

Acronym / Abbreviation	Definition
ESRI	Environmental System Research Institute
FHR	Flood Hazard Rating
ft^2	Square feet
FUF	Friends of the Urban Forest
FY	Fiscal year
GIS	Geographic information system
GGNRA	Golden Gate National Recreation Area
gpcd	Gallons per capita demand
HGL	Hydraulic grade line
IPIC	Interagency Plan Implementation Committee
LID	Low impact design
LOS	Level of service
MAB	Man and the Biosphere
MG	Million gallons
MGD	Million gallons per day
mg/L	Milligram per liter
mi^2	Square miles
MS4	Municipal Separate Storm Sewer System
NEH	National Engineering Handbook
NOAA	National Oceanic and Atmospheric Administration
NOP	Notice of Preparation
NPDES	National Pollutant Discharge Elimination System
NPF	North Point Wet Weather Facility
NRCS	Natural Resource Conservation Service
NWS	National Weather Service
OSP	Oceanside Water Pollution Control Plant
PMC	Program Management Consultant
R&R	Renewal and replacement
ROSE	Recreation and Open Space Element
RPD	Recreation and Parks Department
SBO	Southeast Bay Outfall
RWQCB	Regional Water Quality Control Board

Acronym / Abbreviation	Definition
SDE	Spatial Database Engine
SDG	Stormwater Design Guidelines
SEP	Southeast Water Pollution Control Plant
SFCTA	San Francisco County Transportation Authority
SFDPW	San Francisco Department of Public Works
SFDPW – IDC – Hydraulic Section	Bureau of Engineering Hydraulics Section (formerly HYD)
SFHHDAR	San Francisco Hydraulic-Hydrologic Data Acquisition
SFMTA	San Francisco Municipal Transportation Agency
SFPUC	San Francisco Public Utilities Commission
SoMa	South of Market
SSIP	Sewer System Improvement Program
SSMP	Sewer System Master Plan
SWMM	Stormwater Management Model
SWRCB	State Water Resources Control Board
TBL	Triple Bottom Line
TEP	Transit Effectiveness Project
TS	Transport/storage
TSS	Total suspended solids
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Society
UWA	Urban Watershed Assessments
UWMP	Urban Water Management Plan
WQBELs	Water quality based effluent limitations
WSIP	Water System Improvement Program
WW CAC	Citizen Advisory Committee Wastewater Subcommittee
WWE	Wastewater Enterprise
WWTP	Wastewater treatment plant

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1.0 BAYSIDE DRAINAGE BASIN CHARACTERIZATION SUMMARY

1.1 Purpose and Background

The intent of this technical memorandum is to define the characteristics of the Bayside Drainage Basin of the City and County of San Francisco in support of the San Francisco Public Utilities Commission's (SFPUC) Sewer System Improvement Program (SSIP). Urban Watershed Characterization is a comprehensive analysis of the existing conditions of each of the City's eight urban watersheds within two Drainage Basins, Westside and Bayside. This document summarizes the findings of the Urban Watershed Characterization process as related to the Bayside Drainage Basin and the five urban watersheds of which it is comprised (see Figure 1.2), and provides a data resource for the subsequent steps of the SSIP Urban Watershed Assessment (UWA).

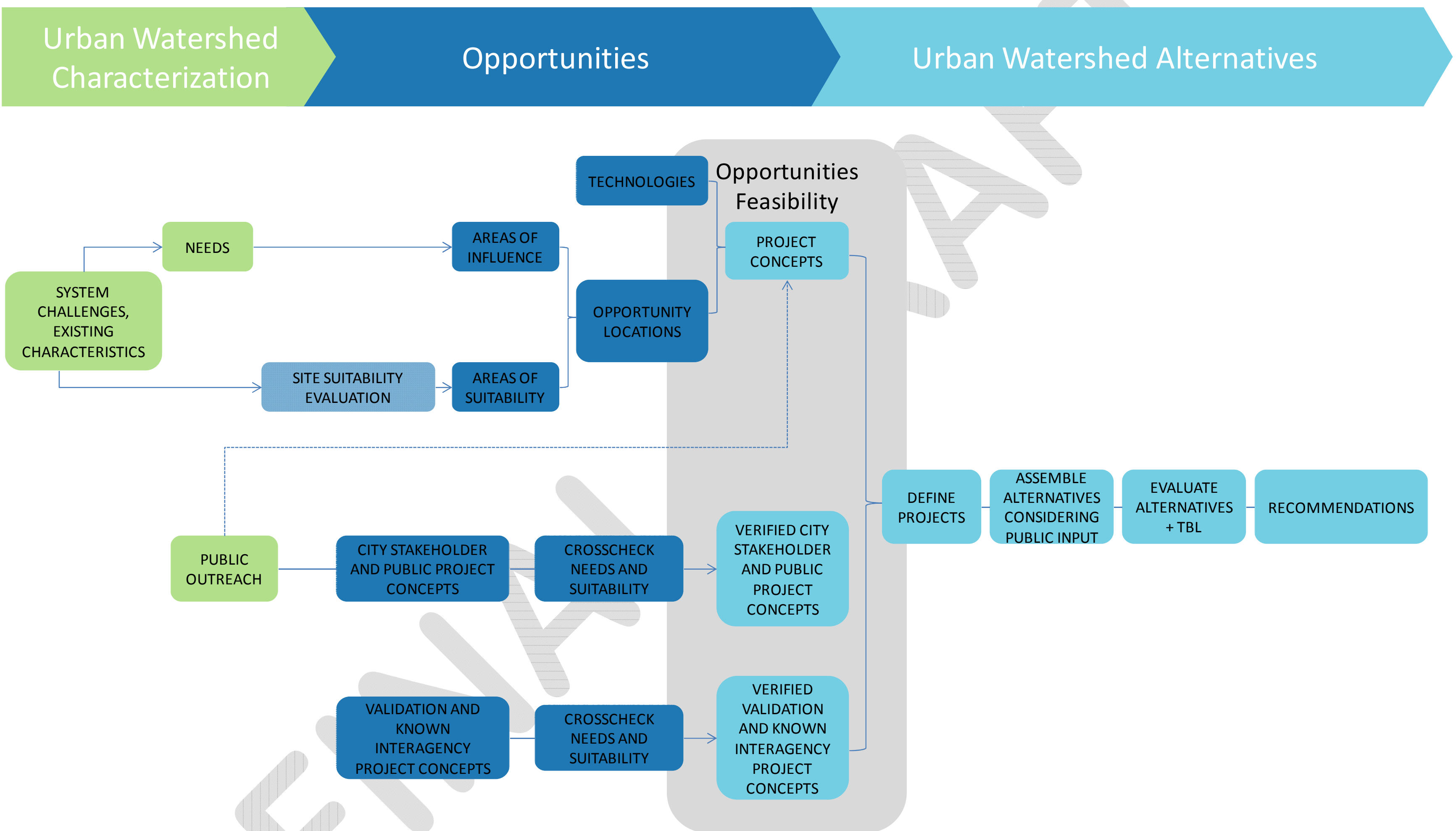
The UWA is a city-wide planning effort that will assist the SFPUC by identifying specific projects, programs, and policies to reach Wastewater Enterprise (WWE) goals and Levels of Service (LOS). Each phase of the UWA – characterization, opportunities, and alternatives – includes a set of analytical processes developed to implement the integrated, watershed-wide approach, outlined in the urban watershed framework, and develop a recommended suite of projects in each of the eight major watersheds to meet all applicable WWE goals and LOS. Together, these three phases follow a sequence of tasks with individual steps that will result in a recommendation for urban watershed projects that will meet the SFPUC Commision endorsed goals and levels of service for the surface drainage and wastewater collection system. Figure 1.1 graphically depicts the UWA process.

1.2 Report Organization

Chapter 2.0, Urban Watershed Characteristics, describes existing conditions, current and planned projects, and the urban water balance for the Bayside Drainage Basin urban watersheds of San Francisco. Chapter 3.0 of this memorandum, Urban Watershed Challenges and Needs Analysis, assesses the deficiencies of the five Bayside urban watersheds based on their current and potential future compliance with the WWE Goals, LOS, and strategies. Appendix A documents the data sources used in the Urban Watershed Characterizations that were chosen based on their relevance to LOS. Collectively, the Bayside Drainage Basin Urban Watershed Characterization Technical Memorandum provides the information needed to develop surface drainage and collection system improvements in the subsequent Urban Watershed Assessment Opportunities Identification Phase.

During the ensuing Opportunities Analysis, the information gathered during the Urban Watershed Characterization will serve as the foundation of information used to identify synergistic opportunities to address the WWE Goals while providing ancillary benefits within the urban watershed.

Figure 1.1
UWA Process Flow Chart



1.3 Sewer System Improvement Program

Every day San Francisco residents, businesses, workers, and visitors rely on the City's sewer system. San Francisco's sewer system is comprised of two core elements, the wastewater collection system and the treatment system. These two core systems consist of a labyrinth of curbs, gutters, catch basins, collection sewers, pump stations, treatment plants and outfalls that support both dry and wet weather needs. The underground collection sewers collect up to 72 million gallons (MG) of water on dry days and 500 MGs of water on rainy days. The system is aging; by 2035, approximately 40% of the sewers will be over 100 years old (assuming current rates of rehabilitation and replacement). Emerging issues such as climate change require closer attention to environmental stewardship and the development of a more sustainable system. Additionally, capacity constraints and compliance with regulatory requirements that are expected to become more stringent in the future are driving the need for substantial improvements to San Francisco's sewer system.

The SFPUC WWE is working proactively to identify the right investments needed for the sewer system infrastructure. The SSIP is the SFPUC's 20-year capital improvement plan to address system-wide needs, update the aging sewer system and protect public health and the environment. The SSIP is the result of an eight-year public planning process incorporating valuable feedback from the community. Improvements will upgrade the wastewater collection, treatment, and discharge facilities using innovative strategies to ensure compliance, reliability, and long-term sustainability.

The WWE Goals and LOS were developed and gained endorsement through a series of seven public workshops held before the Commission between October 2009 and July 2010 and further endorsed through Collection System Validation in August 2012. These goals correlate to qualitative and quantitative performance measures that must be met by proposed capital improvements and policies. The SFPUC's endorsed WWE Goals are:

- Provide a Compliant, Reliable, Resilient and Flexible System that can Respond to Catastrophic Events
- Integrate Green and Grey Infrastructure to Manage Stormwater and Minimize Flooding
- Provide Benefits to Impacted Communities
- Modify the System to Adapt to Climate Change
- Achieve Economic and Environmental Sustainability
- Maintain Ratepayer Affordability

The Urban Watershed Assessments are a key element of the SSIP that defines the process by which the SSIP collection system improvement projects will be developed and evaluated to achieve the WWE Goals. The Urban Watershed Assessments provide an integrated, urban watershed-wide approach to define the most effective capital improvement projects and policy initiatives for each of the City's eight urban watersheds to address surface drainage and collection system challenges.

Once project and policy alternatives demonstrate their ability to achieve the LOS, they will be evaluated using Triple Bottom Line (TBL) Analysis that takes into account a range of social, environmental, and financial costs and benefits.

In addition to the Urban Watershed Assessments, other program efforts are being conducted. One closely related effort is the Collection System Validation. Beginning in September 2011, this effort was concluded in the summer of 2012 with a series of three presentations to the SFPUC Commission. Through the validation process, the SSIP goals and levels of service were affirmed, and in some cases, modified to reflect a further understanding of issues and priorities. The validation process was not, however, intended to supplant the urban watershed assessment process for defining specific projects. The validation process reviewed the projects included in the 2010 SSIP, and in some cases identified reasonable placeholders for projects to meet the intended LOS, but the final definition of surface drainage and collection system recommendations, including integration of green infrastructure elements, will continue to be developed through the more detailed urban watershed assessment process. With regard to CSD control, the validation process provided options that could be considered for achieving higher levels of control. Ancillary improvements include increased capacity, climate change adaptation, and flood control.

Source: San Francisco Department of Public Works

Figure 1.2: Bayside Drainage Basin Urban Watersheds

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

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

Another related and significant proposed SSIP collection system improvement is the Central Bayside System Improvement Project (CBSIP), which is currently in the planning phase. The main purpose of the CBSIP is to address the lack of redundancy to the Channel Force Main, and that project is described further in Section 2.8.1, SFPUC Projects.

1.3.1 Urban Watershed-Based Planning

The 2010 SSIP proposed capital improvements to achieve Commission-endorsed level-of-service (LOS) goals for ongoing regulatory compliance, system reliability, seismic integrity, and sustainable operation of the City's sewer system. It included various projects related to the wastewater treatment facilities and collection system, with a total estimated program cost, including escalation over a 30-year implementation period, of approximately $7 billion. The collection system capital projects identified in the SSIP would be implemented through an urban watershed assessment process, whereby the evaluations of benefits and impacts of individual projects would be assessed in terms of overall LOS performance in each of the urban watersheds, and the costs and benefits of each project would be assessed in terms of financial, environmental and social factors (SSIP-PMC 2013b).

Based on the Commission's endorsement, the SFPUC made a commitment to urban watershed-based planning through the publication of the *Urban Watershed Framework* (RMC 2012). Faced with aging facilities and regional seismic activity as well as a changing climate and regulatory environment, the goal of the *Urban Watershed Framework* is to define an objective, transparent process that will result in recommended collection system projects across all of the urban watersheds to bring the entire combined sewer system (CSS) up to the adopted WWE LOS. The individual steps of the Urban Watershed Assessment process include:

1. Characterize the specific conditions of each urban watershed
2. Identify areas of need within the Combined Sewer System (CSS) service area where the LOS is not being met
3. Identify opportunity areas within the City that are potentially suitable locations to implement green and grey infrastructure
4. Define and prioritize CSS performance goals that will achieve the LOS within each urban watershed
5. Develop sustainable project alternatives to address individual areas of need through improved management of stormwater and wastewater
6. Compile packages of project and policy alternatives into a suite of urban watershed alternatives, each of which will achieve all CSS performance goals within that particular urban watershed
7. Evaluate the proposed urban watershed alternatives to optimize financial, environmental and social benefits to San Francisco
8. Recommend an implementation strategy for all of the preferred urban watershed alternatives

1.3.2 Role of Urban Watershed Characterization

Urban Watershed Characterization is the first step in developing, prioritizing, and recommending SSIP policy and capital improvement projects and potential policy changes to address surface drainage and collection system needs. Urban Watershed Characterization is a comprehensive analysis primarily focused on the existing conditions of each urban watershed, but also considers potential future conditions of the collection system and its contributing areas. The existing conditions include the performance and physical condition of the collection system, physical conditions of its contributing areas, and known challenges within the urban watersheds. The future conditions that may be considered can be regulatory-driven or the effects of scheduled capital improvement projects on the collection system and its contributing areas. Ultimately, Urban Watershed Characterization is meant to identify the existing state and level of control of the surface drainage and collection system, identify the needs within each urban watershed, and develop a comprehensive understanding of any dynamic conditions that may affect future project development within each urban watershed.

For the purposes of the Urban Watershed Characterization, surface drainage and hydrologic conditions are organized by urban watershed, an area of land where all rainfall drains across the surface to the same receiving water body. Geographically, the collection system and hydraulic conditions, including pipes, tunnels and pumps, generally correspond with the urban watersheds. Therefore, proposed alternatives will be considered from the urban watershed-wide and citywide perspectives.

San Francisco divides along a natural ridge into two major drainage basins: the Westside Drainage Basin draining southwest to the Pacific Ocean and the Bayside Drainage Basin draining to the San Francisco Bay. The Bayside Drainage Basin contains approximately 62% of the total city area and is divided into five distinct urban watersheds: North Shore, Channel, Islais Creek, Yosemite, and Sunnydale (CCSF H&H Model – Version September 2012, v520).

The City’s two major urban drainage basins were chosen as the organizing unit to evaluate the collection system and contributing areas. However, since the collection system and the treatment facilities function as an integrated system, the Urban Watershed Assessment team will consider how improvement projects in these urban watersheds will affect the system as a whole in addition to each individual urban watershed.

1.3.3 Subsequent Phases of the Urban Watershed Assessments

As mentioned above, the Urban Watershed Characterization is the first phase of the Urban Watershed Assessments. Subsequent phases include the Opportunities Analysis, Alternatives Development, Alternatives Evaluation, and Recommendations. Each of these phases includes a set of analytical processes to implement the integrated, urban watershed-wide approach, outlined in the Urban Watershed Framework, and develop a recommended suite of projects to meet all WWE Goals and LOS in each urban watershed. These phases include various steps to identify needs, identify potential project locations, identify potential project synergies, optimize multiple benefits, and, ultimately, develop projects to meet WWE Goals and LOS.

The Opportunities Analysis focuses on the identification of project concepts and quantifies or assesses expected performance. Alternatives Development will refine concepts into projects, confirm performance, assemble project suites for each urban watershed that meet collection system LOS, and evaluate them with the Triple Bottom Line Analysis. The Triple Bottom Line process will evaluate project costs and benefits from a financial, social, and environmental perspective and will provide a basis for comparing, contrasting, and recommending alternatives. Recommendations will identify a recommended alternative and consider a phasing and implementation plan.

Therefore, ensuring that individual projects contribute to LOS and that urban watershed alternatives meet the collection system LOS is an iterative process that occurs throughout the Urban Watershed Assessments. Table 1.1 lists the WWE Goals, LOS, and Strategies that apply to the Urban Watershed Assessments. It also describes when and how each LOS will be addressed through the Urban Watershed Assessments.

Table 1.1
WWE Goals, LOS, and Strategies that Apply to Urban Watershed Assessments

WWE GOALS	WWE LOS	STRATEGIES	UWA PROCESS TO MEET LOS
Provide a Compliant, Reliable, Resilient, and Flexible System that can Respond to Catastrophic Events			
	Full compliance with State and Federal regulatory requirements applicable to the treatment and disposal of sewage and stormwater.	Reduce the Central drainage basin (Islais Creek) CSDs by 88 million gallons (from 923 million gallons to 835 million gallons) and to 10occurrences.	Opportunities: Spatially define need and area of influence; identify potentially suitable project concepts to reduce Central CSD Basin CSDs; quantify hydraulic benefit of each concept or group of concepts. Alternatives: Incorporate projects that reduce CSDs into urban watershed alternatives.
	Critical functions are built with redundant infrastructure.	Construct redundancy for Channel, North Shore and Westside force mains.	Opportunities: Develop project concepts to provide redundancy. Alternatives: Refine concepts into projects; assemble suites of projects that address redundancy needs; evaluate possible project synergies and optimize projects with multiple benefits.
		Upgrade treatment plants with redundant electrical feeds. Add redundant pumps at major pump stations.	Opportunities: Develop project concepts to provide redundancy to major pump stations. Alternatives: Refine concepts into projects and assemble suites of projects that include construction of redundant functions.
	Primary Treatment, with disinfection, must be on-line within 72 hours of a major earthquake.	Design critical and new facilities for: magnitude 7.8 earthquake on the San Andreas Fault and magnitude 7.1 earthquake on the Hayward Fault.	Opportunities: Develop project concepts to improve seismic reliability at critical facilities. Alternatives: Refine concepts into projects and assemble suites of projects that include seismic reliability improvements.
Integrate Green and Grey Infrastructure to Manage Stormwater and Minimize Flooding			
	Control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain.	Maximize protection of City in LOS storm.	Opportunities: Spatially define need and area of influence; identify potentially suitable project locations; generate project concepts; quantify hydraulic benefit through hydrologic and hydraulic modeling. Alternatives: Refine project concepts into projects; assemble projects that manage flow from LOS storm.
		Develop projects using an Urban Watershed Approach which employs the Triple Bottom Line (TBL).	Opportunities: Assess hydraulic benefits across urban watersheds; identify potential project synergies and ancillary benefits. Alternatives: Refine project concepts into projects; assemble project suites that meet all LOS and optimize multiple benefits; evaluate urban watershed alternatives with TBL analysis.

WWE GOALS	WWE LOS	STRATEGIES	UWA PROCESS TO MEET LOS
		Develop green infrastructure design standards that are informed by the performance of Early Implementation Projects.	Ongoing
		Evaluate and develop projects to reduce CSDs on public beaches.	Opportunities: Spatially define need and area of influence; identify potentially suitable project concepts using retention or detention to reduce CSDs; quantify hydraulic benefit of each concept or group of concepts. Alternatives: Incorporate projects that use retention or detention to reduce CSDs into urban watershed alternatives.
Provide Benefits to Impacted Communities			
	Be a good neighbor. All projects will adhere to the Environmental Justice and Community Benefits policy.	Make visual improvement at the Treatment Plants and Pump Stations.	Alternatives: Include projects that make visual improvements at Pump Stations.
		Use operational controls to minimize Collection System Odor.	Opportunities: Identify potential project locations; evaluate project impacts upon modeled conditions that affect odors. Alternatives: Refine project concepts into projects; assemble suites of projects and programs that address odor.
		Provide community benefits including job creation, workforce development, contracting opportunities, and greening.	Opportunities: Refine needs and priority of potential benefits through data analysis and community engagement; identify potential synergies to provide priority benefits for all LOS projects. Alternatives: Refine project concepts into projects for all LOS, including additional benefits where possible; evaluate and optimize benefits with TBL analysis; evaluate job and workforce benefits with TBL analysis; prioritize projects in environmental justice areas of concern and disadvantaged communities.
		Work with City and County agencies to coordinate capital projects to maximize multiple benefits.	Opportunities: Identify potential capital project coordination opportunities and other synergies. Alternatives: Refine project concepts into projects for all LOS incorporating synergy opportunities where appropriate; evaluate and optimize benefits with TBL tool. Recommendations: Develop project phasing recommendations or criteria to maximize benefits and optimize timing.

WWE GOALS	WWE LOS	STRATEGIES	UWA PROCESS TO MEET LOS
		Engage residents in locating green infrastructure where multiple benefits can be optimized using TBL.	Opportunities: Identify and prioritize amongst multiple benefits and locate specific needs or issues of concern through community engagement activities; refine challenges and needs developed through characterization; identify potential synergy opportunities to provide multiple benefits. Alternatives: Refine project concepts and potential synergies into projects that provide multiple benefits; evaluate and optimize multiple benefits with TBL analysis.
Modify the System to Adapt to Climate Change			
	New infrastructure must accommodate expected sea level rise within the service life of the asset (i.e., 16 inches by 2050, 25 inches by 2070, 55 inches by 2100).[1]	Site new facilities to accommodate or adapt to expected sea level rise over their life.	Alternatives: Refine project concepts into projects; ensure new facilities can accommodate and/or adapt to expected rise or select alternative project.
	Existing infrastructure will be modified based on actual sea level rise.	Develop and implement an adaptation plan for existing infrastructure to address expected sea level rise within the service life of the asset.	Alternatives: Refine project concepts into projects; include retrofits to accommodate updated sea level rise predictions or select alternative projects.
Achieve Economic and Environmental Sustainability			
	Use nonpotable water sources to meet 100% of WWE facilities nonpotable water demands.	Incorporate conservation measures, stormwater, groundwater, recycled water, and greywater reuse facilities into projects.	Opportunities: Identify potentially suitable locations for projects; identify potential project synergies to incorporate non-potable reuse. Alternatives: Assemble project suites that offset WWE potable use.
	Stabilize life cycle costs to achieve future economic stability.	Provide TBL (life cycle analysis) review of projects.	Alternatives: Evaluate projects and project suites using TBL analysis. Recommendations: Present urban watershed alternatives with stable life cycle costs.
Maintain Ratepayer Affordability			
	Combined Sewer and Water Bill will be less than 2.5% of average household income for a single family.	Plan and phase projects to ensure affordability and predictability for ratepayers.	Recommendations: Choose recommended alternative that meets all LOS and develop project phasing recommendations or criteria to maintain ratepayer affordability.

Source: WWE Goals, LOS and Strategies from Collection System Validation Report, May 2013 (SSIP-PMC 2013b).
Note: [1] A climate change assessment currently underway may cause current estimates to change.

As the table illustrates, Urban Watershed Characterization identifies existing conditions, challenges and needs within each urban watershed. The Opportunities Analysis builds upon this base of information and will further define the spatial extent of each need, its area of influence, and appropriate locations and project types that can address that need. (Also see Section 4.3, Identifying Opportunities from Needs and Characteristics). The expected benefit for each project concept will also be quantified. Through this process, potential project synergies will also begin to emerge as potential projects are identified for each LOS and strategy. In addition, the opportunities phase includes various community engagement activities which will contribute to further definition of socio-economic needs, performance goals, and priorities among ancillary benefits that are not yet defined through this characterization.

Alternatives development will refine concepts into projects and group them into suites to meet all LOS. This phase involves selecting projects to meet the LOS for each individual system need and identifying ways to take advantage of synergies between projects to optimize multiple benefits.

In addition, the socio-economic information from characterization and the community engagement activities in the opportunities phase will inform how to provide benefits to impacted communities for each LOS. The process will also implement strategies to provide benefits to impacted communities. The use of Triple Bottom Line Analysis will support an evaluation of each urban watershed alternative and inform the selection of a recommended alternative that meets all the LOS, including economic sustainability and ratepayer affordability.

1.4 Summary of Bayside Drainage Basin Characteristics

This section provides a summary of the Bayside Drainage Basin characteristics, as well as a brief summary of each urban watershed. Section 2.0, Urban Watershed Characteristics, provides a comprehensive discussion of the drainage, operational, hydrogeologic and geotechnical, street and land use, ecological, and socio-demographic characteristics of the Bayside Drainage Basin and five associated urban watersheds.

The Bayside Drainage Basin covers 18,411 acres and is home to a population of approximately 455,000, 62% and 67% of the citywide totals, respectively. Including visitors and workers, the Bayside Drainage Basin supports the equivalent of around 760,000 inhabitants, representing a diverse population and set of needs across the urban watershed.

The Bayside Drainage Basin includes 21 of the 36 City neighborhoods and portions of 7 more, including major business centers downtown and in the financial district, major tourist centers at Fisherman's Wharf and the Ferry Building, and major redevelopment areas at AT&T Ballpark, Mission Bay and Hunters Point. The Civic Center's collection of major institutional centers, including City Hall, the Main Public Library, the Symphony and Opera Houses, as well as some of the City's most iconic open spaces, the Presidio, Crissy Field, Glen Canyon Park and McLaren Park, are all located in the Bayside Drainage Basin. The San Francisco Department of Planning works closely with communities in developing Area and District Plans to guide the future development of the City's neighborhoods and prioritize physical and policy improvements. The Bayside Drainage Basin includes 27 of these Plans in varying phases of planning and implementation, which provide valuable insight into community desires and potential project synergies.

Almost three-quarters, 71% (13,021 acres) of the Bayside Drainage Basin's land cover is impervious, the result of population growth and urbanization (CCSF H&H Model – Version September 2012, v520). Land use includes 42% residential, 19% commercial/industrial, and 17% open space (including parks), with government, public institutional, and other miscellaneous uses each comprising less than 5% of the total Bayside Drainage Basin area. Many public open spaces present good interagency teaming opportunities for projects with a stormwater management component. While government and institutional sites combined comprise only 4% of total Bayside Drainage Basin area, many project synergy opportunities are expected to be identified at or directly adjacent to those sites.

City streets are characterized into six typologies: residential, commercial, alley, industrial, arterial, and park interior and further characterized by their geometries (e.g. wide sidewalk and right of way). Please see Section 2.4, Street and Land Use Characteristics, for additional discussion of street typologies. Approximately one-third of the Bayside Drainage Basin streets are characterized as residential, which is defined as having a wide sidewalk typology, which means that the right-of-way is between 54'-70' with 12'-15' sidewalks. These streets typically have lower volumes of traffic, both pedestrian and vehicular, which may allow space for green infrastructure. The commercial-wide sidewalk typology covers less than ten percent of the Bayside streets and are generally located in the downtown area serving high traffic volumes. Alleyways are also more common in the commercial areas of downtown. These narrow, low traffic streets can be good candidates for permeable paving and in pedestrian-only cases allow for greening in areas lacking green space. The arterial street typology covers almost one-fifth of the Bayside Drainage Basin, and it carries higher speed and higher volume traffic, often with bus and transit.

Across the Bayside Drainage Basin, the terrain sharply transitions from the interior hills to the flat lowlands adjacent to the shoreline. The flat areas adjacent to the Bay are underlain mostly with low permeability Bay fill soils, which in some development areas has subsided. Low-lying fill areas adjacent to the Bay are at risk for both liquefaction and the transport of soil contaminants. Thus, such areas are not appropriate for infiltration-based green infrastructure, including portions of the Presidio, the Marina, Russian Hill, North Beach, Chinatown, the Financial District, South of Market (SoMa), the Mission, Potrero Hill, and the Bayview neighborhoods.[1] San Francisco's Maher Ordinance delineates potential soil contamination zones where soil sampling and analysis are required before initiating a project. The majority of the sandy soils in the Bayside Drainage Basin are located in North Shore, where over 70% of the urban watershed's pervious areas have high stormwater infiltration

[1] Site level analysis is needed to verify soil conditions, as there are large variations in available soils data.

capacity. Around half the of pervious areas in Channel and Islais Creek contain infiltrative soils, which lend those areas to infiltration-based green infrastructure projects, while around one quarter of the pervious area in Yosemite and Sunnydale have infiltrative soils.

The CSS services 87% of the Bayside Drainage Basin, a total of 16,063 acres whereas the remaining 13% is serviced by various separate stormwater drainage networks that discharge directly to the Bay. Sunnydale is serviced entirely by the CSS. Cumulatively, 91% of Channel, Islais Creek and Yosemite are serviced by the CSS. North Shore is the exception, as the Presidio and Port properties (comprising approximately 35% of the North Shore urban watershed) drain directly to the Bay and have no influence on the CSS. Six hundred and fifty (650) miles of pipes carry combined sanitary and stormwater flows underneath the Bayside Drainage Basin neighborhoods into one of the seven transport/storage (T/S) structures totaling seven miles in length. The T/S structures and associated pump stations convey the Bayside's combined sewer flows to the Southeast Water Pollution Control Plant (SEP) located in the Islais Creek urban watershed. The SEP treats all of the Bayside Drainage Basin's combined flows during dry weather, and up to 250 million gallons per day (MGD) of combined flows during wet weather. The North Point Wet Weather Facility (NPF), located in the North Shore urban watershed, provides an additional 150 MGD of primary treatment capacity during wet weather. When the treatment plants are running at maximum capacity, the T/S facilities can store up to 125 MG.

Combined, the plants in the Bayside Drainage Basin have the design capacity to treat up to 400 MGD of combined flows. Treated effluent from these facilities is released into the Bay. When treatment and storage capacities are operating at peak capacity, excess flows from the collection system receive the equivalent of wet weather primary treatment in the T/S structures and are discharged to the Bay from 29 combined sewer discharge (CSD) Structures. According to the CCSF H&H model (Version EHY13_Ver116), the Bayside Drainage Basin, in response to a statistical "typical year" simulation, experiences 13 rain events that result in discharges through at least one of the CSD structures. The model simulated frequency and volume of CSD discharges varies by CSD Basin. CSD structures in North Shore simulate discharge 4 times a statistical typical year, with a total annual volume estimated to be around 42 million gallons per year (MG/yr). CSD structures in the Central CSD Basin discharge 13 times, with total annual volumes on the order of 1231 MG/yr, respectively. CSD structures in the Southeast CSD Basin discharge 1 time with a statistical typical year simulated annual volume around 0.1 MG/yr.

An Urban Water Balance (see Section 2.9, Urban Water Balance) was performed to quantify the flow of water as it travels into the CSS as stormwater runoff and municipal wastewater, through the system as combined flow, and out of the system as treated effluent. Tracking the flow of water through the City provides insight into sources of excess flow and where potential storage capacity or demand for that water might exist. In the Bayside Drainage Basin, approximately two-thirds of rainfall becomes runoff, the remaining one-third infiltrates into the ground or evapotranspires back into the atmosphere. Overall, on an annual basis sanitary flow makes up 47% of the total annual flow into the CSS, stormwater runoff makes up

26%, and base flow the remaining 27%. While wastewater and base flow remain fairly constant year round, virtually all runoff occurs between October and April during a typical year[2], resulting in monthly discharge volumes in the wintertime that are about twice the summertime average. 100% of the total combined flow discharge volume from the Bayside Drainage Basin receives treatment. The SEP provides secondary treatment to 83% of the annual combined flow volume during a typical year. Combined, the SEP and NPF provide primary treatment to another 12 percent, and less than five percent is decanted in the T/S boxes before discharging to the Bay. Since primary-treated discharges and CSD events both occur in conjunction with larger storm events, all such discharges occur between October and April during a typical year.

1.4.1 North Shore

The North Shore makes up 17% of the Bayside Drainage Basin covering 3,048 acres stretching along the City's northern edge from the Golden Gate to the Embarcadero. The Presidio, approximately one-third of the urban watershed, drains directly to the Bay and is not in the CSS service area. The remaining CSS service area drains inland neighborhood hills sharply down to the low-lying flat areas along the water's edge. Wastewater is conveyed through pipes, tunnels and boxes to the North Shore Pump Station, which conveys sanitary flow in dry weather to the SEP and combined flow in wet weather to both the NPF and SEP. North Shore urban watershed has six CSD outfalls from T/S structures in addition to the NPF outfalls.

1.4.2 Channel

Channel is the second largest urban watershed in the Bayside Drainage Basin, making up 31% of the Bayside and covering 5,665 acres, including the neighborhoods of Western Addition, Civic Center, SoMa, the Mission and portions of Twin Peaks and Potrero Hill. The topography transitions sharply from Twin Peaks and the central ridgeline down to the Western Addition, Hayes Valley and Mission neighborhoods. Dense development and poor soils contribute to Channel's highly impervious land cover; at 83% it is the most impervious of the five Bayside Drainage Basin urban watersheds. Historically, the main drainage ways in Channel were Hayes, Mission and Arroyo Dolores Creeks, which all flowed to Mission Bay. Today, the main sewer trunk lines follow the historical paths of the creeks and convey flows to the Channel T/S Box and Pump Station, which then conveys flows to the SEP in dry and wet weather. A portion of Channel has gravity flow redirected to the NPF during wet weather through the North Point Main. Channel has nine CSD outfalls, two directly into the Bay and seven into Mission Creek slough.

[2] A typical year refers to a synthetic representation of the rainfall profile for an average year in San Francisco. The typical year was created using historic data and is used for model simulations to predict sewer system function and performance.

1.4.3 Islais Creek

Islais Creek is the largest urban watershed, making up 36% of the Bayside Drainage Basin and covering 6,692 acres extending from Twin Peaks south to the border with Daly City and east to Bayview Hunters Point. Historical Precita Creek carried flows from Twin Peaks along the north edge of the urban watershed down into Islais Creek, which also collected flows from Crocker Amazon and the Outer Mission, and then emptied into tidal flats and the Bay. The terrain of Islais Creek drops dramatically from the hills of Twin Peaks, Glen Canyon, and Bernal Heights into Noe Valley, Glen Park and Bayview. The Interstate-280 (I-280) corridor creates a barrier to natural flow paths leading down to the Bay. Similar to the Channel system, the main sewer lines follow the historical flow paths of the Islais and Precita Creeks. The urban watershed gravity drains either to the Mariposa/20th T/S Boxes, the Islais Creek T/S Box, or Southeast Lift Station, all of which pump flow to the SEP located near Islais Creek slough. Islais Creek urban watershed has 10 CSD outfalls and two outfalls from SEP.

1.4.4 Yosemite

Yosemite urban watershed makes up 11% of the Bayside Drainage Basin, covering 2,032 acres in the Excelsior and Bayview. Historical Yosemite Creek flowed from McLaren Park down through the Bayview and the Yosemite Slough into the Bay. The eastern portion of this urban watershed, including Hunters Point and Candlestick Point, is built on Bay fill and is mostly part of the MS4 service area. Three-quarters of Yosemite is serviced by the CSS. Dry-weather flow from the upper Yosemite urban watershed drains to the Islais Creek urban watershed via the Hunters Point Tunnel. Dry-weather flow from the lower Yosemite urban watershed combines with dry-weather flow from Sunnydale and is pumped by the Griffith Pump Station to the Islais Creek urban watershed through the Hunters Point Tunnel. The Griffith Pump Station also pumps wet-weather flows from Yosemite and Sunnydale to Islais Creek through the Hunters Point Tunnel where it is further conveyed to SEP for treatment. Yosemite has three CSD outfalls into Yosemite Slough.

1.4.5 Sunnydale

Sunnydale is the smallest urban watershed and makes up 5% of the Bayside Drainage Basin, covering 974 acres in the Visitacion Valley neighborhood. This urban watershed is the least developed on the Bayside Drainage Basin and overlays fertile soils that were historically used for agriculture. The upper reaches of the urban watershed are largely occupied by McLaren Park. The Visitacion Valley neighborhood fills out the lowlands extending to the Bay. Flows from Sunnydale are collected in the Sunnydale T/S structures and then conveyed to Yosemite through the Candlestick Tunnel. Sunnydale has one CSD outfall into the Bay.

1.5 Summary of Bayside Drainage Basin Needs

There are numerous and varied challenges facing the Bayside Drainage Basin CSS to be addressed through the SSIP. This section provides a summary of the Bayside Drainage Basin needs. Section 3.2, Needs Analysis Relative to Wastewater Enterprise Goals and Levels of Service, of this document evaluates the Bayside Drainage Basin collection system's current and future ability to meet the SSIP WWE Goals and identified those areas needing improvement to meet those goals. The current needs fall under four main themes: regulatory compliance, excess flow, structural deficiencies, and operational issues. The analysis also considers how future conditions in the Bayside Drainage Basin may impact long-term system needs.

Regulatory

San Francisco is in compliance with its MS4 and Bayside National Pollutant Discharge Elimination System (NPDES) Permit requirements, which regulate discharges from the separate sewer and combined sewer, respectively. The Needs Analysis provided in detail in Section 3.2, Needs Analysis Relative to Wastewater Enterprise Goals and Levels of Service focused on the components of those permits that most directly relate to collection system performance during wet weather. These components include regulations related to long term annual average CSD frequency, efficacy of CSO controls, maximization of flow to treatment, and MS4 post-construction stormwater management. The Bayside Permit (NPDES Permit No. CA0037664, Order No. R2-2008-0007) references that the the design criteria for CSDs in the Bayside Drainage Basin were developed in accordance with the following regulatory design criteria: a long term annual average of 4 discharge events per year in North Shore, 10 in Central Bayside (the combination of Islais and Channel urban watersheds), and 1 in Southeast Bayside (the combination of Sunnydale and Yosemite urban watersheds). Based on year to year reporting of observed data, the system has on average 3 discharge events per year in North Shore, 11 per year in Central Bayside, and 1 per year in Southeast Bayside. All discharge undergoes equivalent primary treatment before release. SFPUC treats 100% of wet weather flows; approximately 95% of Bayside Drainage Basin flows are treated at the SEP and NPF, and 5% are treated in the T/S structures. Historical and model data suggest that of the three permitted areas in the Bayside Drainage Basin, the Central Bayside – which is comprised by Channel and Islais Creek urban watersheds – is the most in need of improvements to maintain a long-term CSD event frequency that meets the long term annual average design criteria referenced in the Bayside Permit. Although there are no specific challenges in the current conditions, the regulatory environment is subject to change and may be a factor for prioritizing improvements.

Excess Flow

Several areas experience excess flow during intense wet weather due to conveyance, pumping or storage capacity limitations downstream. Low-lying areas and those where steep slopes meet flat terrain slow and constrain flows within the CSS. Debris and grease build up also restricts flow in pipes and reduces the capacity of pumps and other structures, which can be exacerbated in areas where maintenance access is difficult. These restrictions also limit the potential to further optimize collection system storage.

A combination of hydraulic and hydrologic modeling, field observations, interviews with operation staff, and public feedback informed an overall mapping of areas that experience concentrations of excess flow during intense storms. Two potential consequences from these conditions, property damage and personal injury, were analyzed using risk analysis to determine the likelihood of negative impacts. Velocity, depth and area, parcel, building and land use factors, along with Collection System Asset Management Program (CSAMP), proximity to population and flood hazard rating values, were analyzed to determine risk score classifications from negligible, where no significant impacts are expected, to very high, where impacts ranging from minor to major are possible at most sites.

Across the Bayside Drainage Basin, commercial/industrial and residential areas are most at risk for property damage. Approximately 58% of the building area at risk for major damage is commercial/industrial, and 37% is residential. Channel urban watershed contains the greatest quantity and density of property at risk for potentially significant flood damage. Islais Creek has a slightly lower, but still substantial, quantity and density of at-risk property. Yosemite also has a relatively high density of at-risk property, but not a large quantity due to the small urban watershed size. North Shore and Sunnydale have significantly lower quantities and densities of at-risk property.

Within the Bayside Drainage Basin, the vast majority of personal injury risk areas are located along historical creek channels. Excess flow in flat, low-lying areas generally has a low enough velocity that it does not pose a serious risk for physical injury.

Structural Deficiencies

This analysis, which is described fully in Section 3.2.2, focused on the T/S boxes, tunnels, brick sewers, sewers greater than 36 inches, and force mains within the system, as the WWE Renewal and Replacement Program (R&R) is addressing sewers that are less than or equal to 36 inches in diameter. Within the Bayside Drainage Basin, certain baffle controls and flow release structures are not functioning optimally in outfalls, potentially resulting in solids discharge into Mission Creek and the Bay. In many cases, the T/S boxes, pumps and brick sewers are seismically deficient. As the system continues to age, all of these challenges will become more widespread and frequent. The SSIP includes a comprehensive condition assessment program that is currently analyzing the structural and seismic deficiencies of the SFPUC's wastewater assets and will ultimately develop a detailed list of prioritized improvement recommendations.

Operational Issues

Challenges for operation and maintenance of the system include odor and capacity limitations from grit and solids within the conveyance pipes and system inefficiency that could be improved with additional real time control data and refinement of pump operating rules. Odor is most often caused by stagnant wastewater that is allowed to settle along pipes, especially in dry periods without stormwater to help dilute the sewage and increase flow velocities to transport solids. This commonly occurs in older brick sewers with variable slopes and large tunnel structures. Odor can also originate from catch basin sumps. Better rainfall forecasting, CSS flow monitoring, and CSD monitoring is needed to assist operators in effectively managing the system. Linking that real-time data to operational controls would improve system efficiency. Some of the pumps in the Bayside Drainage Basin operate at capacity, while others have excess capacity. Modifications to the pump operating rules may improve system capacity and overall operations.

1.5.1 Level of Service-Specific Areas of Need

The following tables (Tables 1.2 through 1.6) document and summarize the areas of need discussed in Section 1.5, as well as in Section 3.2, Needs Analysis Relative to Wastewater Enterprise Goals and Levels of Service. Needs are categorized by urban watershed within the context of five WWE Goals and associated LOS. These areas are also shown approximately by location on Figure 1.3. Areas of need indicates where the SFPUC Commission endorsed levels of service cannot be met with existing infrastructure.

LOS 1 - Compliant & Resilient System
Combined Sewer Pump Stations (PS)
Combined Sewer System
Transport/Storage Structure (T/S), Tunnel, Force Main (FM), Sewer Main
Wastewater Treatment Plants

LOS 2 - Stormwater Management
Low-lying Areas/Excess Flow Areas

LOS 3 - Community Benefit
Odor
Open Space Need
Environmental Justice/ Disadvantaged Community
Pedestrian/Bicycle Injury Corridor

LOS 4 - Climate Adaptation
CSD outfalls

LOS 5 - Sustainability
Non-Potable Water Reuse

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

Figure 1.3: LOS Areas of Need - Bayside Summary

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

NORTH
0 2,500 5,000 Feet
Scale: 1 inch = 5,000 feet
Source: Chapter 1 Areas of Need Tables

WWE Goal 1

Provide a Compliant, Reliable, Resilient, and Flexible System That Can Respond to Catastrophic Events

<u>WWE Level of Service</u>

- Full compliance with State and Federal regulatory requirements applicable to the treatment and disposal of sewage and stormwater
- Critical functions are built with redundant infrastructure
- Primary Treatment with disinfection will be on-line within 72 hours of an earthquake

Table 1.2
Areas of Need – Provide a Compliant, Reliable, Resilient, and Flexible System That Can Respond to Catastrophic Events

Urban Watershed	Wastewater Collection System Needs
North Shore	Evaluate potential modifications to the North Point Main, especially to the dropouts in SoMa in order to potentially increase treatment at NPF Redundancy for vulnerable portion of North Shore Force Main NPF, NP outfall, and pump station reliability improvements (Palace of Fine Arts, North Shore) R&R aging assets (Marina and Jackson T/S boxes, North Point Main, 5.3 miles of high-risk brick sewers, 0.4 mile of high-risk major sewers, and 1 mile of force mains
Channel	Urban watershed improvements to maintain long-term average of 10 or less CSD events per year in the Central Basin Redundancy for Channel force main Pump station reliability improvements (Berry, Merlin/Morris, Geary Underpass, Channel, Shotwell, Harriet-Lucerne, 20th Street) R&R aging assets (Channel T/S box, Brannan Street Tunnel, North Point Main, 25.3 miles of high-risk brick sewers, 1.9 miles of high-risk major sewers, and 1.4 miles of force mains
Islais Creek	Urban watershed improvements to maintain long-term average of 10 or less CSD events per year in Central Basin SEP, Bay Outfall, and pump station reliability improvements (e.g., Bruce Flynn, Rankin) Renew or replace aging assets (Mariposa and Islais Creek T/S boxes, College Hill tunnel, 0.1 mil of high-risk brick sewers, 1.3 miles of high-risk major sewers, and 3.4 miles of force mains
Yosemite	Re-evaluate Griffith Pump Station operating plan Griffith and Hudson pump station reliability improvements R&R aging assets (Yosemite T/S box, Hunters Point Tunnel, 1.6 miles of high-risk major sewers, and 0.4 mile of force mains)

Urban Watershed	Wastewater Collection System Needs
Sunnydale	Re-evaluate Sunnydale Pump Station operating plan Sunnydale Pump Station reliability improvements R&R aging assets (Sunnydale T/S box, Sunnydale and Candlestick tunnels, 0.5 mile of high-risk major sewers, and 0.4 mile of force mains)

Sources: SSIP-PMC; CSAMP Database, October 2012.

WWE Goal 2

Integrate Green and Grey Infrastructure to Manage Stormwater

<u>WWE Level of Service</u>

- Control and manage flows from a storm of a 3-hour duration that delivers 1.3 inches of rain.

Table 1.3
Areas of Need – Integrate Green and Grey
Infrastructure to Manage Stormwater

Urban Watershed	Wastewater Collection System Needs
North Shore	Marina District (Baker Street between Filbert and Chestnut Streets, Marina Boulevard from Pierce to Scott Streets, and Steiner Street in Cow Hollow crossing into the Marina on Pierce Street for two blocks) Embarcadero from Chestnut to Taylor Street, then inland on Marina and Powell Streets for six blocks Financial District between Ferry Building to Front Street
Channel	Panhandle Parkway running along Oak and Fell Streets Western Addition from Sutter and Pierce Streets down to Market Street and Van Ness Avenue Inner Mission between Treat Street and South Van Ness Avenue Design District along 13th Street Central SoMa south of Folsom Street along 5th and 6th Streets
Islais Creek	Cesar Chavez from Guerrero Street to Potrero Avenue Lower Alemany Boulevard on both sides of Highway 101 Various locations in Excelsior, Outer Mission and southern Glen Park neighborhoods
Yosemite	Lower Yosemite Creek, especially around the slough
Sunnydale	Sporadic areas in Visitacion Valley lowlands

Source: CCSF H&H Model – Version September 2012, v537.

WWE Goal 3

Provide Benefits to Impacted Communities

WWE Level of Service

- Limit odors to within the treatment facility's fence lines
- Be a good neighbor; all projects will adhere to the Environmental Justice and Community Benefits policy[3]

Table 1.4
Areas of Need – Provide Benefits to Impacted Communities

Urban Watershed	Wastewater Collection System Needs
North Shore	Odors in the Financial District around Sacramento and Sansome Streets Disadvantaged communities in Chinatown and North Beach neighborhoods* Open space need in Downtown and Chinatown neighborhoods Bicycle and pedestrian injury corridors and key walking streets concentrated in Chinatown, Financial District, and Northbeach neighborhoods
Channel	Odors at locations adjacent to the Market Street corridor, at the end of Channel Sluice and around the Panhandle Environmental Justice areas of concern in South of Market, and Potrero Hill neighborhoods* Disadvantaged communities in Downtown/Civic Center, Western Addition, and Mission neighborhoods* Open space need in Western Addition, Mission, and parts of South of Market neighborhoods* Bicycle and pedestrian injury corridors and key walking streets concentrated in Downtown, South of Market, Western Addition, and Mission neighborhoods
Islais Creek	Odors in areas surrounding the SEP Environmental Justice areas of concern in Potrero Hill and Bayview neighborhoods* Disadvantaged communities in Oceanview, Croker Amazon, and Excelsior neighborhoods* Open space need in Crocker Amazon and Excelsior neighborhoods* Some bicycle and pedestrian injury corridors along Geneva Avenue, and Mission Street as well as key walking streets in most neighborhoods*
Yosemite	Environmental Justice areas of concern in Bayview neighborhood* Disadvantaged communities in Excelsior and Visitacion Valley neighborhoods* Open space need in part of Bayview neighborhood* Some bicycle and pedestrian injury corridors along Bayshore

[3] Additional socio-economic needs will be refined through opportunities identification and will be informed with community engagement feedback in adherence with the Environmental Justice and Community Benefits Policies.

Urban Watershed	Wastewater Collection System Needs
	Boulevard as well as key walking streets in each neighborhood
Sunnydale	Environmental Justice areas of concern in Bayview neighborhood* Disadvantaged communities in Visitacion Valley neighborhood* Open space need in parts of Visitacion Valley neighborhood* Some bicycle and pedestrian injury corridors and key walking streets*

Sources: San Francisco Planning Department, US Census, SFPUC Community Benefits Group, San Francisco Metropolitan Transportation Authority, CHP SWITRS 2005-2010, Department of Public Health, SSIP-PMC.

*Note: Additional socio-economic needs will be refined through the opportunities and alternatives phases of the UWA and will be informed with community engagement feedback in adherence with the Environmental Justice and Community Benefits Policies.

WWE Goal 4

Modify the System to Adapt to Climate Change

<u>WWE Level of Service</u>

- New infrastructure must accommodate expected sea level rise within the service life of the asset (i.e., 16 inches by 2050, 25 inches by 2070, and 55 inches by 2100)[4]
- Existing infrastructure will be modified based on actual sea level rise and predicted storm surge

Table 1.5
Areas of Need – Modify the System to Adapt to Climate Change

Urban Watershed	Wastewater Collection System Needs	Discharge Name	Weir Elevation (ft, City Datum)
North Shore	CSD outfalls	009 (Baker)	-4
		010 (Pierce)	-4
		011 (Laguna)	-2.9
		013 (Beach)	-3.51
		015 (Sansome)	-4
		017 (Jackson)	-3.9
Channel	CSD outfalls	018 (Howard)	-3.5
		019 (Brannan)	-3.75
		022 (3rd Street)	-3.5
		023 (4th Street (N))	-3.5

[4] A climate change assessment currently underway may cause current estimates to change.

Urban Watershed	Wastewater Collection System Needs	Discharge Name	Weir Elevation (ft, City Datum)
		024 (5th Street)	-3.5
		025 (6th Street)	-3.5
		026 (Division Street)	-3.5
		027 (6th Street (S))	-3.11
		028 (4th Street (S))	-3.5
Islais Creek	CSD outfalls	029 (Mariposa)	-3.5
		030 (20th Street)	-3
		030A (22nd Street)	-2.7
		031 (3rd Street)	-3
		031A (Islais North)	-3
		032 (Marin Street)	-3
		033 (Selby Street)	-3
		035 (3rd Street (S))	-3
		037 (Evans Street)	1.3
		038 (Hudson Street)	7
Yosemite	CSD outfalls	040 (Griffith)	-2.5
		041 (Yosemite)	-2.7
		042 (Fitch)	-2.7
Sunnydale	CSD outfalls	043 (Sunnydale)	-2.6

Source: SFPUC Table 1-1. Active Combined Sewer Discharge Structures – Revised 7/26/2012.

WWE Goal 5

Achieve Economic and Environmental Sustainability

<u>WWE Level of Service</u>

- Beneficial reuse of 100% biosolids
- Use nonpotable water sources to meet 100% of WWE facilities' nonpotable water demands
- Beneficially use 100% of biogas generated by WWE treatment facilities
- Stabilize life cycle costs to achieve future economic stability

Table 1.6
Areas of Need – Achieve Economic and Environmental Sustainability

Urban Watershed	Areas of Need[1]
North Shore	Nonpotable uses at NPF being met with potable water - Potable water is used to flush the Northpoint Tanks, and Landscape irrigation and toilet flushing being met with potable water at NPF
Channel	None
Islais Creek	Landscape irrigation and toilet flushing being met with potable water at SEP
Yosemite	None
Sunnydale	None

Source: Email correspondence with Andrew Clark, SFPUC via John Scarpulla SFPUC June 3, 2013.

Note: Volumes of potable water use are currently being researched and will be applied during the Watershed Alternatives phase of work.

[1] All T/S boxes, with the exception of the Islais Creek T/S box, are self-cleaning and do not use potable water for flushing. The Islais Creek T/S box uses treated effluent from the SEP for flushing.

Areas of Need by Urban Watershed

The following section summarizes the areas of need by urban watershed. Additional detail discussion on the needs of each urban watershed can be found in Chapter 3.0.

North Shore

The vast majority of the challenges in the North Shore urban watershed are located at the shoreline, from the Palace of Fine Arts, past Fisherman's Wharf to the Embarcadero. The collection system infrastructure in this area is aging and already challenged with excess flow and odor issues. The Marina T/S Box – located along Marina Boulevard between the Palace of Fine Arts and Fort Mason – has been identified as having seismic reliability concerns due to age and surrounding fill soil. In addition, the North Shore Force Main and portions of the North Point Main have also been identified as needing major repairs. Odor issues are found further into the financial district near the Embarcadero Center and Sue Bierman Park. SFPUC Operations identified the Fisherman's Wharf area as a maintenance hotspot due to excessive cooking grease entering the system from restaurants in the area and hardening on the interior of the pipes, severely restricting conveyance capacity in some areas.

In the western side of the North Shore near the Presidio and on the northern edge in Fisherman's Wharf, several of the streets are at risk for potential property damage during the LOS storm. System capacity is also a challenge where the Marina and Pacific Heights meet the Presidio, along Lyon Street and Pacific Avenue.

CSD structures in North Shore will require retrofit improvements to counter the impacts of sea level rise; they are amongst the lowest (weir crest) elevations in the City. While North Shore is in compliance with the Bayside Permit's long-term annual average CSD design criteria , the primary water contact recreation areas in North Shore – namely Aquatic Park and Crissy Field – make it an area of heightened interest. In terms of local social and environmental needs, Downtown and Chinatown are identified as high need areas for new open space in the City's Recreation and Open Space Element (ROSE) of the *San Francisco General Plan*. In general, concentrations of higher bicycle and pedestrian safety need areas exist in Chinatown and Financial District neighborhoods. The number of key walking streets is also concentrated in the Financial District and part of North Beach. However, almost every neighborhood in the North Shore urban watershed has at least one key walking street.

<u>Channel</u>

Many of the challenges for the Channel urban watershed are concentrated in the SoMa neighborhood near Market Street and adjacent to Mission Bay. Odor issues extend along the shoreline from the Embarcadero south to Mission Bay, and in the area between Townsend Street and Mission Bay. The Brannan Street Tunnel, constructed in 1873, is expected to need major rehabilitation work (BCM JV 2010f). The Channel Force Main, which carries a proportion of flows to the SEP in dry weather, has structural issues that need to be addressed for reliability. The CBSIP is considering channel force main redundancy needs. The 5th and 6th Street Box Sewers and North Point Main are located in unstable areas with seismic concerns. More than 25 miles of brick sewers throughout the Channel are in need of improvements in the Civic Center Area, Western Addition, SoMa and the western side of the Mission. These areas also experience challenges from grit and debris settling in pipes with relatively shallow slopes.

Areas along the historical Hayes and Mission Creek channels and in pockets of SoMa are likely to experience excess flow during the LOS storm and occasionally during storms smaller than the LOS storm, and with it the risk for potential property damage. These areas of concern spread along the historical Hayes Creek channel in the Western Addition neighborhood from Sutter and Pierce Streets to Market Street and Van Ness Avenue, along the historical Mission Creek channel in the inner Mission neighborhood from Folsom and 18th Streets north to 13th Street then east through the Design District on Division Street, and into SoMa extending over to 4th Street.

In the future, there may be a desire to reduce CSDs in the Mission Creek area because of increased recreational use as an outcome of land use changing from industrial to residential and mixed use. The MS4 stormwater requirements may become more stringent requiring additional oversight and maintenance for these areas, including the Mission Bay redevelopment. Areas within Western Addition and the Mission are identified as high needs for open space and dispersed locations in SoMa have moderate open space needs. In general, concentrations of higher bicycle and pedestrian safety need areas exist in the Downtown, South of Market, Western Addition, and Mission neighborhoods. High pedestrian injury corridors concentrate in Downtown, the Mission, and parts of Western Addition and South of Market. The number of key walking streets is also concentrated in the Downtown, South of

Market, and Mission neighborhoods. However, almost every neighborhood in the Channel urban watershed has at least one key walking street.

Islais Creek

Challenges in the Islais Creek urban watershed are focused in the areas adjacent to the SEP, around the Islais Creek slough, and the Cayuga, Alemany, and Cesar Chavez sewers that follow historical creek alignments. Although the Islais Creek T/S box is typically flushed after each storm event or once a week during dry weather, there are odor issues along the length of the structure at the edge of the Bayview where it meets Potrero Hill. The entire Central Waterfront area from Mission Bay to Islais Creek slough experiences grit deposition that impairs flows and available capacity. The Channel Force Main that carries flows from the Channel Pump Station through the Islais Creek urban watershed to the SEP requires reliability and redundancy improvements, and the College Hill Tunnel is expected to need major repairs.

Areas most at risk for excess flow during the LOS storm generally coincide with former marshland near Islais Creek slough and the historical alignments of Precita Creek and Islais Creek. More specifically these areas include: north of the SEP wrapping around Islais Creek slough and extending west up Cesar Chavez Street, lower Alemany Boulevard where I-280 and Highway 101 intersect near the Alemany Market, and Cayuga Street near where San Jose Avenue splits from I-280. Across the Noe Valley, Excelsior, Outer Mission, and the Bayview neighborhoods, there are pockets of low-lying areas that will likely experience excess flow during large storms.

In the future, there may be a desire to reduce CSDs in the Mission Creek area because of increased recreational use as an outcome of land use changing from industrial to residential and mixed use. The MS4 stormwater requirements may become more stringent requiring additional oversight and maintenance for redevelopment areas, including Pier 70 and Hunters Point. Dispersed locations in western Excelsior and northern Crocker Amazon are identified as having moderate open space needs. There are potential bicycle injury corridors along Geneva Avenue and Mission Street as well as key walking streets along Geneva, Ocean, Russia and Cortland avenues; Chenery and Dolores streets; and others.

Yosemite

The collection system challenges in the Yosemite urban watershed are limited. The major needs relate to operating efficiency (pump operational set points) of the Griffith Pump Station and rehabilitation of the two major tunnels that cross Yosemite (i.e., Candlestick and Hunters Point tunnels). The area near the Yosemite T/S Structure, coinciding with the historical Yosemite Slough, is likely to experience flooding during the LOS storm. In areas within the Portola and Bayview neighborhoods, certain low-lying streets will likely experience excess flow during large storms.

Hunters Point redevelopment is within the MS4 service area, where stormwater requirements are expected to become more stringent requiring additional oversight and maintenance. Dispersed locations in the Bayview are identified as having moderate open space needs. There is a potential bicycle injury corridor along Bayshore Boulevard and key walking streets along Bayshore Boulevard, 3rd Street, Gilman Avenue and Ingerson Avenue.

Sunnydale

There are very few existing challenges within the Sunnydale urban watershed. As noted above, major rehabilitation is needed for the Sunnydale Tunnel that conveys flows from the Sunnydale system to the Sunnydale T/S box. In the Visitacion Valley neighborhood, several streets are predicted to experience excess flow and the risk of potential property damage during the LOS storm.

Dispersed locations in Visitacion Valley are identified as having moderate open space needs. The area immediately east of the neighborhood, between Bayshore Boulevard and the Caltrain railroad tracks, is currently under redevelopment and there are plans to construct additional open space in the process. Key walking streets exist along Sunnydale Avenue, Leland Avenue, Bayshore Boulevard, and Blanken Avenue.

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2.0 URBAN WATERSHED CHARACTERISTICS

San Francisco divides along a natural ridge into two major drainage basins: the Westside drains to the Pacific Ocean and the Bayside Drainage Basin drains to the San Francisco Bay. The Bayside Drainage Basin contains approximately 62% of the total city area (18,411 acres), and the Westside contains the remaining approximately 38% (11,153 acres). The two drainage basins are divided into eight distinct urban watersheds – three on the west side and five on the Bay side. These drainage basins and urban watersheds are illustrated in Figure 1.2. (Note: The Treasure Island Development Authority is responsible for the long-term redevelopment planning of Treasure Island and Yerba Buena Island, and so those areas are not included in this Urban Watershed Assessment process).

To provide the foundation for identifying urban watershed improvement needs and opportunities, this section will characterize the existing state of the Bayside Drainage Basin by reviewing the state of each of the five urban watersheds. From north to south, the five Bayside Drainage Basin urban watersheds are: North Shore, Channel, Islais Creek, Yosemite, and Sunnydale. Characterization describes the defining features of the urban watersheds' surface drainage and collection system that will provide a foundation for identifying and selecting project alternatives that best meet the needs of the City's urban watersheds and communities.

2.1 Drainage Characteristics

This section describes the fundamental hydrologic characteristics of each urban watershed and provides a description of the collection system and its components. Defining hydrologic characteristics including average slope, impervious area, pervious area by soil type, and historical drainage characteristics including the presence of creeks, marshes, and wetlands are summarized for each of the five urban watersheds. This section also describes the physical characteristics of the collection system in the Bayside Drainage Basin, including the pipe network, T/S structures, tunnels, force mains, and pump stations. The performance of the system is also described as it relates to volume of wastewater collected, conditions that lead to CSDs, as well as issues like surface water ponding and collection system surcharge. A basic understanding of the collection system and the physical conditions that may lead to system issues is needed to identify system challenges, needs, and potential projects to address them.

Stormwater runoff in San Francisco follows one of three general pathways: 1) runoff directly to the ocean, Bay, or a lake; 2) runoff into a municipal separate stormwater sewer system (MS4), which then discharges to the ocean, Bay, or Lake Merced; 3) runoff into the CSS, which ultimately discharges secondary treated effluent to the Bay from SEP, to the ocean at OSP or to the Bay as primary treated effluent at NPF; or 4) CSD, which discharges primary treated effluent to the ocean or Bay (see Figure 2.1).

The CSS services more than 90% of the city (see Figure 2.2). In addition to stormwater, it also collects municipal sewage (also referred to as "dry weather

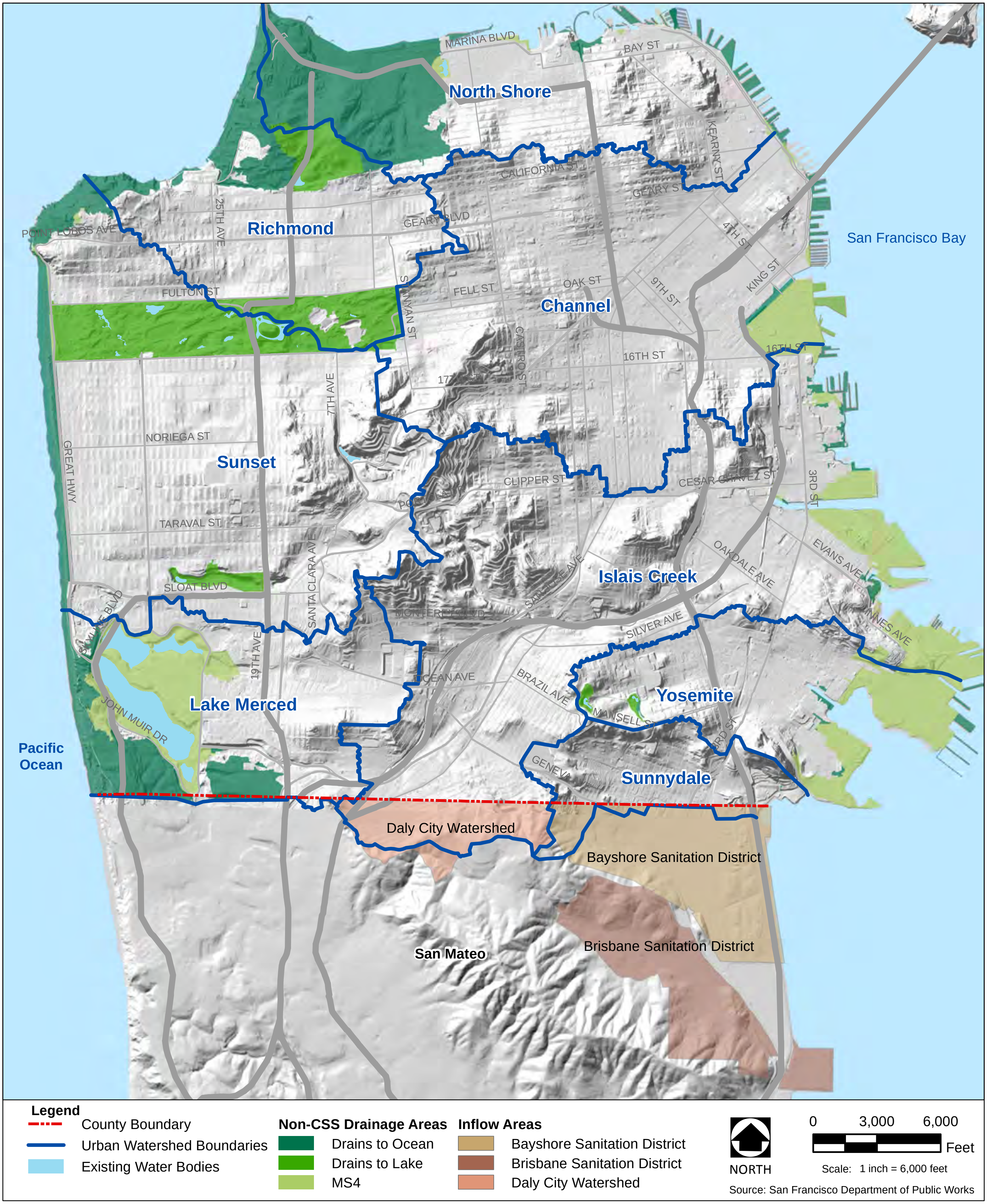

Figure 2.1: Service Area Map

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flows") from buildings and groundwater; hence, it is a "combined" system. The CSS consists of a network of pipes, storage nodes, and pump stations that collects stormwater and sewage and then conveys the combined flows to one of three wastewater treatment plants (WWTPs) before discharging treated effluent to the Bay or ocean through deep-water outfalls. Two of the treatment plants, the SEP and the Oceanside Water Pollution Control Plant (OSP), operate year round. The third, the NPF, operates only during wet weather. The collection system utilizes topography whenever possible, taking advantage of gravity for the collection, transport, treatment, and discharge of wastewater. The Bayside Drainage Basin primarily drains to the SEP, with some flows being routed through the NPF.

In addition to flows generated in the City, the Bayside Drainage Basin CSS receives and treats flows from the following three agencies located near the City's southern boundary[5]:

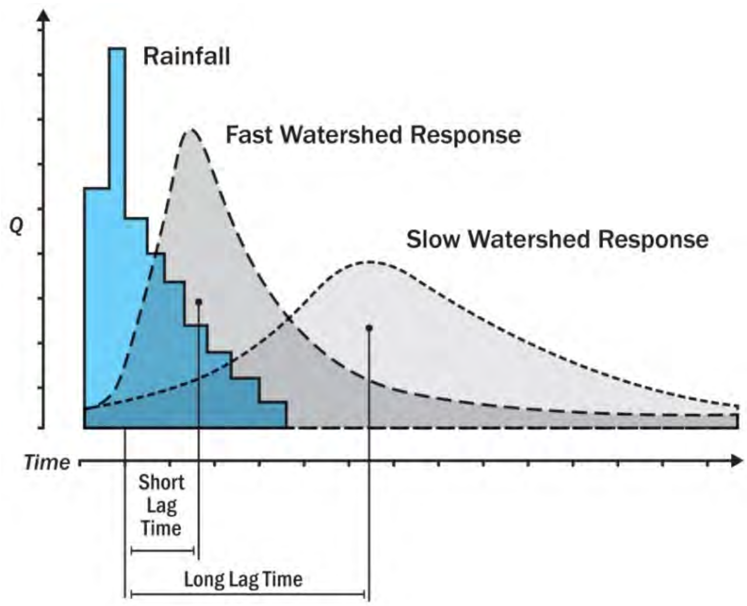
- City of Brisbane: Sanitary flow is discharged into the CSS in the Sunnydale urban watershed at an average dry-weather rate of 0.37 MGD.
- Bayshore Sanitary District: Sanitary flow is discharged into the CSS in the Sunnydale urban watershed at an average dry-weather rate of 0.40 MGD.
- North San Mateo County Sanitation District: A small section of Daly City drains combined flows by gravity into the CSS in the Islais Creek urban watershed and, to a lesser extent, the Sunnydale urban watershed. The average dry-weather flow is 0.79 MGD. Wet-weather flows are variable, but average about 520 MG/yr.

Small areas of San Francisco (about 8% of the total land area) are served by sewer systems that have separate pipe networks to convey untreated urban stormwater to a receiving water body and sewage to the CSS and ultimately a treatment plant, respectively. Separate sewer systems on the Bayside Drainage Basin include Mission Bay, Hunters Point, and Port of San Francisco properties. Only a small portion of the city drains directly to the ocean, Bay, or a lake.

The San Francisco drainage system can be divided into two major components: surface drainage (i.e., hydrology) and subsurface collection system (i.e., hydraulics). The hydrologic and hydraulic characteristics of an urban watershed combine to determine the flow regime resulting from a rain event, or, less formally, the urban watershed response to rainfall. That response can be illustrated by juxtaposing the rainfall hyetograph against the stormwater runoff hydrograph. Figure 2.2 illustrates the difference between a fast urban watershed response typical in urbanized areas and a slow response typical in undeveloped areas. Not only is the response time much faster under urbanized conditions, but the total runoff volume is also much higher.

[5] See *Sewer System Master Plan – Chapter 3: Wastewater Facilities Operation and Performance* for more details (BCM JV 2010h).

Figure 2.2
Natural versus Urbanized Hydrographs



The primary defining characteristics presented in Table 2.1 determine how a watershed typically responds to a rainfall event. Some characteristics allow the watershed to slow and absorb runoff, while others accelerate the runoff response resulting in a “flashy” watershed.

Table 2.1
Generalized Watershed Characteristics

Slower Response	Faster Response
Low % of Impervious Area	High % of Impervious Area
Sandy/Loamy Soils	Silty/Clayey Soils
Vegetation	Bare Surfaces
Extensive Surface Drainage	Extensive Piped Drainage
Flat Topography	Steep Topography
Significant Detention	Little Detention

The first four characteristics listed above affect surface flows. The fifth characteristic, topography, affects both surface and subsurface flows. Detention, the sixth characteristic, only exists in San Francisco in appreciable amounts in the subsurface system. The state of these characteristics in the Bayside Drainage Basin is summarized in the following subsections.

2.1.1 Surface Drainage

Historical Drainage Characteristics

The Bayside Drainage Basin has steep rocky terrain in its interior that drains quickly down to the flatlands along the periphery of the city. Historically, the Bayside Drainage Basin contained a series of creeks that formed in valleys stretching inland and drained toward the marshes and wetlands bordering the Bay shore. During development around the turn of the 20th century, creeks, marshes, wetlands, and coves (e.g., Mission Bay) up and down the shoreline were filled in to accommodate ever-expanding population and industry. Creeks such as Hayes, Mission, Dolores, Islais, and Yosemite Creeks were diverted to underground pipes that now drain into the SFPUC's CSS. Most of San Francisco's historical creeks and tidal lands no longer exist.

Table 2.2 lists the major historical characteristics of the five urban watersheds that comprise the Bayside Drainage Basin.

Table 2.2
Historical Drainage Features of Bayside Drainage Basin Urban Watersheds

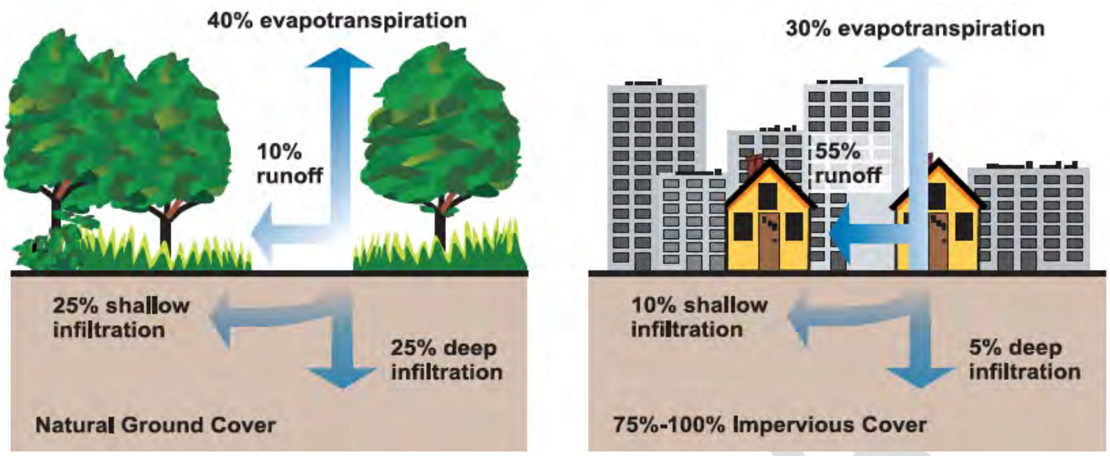
Characteristics	North Shore	Channel	Islais Creek	Yosemite	Sunnydale
Major Historical Hydrologic Features[1]	Yerba Buena Cove	Mission, Hayes, and Dolores Creeks	Islais and Precita Creeks	Yosemite Creek	Farmland
	127-acre Presidio tidal marsh	240-Acre Mission Bay	Islais Creek Estuary	Yosemite Slough	Two small creeks
		Mission Bay Tidal Marsh			

Note:
[1] As per *Citywide Summary Report 2010: Urban Watershed Planning Charrettes* (SFPUC 2011f).

Another impact of urbanization was the transformation of the land surface. While current flow patterns generally follow historical ones, the flow regime has been greatly impacted by extensive surface development and the accompanying sewer systems. As the amount of impervious surfaces have increased, especially in Channel, the eastern portion of North Shore, and the lowland parts of Islais Creek, the amount of infiltration and evapotranspiration has decreased while surface runoff has increased. The result is a "flashy" urban watershed response that produces higher peak flows sooner after rain hits the ground. Typical stormwater flow regimes under natural and urbanized conditions are illustrated in Figure 2.3.

Figure 2.3
Effects of Urbanization on Stormwater Flow Regime

Natural Conditions | Urbanized Conditions



Defining Characteristics of Surface Drainage System in Urban Watersheds

Table 2.3 summarizes the defining hydrologic characteristics of the five urban watersheds that comprise the Bayside Drainage Basin. All of the numeric data shown below resulted from pre-processing spatial data sets to create CCSF H&H Model input.

Table 2.3
Drainage Characteristics of Bayside Drainage Basin Urban Watersheds

Characteristics		North Shore	Channel	Islais Creek	Yosemite	Sunnydale
Total Drainage Area[1]		3,048 acres 4.8 mi^2	5,665 acres 8.9 mi^2	6,692 acres 10.5 mi^2	2,032 acres 3.2 mi^2	974 acres 1.5 mi^2
Drainage to Bay, ocean, and lakes[2]		1,038 acres	11 acres	36 acres	37 acres	0.4 acres
Port of San Francisco MS4 Service Area[3]		68 acres	64 acres	280 acres	0 acres	0 acres
SFPUC MS4 Service Area[4]		12 acres	206 acres	256 acres	427 acres	<1 acres
CSS Service Area[5]		1,981 acres	5,407 acres	6,157 acres	1,544 acres	974 acres
Average Slope (%)		13%	9%	14%	10%	16%
Impervious Area (%)		62%	82%	71%	62%	53%
Total CSS Service Area[6] (%)	A Soils[7]	7%	13%	1%	8%	2%
	B Soils[7]	2%	3%	33%	10%	27%
	C Soils[7]	0%	1%	1%	10%	8%
	D Soils[7]	56%	79%	57%	48%	62%
Rainfall Factor[8]		1.07	1.00	1.02	0.99	1.01

Source: CCSF H&H Model – Version September 2012 v520; SFPUC MS4 Draiange Areas Map, 2013.

Notes:
[1] Refers to modeled subcatchments in the *CCSF H&H Model - Version September 2012,v520*.
[2] Refers to modeled subcatchments in the *CCSF H&H Model - Version September 2012,v520* that do not drain to MS4 or CSS areas.
[3] Refers to permited MS4 areas for the Port of San Francisco, SFPUC MS4 Drainage Areas Map, 2013.
[4] Refers to permited MS4 areas for the San Francisco Public Utilities Commission, SFPUC MS4 Drainage Areas Map, 2013. Includes 9 acres of PUC/PORT permites area. Note: Some piers and other structures are within permited MS4 areas, but are not all represented within modeled watershed areas.
[5] Refers to modeled subcatchments in the *CCSF H&H Model - Version September 2012, v520*.
[6] Refers to CSS subcatchments in the *CCSF H&H Model - Version September 2012, v520*.
[7] Soil groups are defined in Section 2.3.1, Hydrologic Soil Groups.
[8] The Rainfall Factor is applied to adjust rainfall to account for spatial variability in rainfall across the city. Data gathered from the citywide network of 27 rain gages operated by the City was used to determine the spatial distribution factor for each urban watershed.

The defining hydrologic characteristics of each Bayside Drainage Basin urban watershed are discussed below.

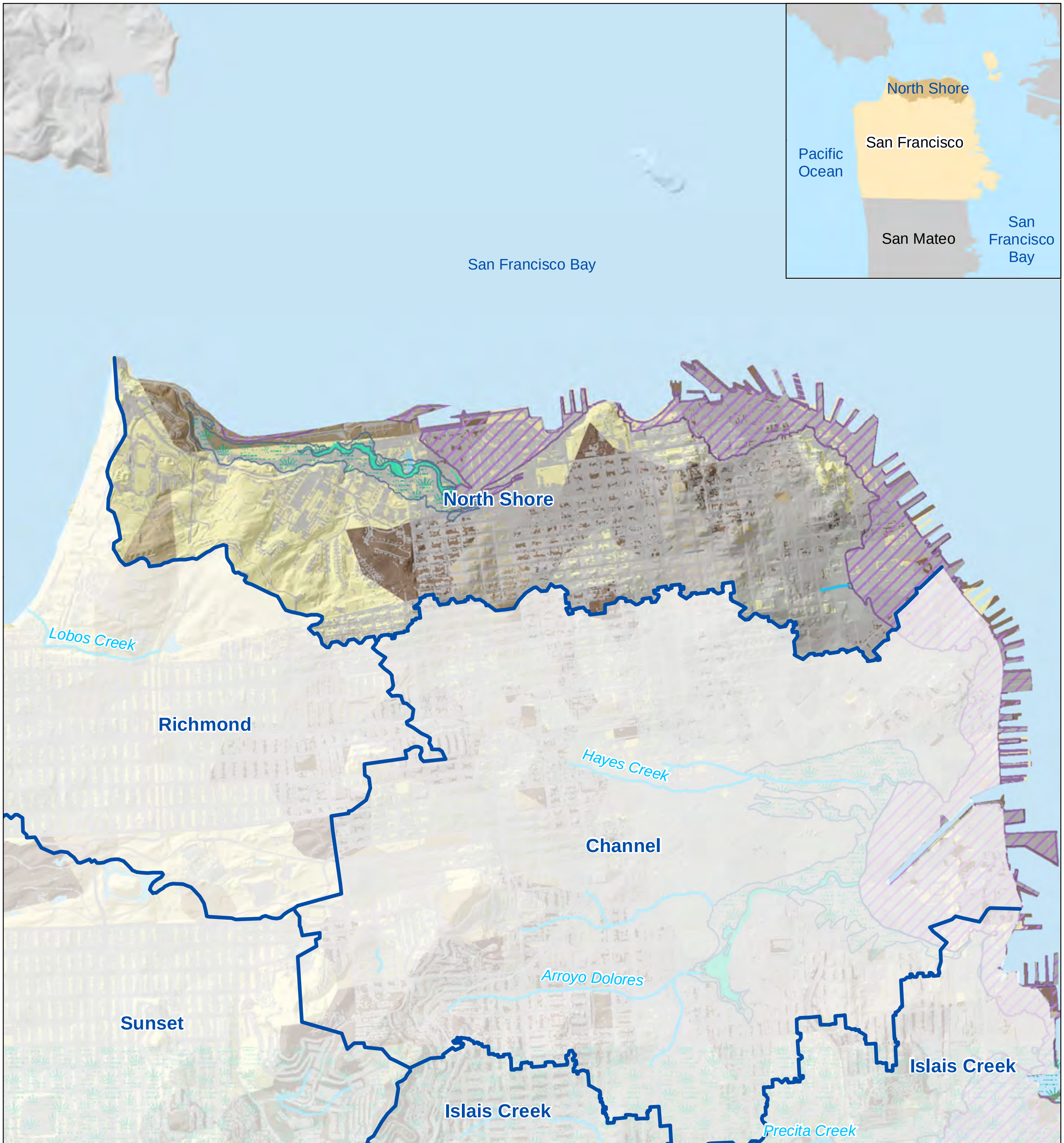
North Shore Urban Watershed

The midsized urban watershed on the Bayside (3,048 acres), North Shore is highly urbanized and largely impervious outside of the Presidio of San Francisco, the vast majority of which is not in the CSS service area. Port jurisdiction is generally located north of Jefferson Street and east of Powell Street, Kearney Street, and Front Street along The Embarcadero. Port jurisdiction is also generally located between Webster Street and Laguna Street, north of North Point Street. The native landscape in the North Shore urban watershed consisted mainly of sand, serpentine rock, and large flats of Bay mud. Many of the iconic neighborhoods in the North Shore urban watershed, including the Financial District, Fisherman's Wharf, and the Marina District, were filled in with sand, Bay mud, and urban debris to create new land for development (SFPUC 2011f). Consequently, the soil types in those neighborhoods are highly variable and predominantly exhibit low to no permeability (see Figure 2.4a). In contrast, there are some good soils in portions of the central urban watershed.

In the western part of the urban watershed the Presidio drains to the Bay, not the CSS. Within the CSS service area, water drains quickly from Pacific Heights, Russian Hill, and Telegraph hill down to the flatter areas in the Marina, Fisherman's Wharf, North Beach, Barbary Coast, and Jackson Square neighborhoods. Due to the combination of factors such as high development density and the transition from steep to flat terrain, managing stormwater in low-lying, flat areas near the Bay is challenging; the areas have historically been prone to property damage during large storms.

Channel Urban Watershed

Channel urban watershed is the second-largest urban watershed on the Bayside Drainage Basin (5,665 acres) and varies significantly in elevation, ranging from approximately 922 feet at Twin Peaks down to sea level at the waterfront. Port



Legend

- County Boundary
- Urban Watershed Boundaries
- Historic Creeks
- Historic Tidal Marsh
- Historic Slough
- Bay Fill
- Existing Water Bodies
- Impervious Surfaces

Surface Soil Hydrologic Classification

- A
- B
- C
- D

NORTH

0 2,000 4,000 Feet

Scale: 1 inch = 4,000 feet

Source: San Francisco Department of Public Works; Oakland Museum of California

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Figure 2.4a: North Shore Urban Watershed Hydrology

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jurisdiction is generally located along the entire shoreline of this urban watershed, generally east of Steuart Street, 3rd Street, as well as along The Embarcadero. Figure 2.4b depicts Channel urban watershed's hydrology. The Channel urban watershed was originally covered in sand dunes, marshes, and creeks all draining to a large water body known as Mission Bay, which occupied 240 acres bounded by what are now Townsend, Eighth, and Sixteenth Streets. That area is still referred to as Mission Bay, and it drains in to an MS4 system. Historically, Hayes Creek, Mission Creek, and Dolores Creek drained the urban watershed into Mission Bay. Today these creeks run in pipes underneath the Civic Center area and Mission District. When the Richmond, Sunset, Western Addition, and Financial District were leveled for development, sand from these areas was used to fill Mission Bay and the surrounding creeks (SFPUC 2011f).

Due to the rocky interior and large areas of fill along the shore, most of Channel is impervious, although there are swaths of highly-pervious soils in the northern half of the urban watershed. Many of the fill areas closer to the Bay, such as the SoMa neighborhood, have subsided, resulting in depressed ground surface elevations near sea level. Channel contains some of the most highly urbanized neighborhoods in the city, such as the Financial District South, SoMa, Inner Mission, Mission Bay, Western Addition, Civic Center, and the Tenderloin. These neighborhoods tend to be flat with extensive impervious cover. Consequently, most rainfall becomes surface runoff, but there is limited topographic relief to drive drainage; therefore, intense rainfall events are prone to resulting in property damage along historical creeks. Across much of the urban watershed, change in elevation combined with high development density and poor soils makes stormwater management in many low-lying areas challenging.

<u>Islais Creek Urban Watershed</u>

Islais Creek is the largest urban watershed on the Bayside (6,692 acres) and is located on the southeastern side of the City and bordered by Daly City to the southwest (see Figure 2.4c). Port jurisdiction in this urban watershed is located generally east of Illinois Street and Cargo Way, with much of the land located south of 26th Street and east of Cargo Way located in the MS4. Historically, Islais Creek had two branches – one flowing from south of Twin Peaks through Glen Canyon, and the other flowing from present-day Cayuga Avenue and Regent Street. Additionally, Precita Creek drained Noe Valley into Islais Creek. Historically, the mouth of Islais Creek was wider than it is today and joined the Bay in today's Bayview and Hunters Point neighborhoods (SFPUC, 2011g). The tidal lands filled to create part of what are today the Bayview and Hunters Point neighborhoods drain to an MS4.

The northwest portion of Islais Creek is characterized by steep slopes. The steepest topography is in the northwest area of Glen Canyon, the source of the headwaters of Islais Creek, which has approximately a 40% slope gradient. The topography gradually recedes in the eastern portion of the basin, becoming increasingly flat towards the Bay (RMC 2008).

Managing stormwater flows along the historical creek channels is very difficult, often resulting in localized flooding. This is particularly true along the I-280 corridor at

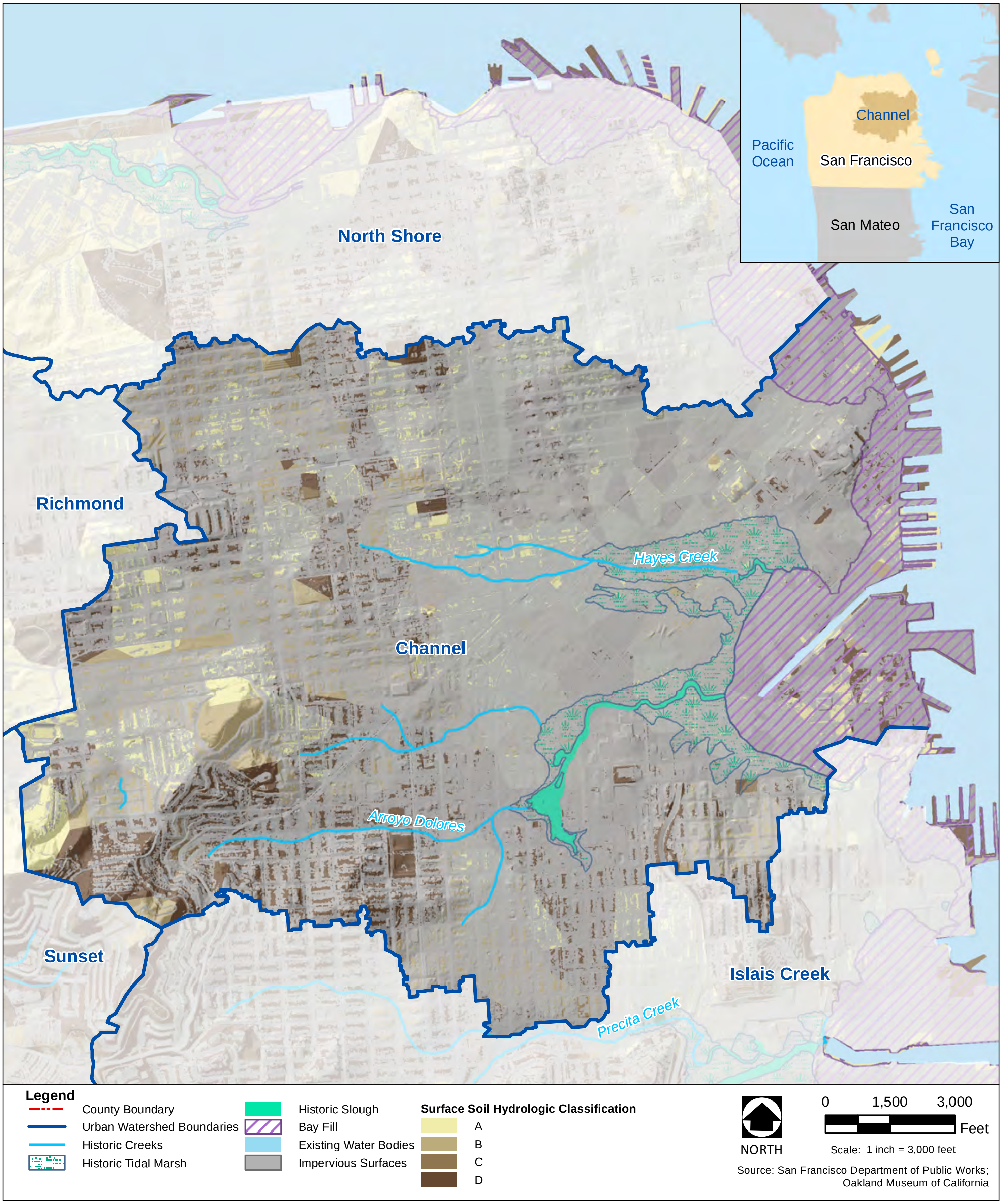

Figure 2.4b: Channel Urban Watershed Hydrology

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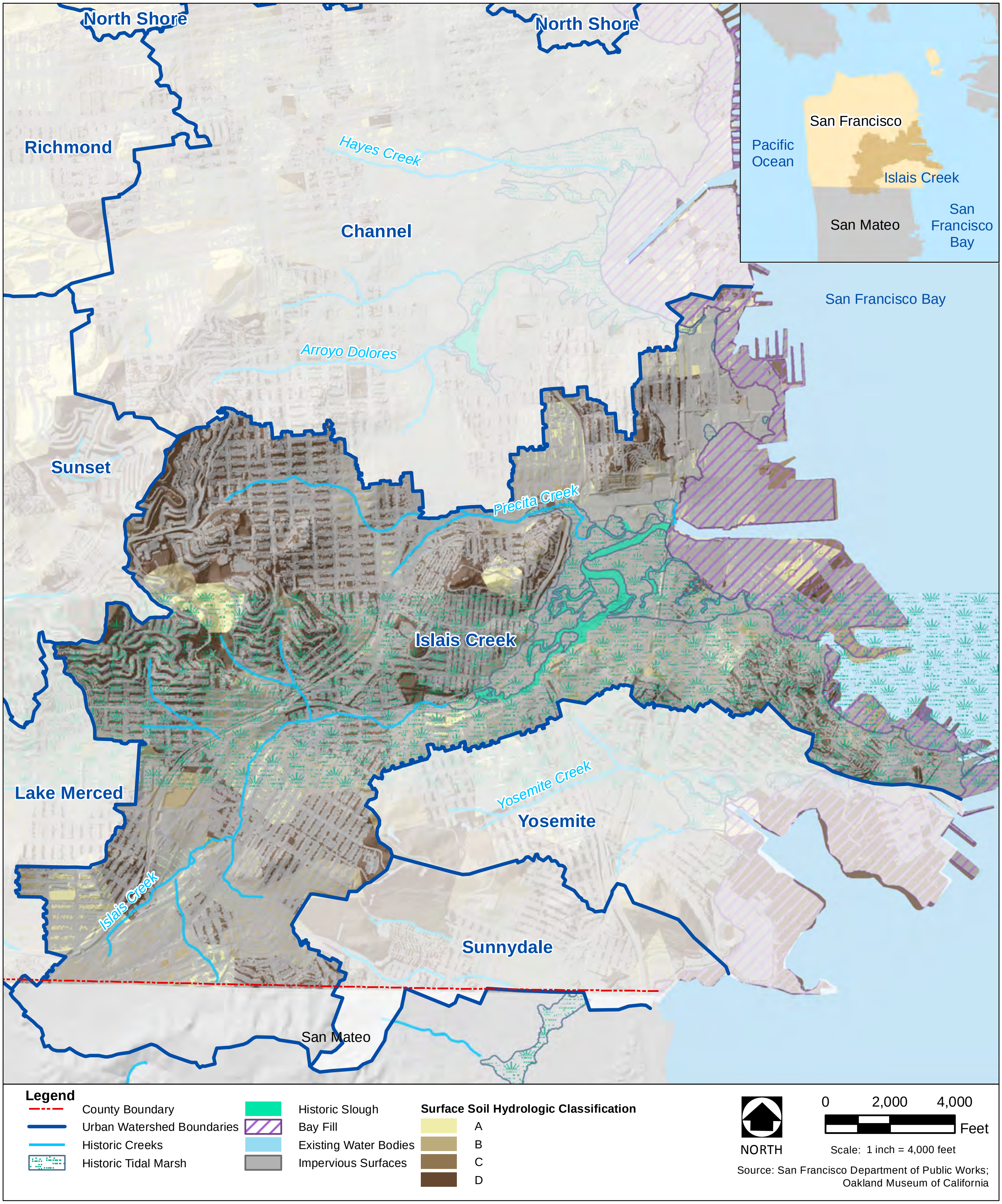

Figure 2.4c: Islais Creek Urban Watershed Hydrology

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Yosemite Urban Watershed

Yosemite is the second smallest urban watershed on the Bayside (2,032 acres) and is framed by Hunters Point to the north and Bayview Hill to the south (see Figure 2.4d). This urban watershed does not contain any land under Port jurisdiction. Originating from a hilltop spring in McLaren Park, Yosemite Creek historically ran through the Portola and Bayview neighborhoods before entering San Francisco Bay through Yosemite Slough (SFPUC 2011f). A portion of Yosemite Slough remains today, but the creek has been channelized in underground culverts. Much of Hunters Point and Candlestick Point is located on Bay fill, and these fill areas drain to an MS4.

Managing stormwater flows at the mouth of the historical Yosemite Slough and on Candlestick Point is made difficult by flat grades, poorly drained soils, and extensive swaths of impervious surfaces. Consequently, these areas may experience property damange during larger storms.

Sunnydale Urban Watershed

Sunnydale is the smallest urban watershed on the Bayside (974 acres). This urban watershed is comprised mainly of Visitacion Valley and is bounded by Bayview Hill to the north, the central ridgeline to the west, and Daly City to the south. This urban watershed does not contain any land under Port jurisdiction. Unlike the rocky northern areas of San Francisco (see Figure 2.4e), Visitacion Valley rests atop fertile soils that made the area especially conducive to farming (SFPUC 2011f).

Sunnydale is not only the smallest urban watershed in the city, but it is also the least developed Bayside Drainage Basin urban watershed, with about half of its surface area being impervious. McLaren Park occupies a large portion of its headlands, and Bayview Hill is mostly undeveloped. Sunnydale is the location of a former garbage dumpand most of the area east of Bayshore Boulevard was formerly tidal marsh. Highway 101 in this area is mostly built on fill. Stormwater management is generally less challenging in Sunnydale than other Bayside Drainage Basin urban watersheds.

2.1.2 Collection System

Collection System Physical Components

The Bayside Drainage Basin CSS pipe network contains approximately 650 miles of pipes ranging in size from 8 inches to over 10 feet in diameter. In addition to the pipe network, the collection system is also comprised of larger tunnels, underground storage vaults called T/S structures, and pump/lift stations. All combined flows pass through the T/S structures before being pumped to the treatment plants.

The major facilities in the North Shore and Channel urban watersheds include a 7-mile system of underground T/S structures (Marina T/S Box, North Point T/S Tunnel, Jackson T/S Box, and Channel T/S Box), which follow the northern and central shoreline of the city. The large rectangular T/S structures are up to 22 feet in width and 45 feet in depth (BCM JV 2010a). The Marina, North Point, and Jackson T/S structures are cumulatively referred to as the “North Shore T/S Structures.” The

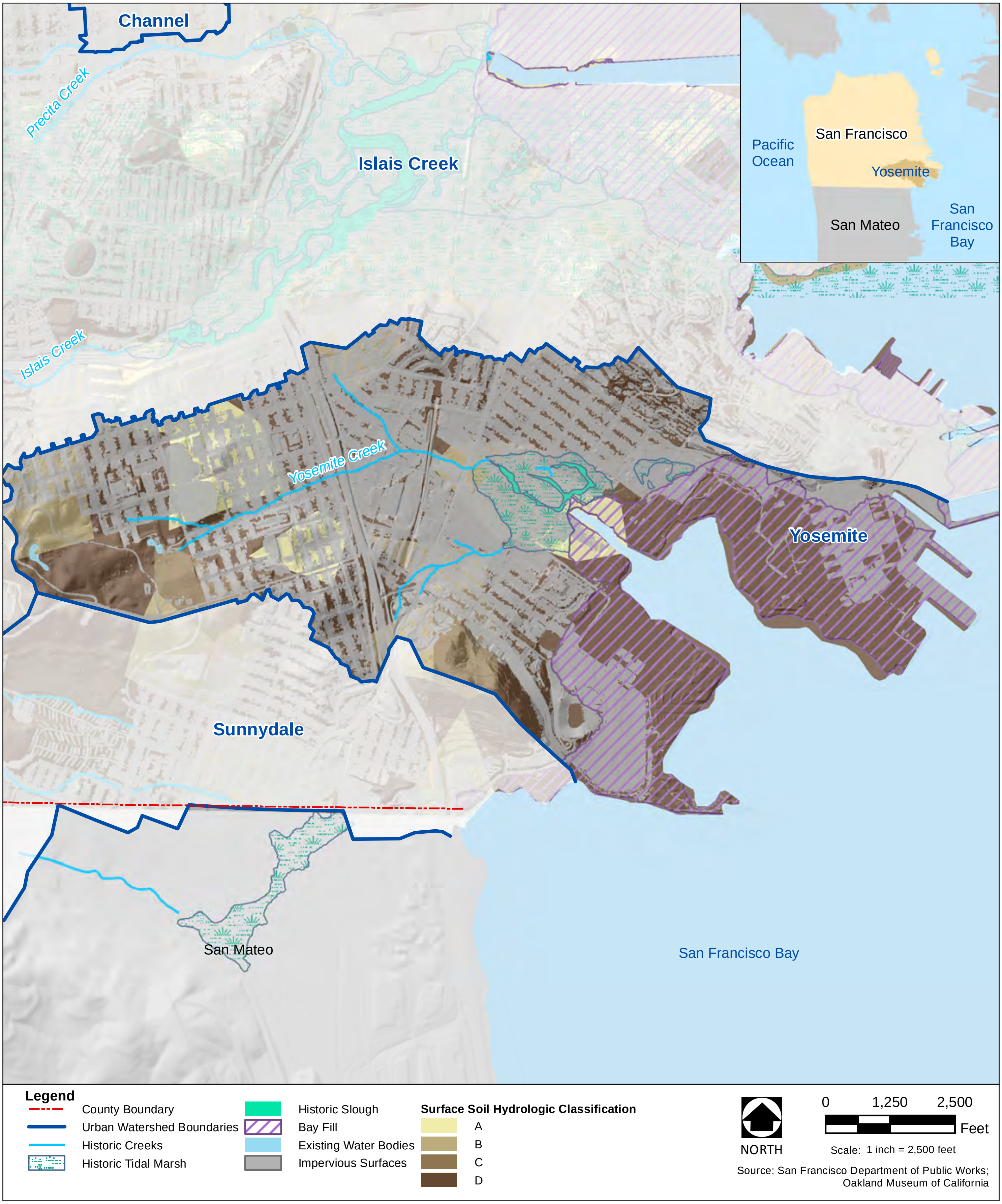

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Figure 2.4d: Yosemite Urban Watershed Hydrology

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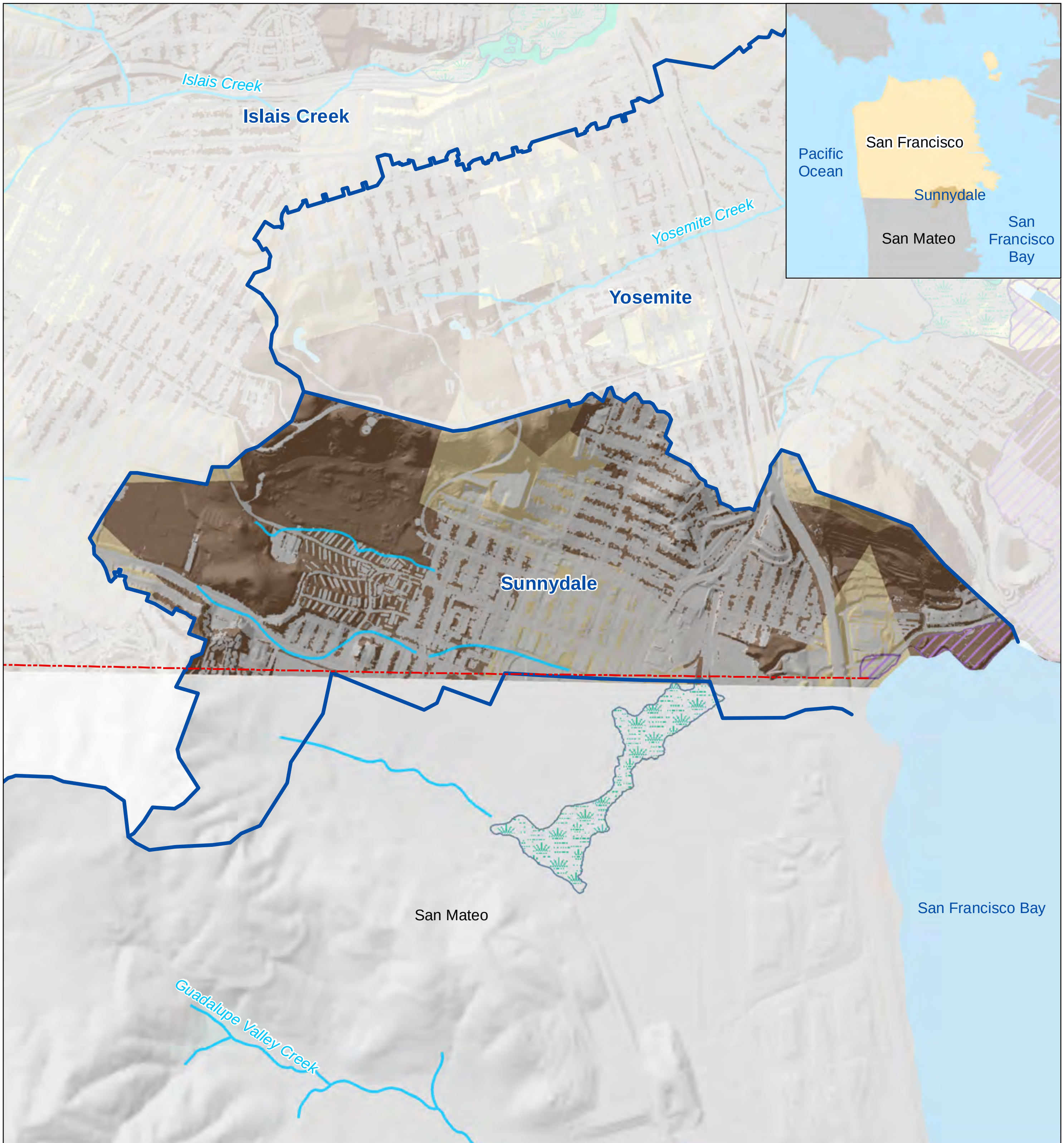

Legend

- County Boundary
- Urban Watershed Boundaries
- Historic Creeks
- Historic Tidal Marsh
- Historic Slough
- Bay Fill
- Existing Water Bodies
- Impervious Surfaces

Surface Soil Hydrologic Classification

- A
- B
- C
- D

NORTH

0 1,000 2,000 Feet

Scale: 1 inch = 2,000 feet

Source: San Francisco Department of Public Works; Oakland Museum of California

Figure 2.4e: Sunnydale Urban Watershed Hydrology

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major southeast bayside facilities (Mariposa, Islais Creek, Yosemite, and Sunnydale T/S Boxes in conjunction with their affiliated pump stations) occur in clusters within the Channel, Yosemite, and Sunnydale urban watersheds. Additional information on the T/S structures can be found in Chapter 3 of the 2010 SSMP, *Wastewater Facilities Operations and Performance* (BCM JV 2010h) and in Appendix H, *Transport Storage Structures and CSD Structures*.

The T/S structures provide storage and decant treatment for stormwater and wastewater during wet-weather conditions, and the Islais Creek Box is also used for the equalization of flow to the SEP to smooth out diurnal wastewater production patterns. Flows are generally pumped from one T/S structure to another or directly to the SEP. When treatment capacities at the plants and storage capacity within the collection system are exceeded, excess flows are discharged into the Bay through the 29 nearshore CSD structures.

The Bayside Drainage Basin sewer system currently has seven large (60-inch or more in diameter) tunnels – North Point Main-Sansome Street, North Point Main-Moscone Center, Brannan Street, Hunters Point, Candlestick, Sunnydale, and Sunnydale Auxiliary. Appendix K of the SSMP, *Tunnels*, contains additional information on these tunnels (BCM JV 2010f).

The Bayside Drainage Basin collection system has five major all-weather pump stations (Channel, Griffith, Mariposa, North Shore, and Southeast Lift Station), two major wet-weather pump stations (Bruce Flynn and Sunnydale), and a dozen minor pump stations. The two major force mains on the Bayside are the 36-inch North Shore Force Main that runs 7,700 feet from the North Shore Pump Station to the intersection of Steuart and Howard Streets, and the 66-inch Channel Force Main that runs 11,215 feet from the Channel Pump Station to the SEP (BCM JV 2010a). Appendix I of the SSMP, *Pump Stations*, contains detailed information on all pump stations in the city (BCM JV 2010c).

Table 2.4 summarizes the physical characteristics of the CSS within the five urban watersheds that make up the Bayside Drainage Basin.

Table 2.4
Physical Characteristics of the Bayside Drainage Basin Collection System[8]

Characteristics	North Shore	Channel	Islais Creek	Yosemite	Sunnydale
CSS Service Area[1]	1,981 acres 3.1 mi^2	5,407 acres 8.4 mi^2	6,157 acres 9.6 mi^2	1,544 acres 2.4 mi^2	974 acres 1.5 mi^2
Length of CSS Piping	95 miles	229 miles	256 miles	49 miles	24 miles
Pipe Density	253 ft/ac	224 ft/ac	220 ft/ac	168 ft/ac	130 ft/ac
CSS Storage Volume[2]	24 MG	38 MG	46 MG	12 MG	10 MG
Normalized Storage Depth[3]	0.446 inch	0.259 inch	0.275 inch	0.286 inch	0.378 inch

Characteristics	North Shore	Channel	Islais Creek	Yosemite	Sunnydale
Downstream Pumping Capacity[4]	150 MGD[5] (North Shore PS)	103 MGD (Channel PS)	180 MGD (Bruce Flynn PS[7]) 70 MGD[6] (SEP LS)	150 MGD[7] (Griffith PS)	63 MGD (Sunnydale PS)

Notes:
PS = pump station.
LS = lift station.
1 Only includes areas that drain to the combined sewer system. Area is therefore less than total city area.
2 Includes sewers and T/S structures below set weir elevations. (volume)
3 This value represents the depth of rainfall over the entire urban watershed that can be accommodated by the CSS Storage Volume in that urban watershed.
4 *Pump Station Condition Assessment Draft Report*, May 2013.
5 Wet Weather Treatment Plant: 140 MGD, all weather force main pump capacity 30 MGD (from conversations with system operators).
6 See *San Francisco Sewer System Master Plan* (SFPUC 2010a) Table 3.
7 Wastewater pumps are 120 MGD; dry weather pumps water pumps 10 MGD. Wastewater pumps currently set at 120 MGD in model; however, wastewater pumps max rate is 150.
8 See *San Francisco Sewer System Master Plan* (SFPUC 2010a), *Sewer System Improvement Program Report* (SFPUC 2010c), and *Pump Station Condition Assessment Draft Report*, May 2013 (SSIP-PMC 2013) for more information about collection system infrastructure.

Defining Characteristics of Collection System in Urban Watersheds

The defining hydraulic characteristics of each Bayside Drainage Basin urban watershed are discussed below.

North Shore Urban Watershed

Figure 2.5a depicts the major components of the North Shore urban watershed. Approximately 65% of the North Shore urban watershed (3.1 square miles [mi^2]) is serviced by the CSS. Most of the remaining 35% is located in the Presidio and on Port properties and drains directly to the Bay, while the Palace of Fine Arts drains to its onsite lake prior to flowing to the CSS via a pump station adjacent to the lake.

Stormwater and wastewater in the western portion of the CSS service area drain by gravity to the Marina T/S Box. Additionally, the Palace of Fine Arts pumps to the Marina T/S box. The Marina T/S Box feeds into the North Point T/S Tunnel, which also collects flows from the central portion of the CSS service area. The North Point T/S Tunnel then conveys all flows east to the North Shore Pump Station. Similarly, the Jackson T/S Box collects stormwater and wastewater from the eastern portion of the CSS service area and conveys flows west to the North Shore Pump Station. In dry weather, North Shore Pump Station pumps to the Channel T/S Box via the North Shore Force Main. In wet weather, the pump station can divert up to 150 MGD of combined flows to the NPF, equaling the maximum treatment capacity at that plant.

Flows between the North Shore and Channel urban watersheds are further interconnected by the North Point Main. As opposed to pumping dry-weather flows from North Shore to Channel, as does the North Shore Force Main, the North Point Main collects combined flows from a portion of the northeast Channel urban

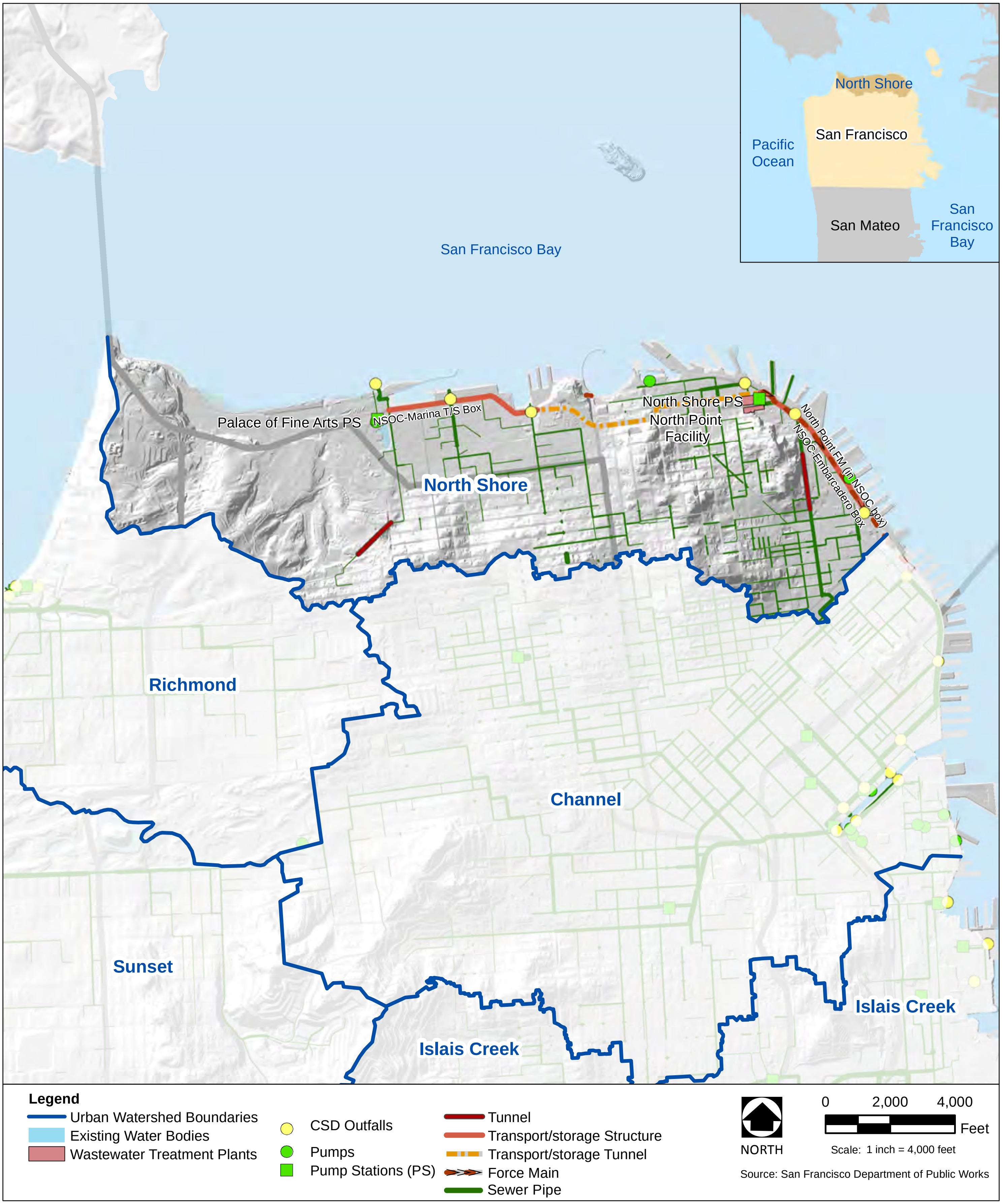

Figure 2.5a: Major CSS Components in the North Shore Urban Watershed

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watershed and drains by gravity to the NPF, up to the main's hydraulic capacity of approximately 75 MGD[6] (SFPUC 2010a).

The CSS service area in the North Shore urban watershed has the highest sewer pipe density, as measured by feet of pipe per acre of drainage area, of any Bayside Drainage Basin urban watershed. Also, there are severe elevation transitions from Pacific Heights, Russian Hill, and Telegraph Hill down to the Marina, Fisherman's Wharf, North Beach, Barbary Coast, and Jackson Square neighborhoods. The dense pipe network and steep slopes combine to strain conveyance capacity in low-lying, flat areas during heavy storms, resulting in episodic localized ponding and surcharge along the near shore area from Palace of Fine Arts to Fisherman's Wharf.

Table 2.5
Flow Characteristics of the Bayside Drainage Basin Collection System

Characteristics	North Shore	Channel	Islais Creek	Yosemite	Sunnydale
Total Dry Weather Flows[1]	1,008 MG/yr	2,545 MG/yr	2,580 MG/yr	620 MG/yr	307 MG/yr
Total Wet Weather Flow[1]	4,786 MG/yr	8,503 MG/yr	6,499 MG/yr	1,413 MG/yr	873 MG/yr
Total CSD Flow	41.6 MG/yr	515.5 MG/yr	715.5 MG/yr	0 MG/yr	0 MG/yr
Total CSS Flows[1]	5,794 MG/yr	11,048 MG/yr	9,079 MG/yr	2,033 MG/yr	1,180 MG/yr

Notes:
[1] Based on model results (October 2012) using the SFPUC Typical Year rainfall data set.
[2] Results from "typical year" model simulation using CCSF H&H Model Baseline Version: EHY13_Ver116 (June 2013). Also see Table 3.2.

At the downstream end of the CSS service area, the North Shore T/S Structures provides more storage volume per unit area than other T/S structures (i.e., the highest Normalized Storage Depth per Table 2.4), and the most downstream pumping capacity of the five Bayside Drainage Basin urban watersheds. These attributes moderate CSD events in number and especially in volume.

Channel Urban Watershed

Approximately 95% of the Channel urban watershed (8.4 mi^2) is serviced by the CSS (see Figure 2.5b). The remaining 5%, located in Mission Bay and Port areas, is serviced by MS4 systems which drains stormwater to the Bay.

The main sewer trunk lines follow the historical flow paths of Hayes, Mission, and Dolores Creeks. Stormwater and wastewater in the combined sewer area are conveyed easterly by the pipe network to the Channel T/S Box, which parallels the Bay waterfront along the Embarcadero and the Mission Creek Channel. The Channel

[6] Hydraulic capacity of North Point Main is variable in proportion to hydraulic head and sediment accumulation.

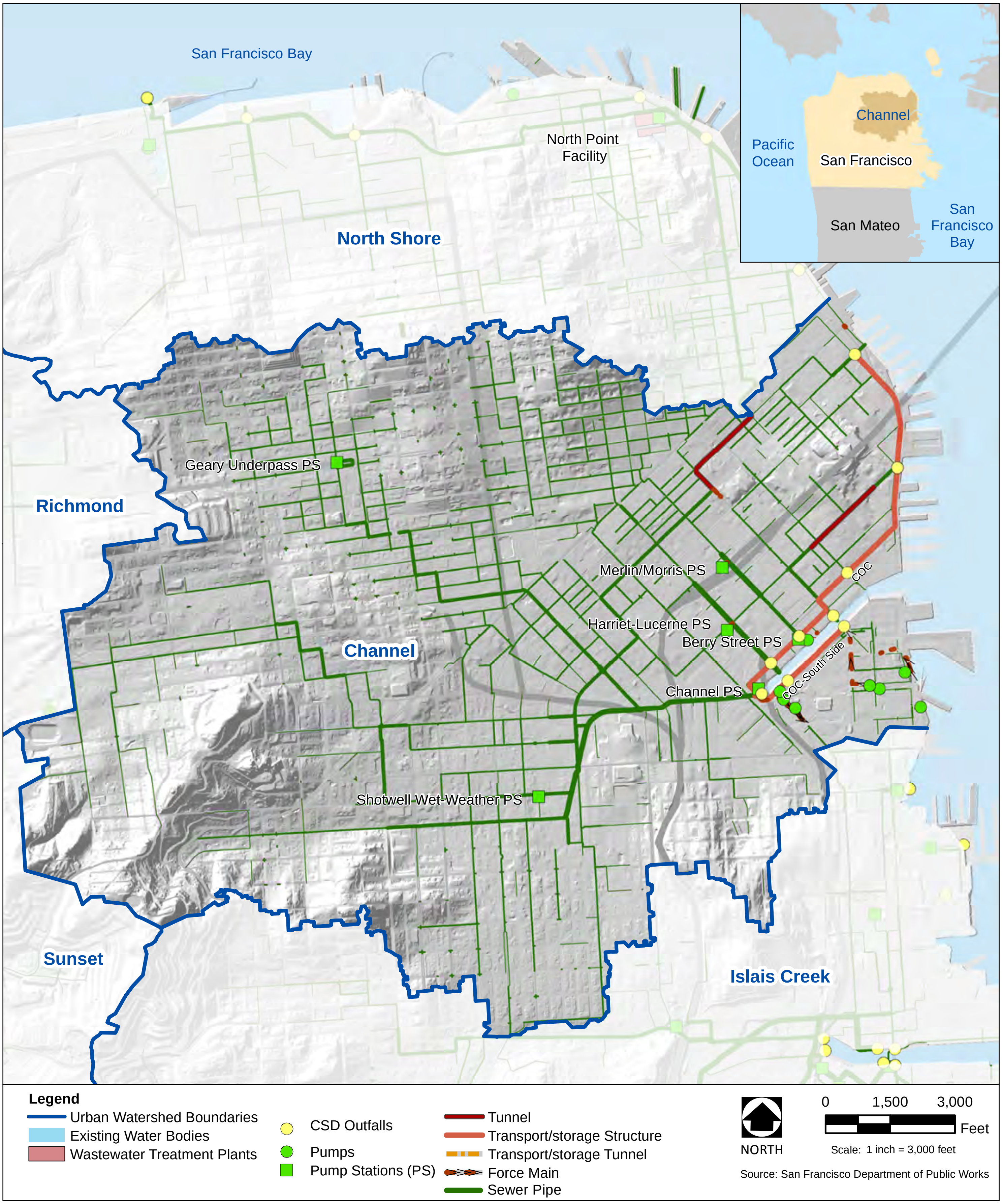

Figure 2.5b: Major CSS Components in the Channel Urban Watershed

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T/S Box feeds the Channel Pump Station located at 6th and Berry Streets, which pumps flows to the SEP via the Channel Force Main.

During normal dry-weather operation, the Channel T/S Box also receives flow from the North Shore urban watershed via the North Shore Force Main. However, when wet weather events cause the SEP to approach its secondary treatment capacity of 150 MGD, flows from the North Shore urban watershed are diverted to the NPF for primary treatment and discharge. Additionally, combined flow from a portion of the northeast portion of the Channel urban watershed drains by gravity to the NPF via the North Point Main, up to the main's hydraulic capacity of approximately 75 MGD[7] (SFPUC 2010a). The North Shore Main is an historical gravity-driven sewer constructed in the late 19th century that runs northeasterly along Mission Street and then turns north, running along Sansome Street to the NPF.

The major CSS components of the Channel urban watershed are depicted in Figure 2.5b. The CSS service area throughout the Channel urban watershed has high sewer pipe density, with steep terrain found around its inland periphery, especially around Twin Peaks. There are severe elevation transitions from these peripheral hills down to the Western Addition, Hayes Valley, Noe Valley, and Mission neighborhoods, which may result in episodic localized ponding and surcharge at the base of hillsides during heavy storms. Flooding in the Channel urban watershed may largely be due to the convergence of natural flow paths and major sewer interceptors in low-lying areas. In most of these cases, sewers may not be able to carry flow from larger rainfall events to the T/S structures. Localized depressions, common throughout the SoMa neighborhood, may also exacerbate flooding because water may escape the CSS during large storm events and pool in the area until flow in the system subsides. The SoMa and Inner Mission neighborhoods are susceptible to flooding even during moderate storms that coincide with high tide, which can exacerbate backwater conditions at the outfalls.

<u>Islais Creek Urban Watershed</u>

Figure 2.5c depicts the major CSS components in the Islais Creek urban watershed. Approximately 92% of the Islais Creek urban watershed (9.6 mi^2) is serviced by the CSS. The remaining 8% is located mostly in the Bayshore and Hunters Point neighborhoods or on Port properties. These areas drain mostly to MS4 systems, with some small areas outside of SFPUC and SF Port jurisdictions (e.g., federally owned piers) draining directly to the Bay.

The main sewer trunk lines follow the historical flow paths of Islais and Precita Creeks. Stormwater and wastewater from the majority of the urban watershed are conveyed easterly/northeasterly by the pipe network to the all-weather Southeast Lift Station located next to the SEP. During wet weather events, excess flow is diverted to the Islais T/S Box, which wraps around the top of the remaining Islais Creek channel then extends up the historical creek bed to the large box sewer running along

[7] Hydraulic capacity of North Point Main is variable proportionate to hydraulic head and accumulated sediment.

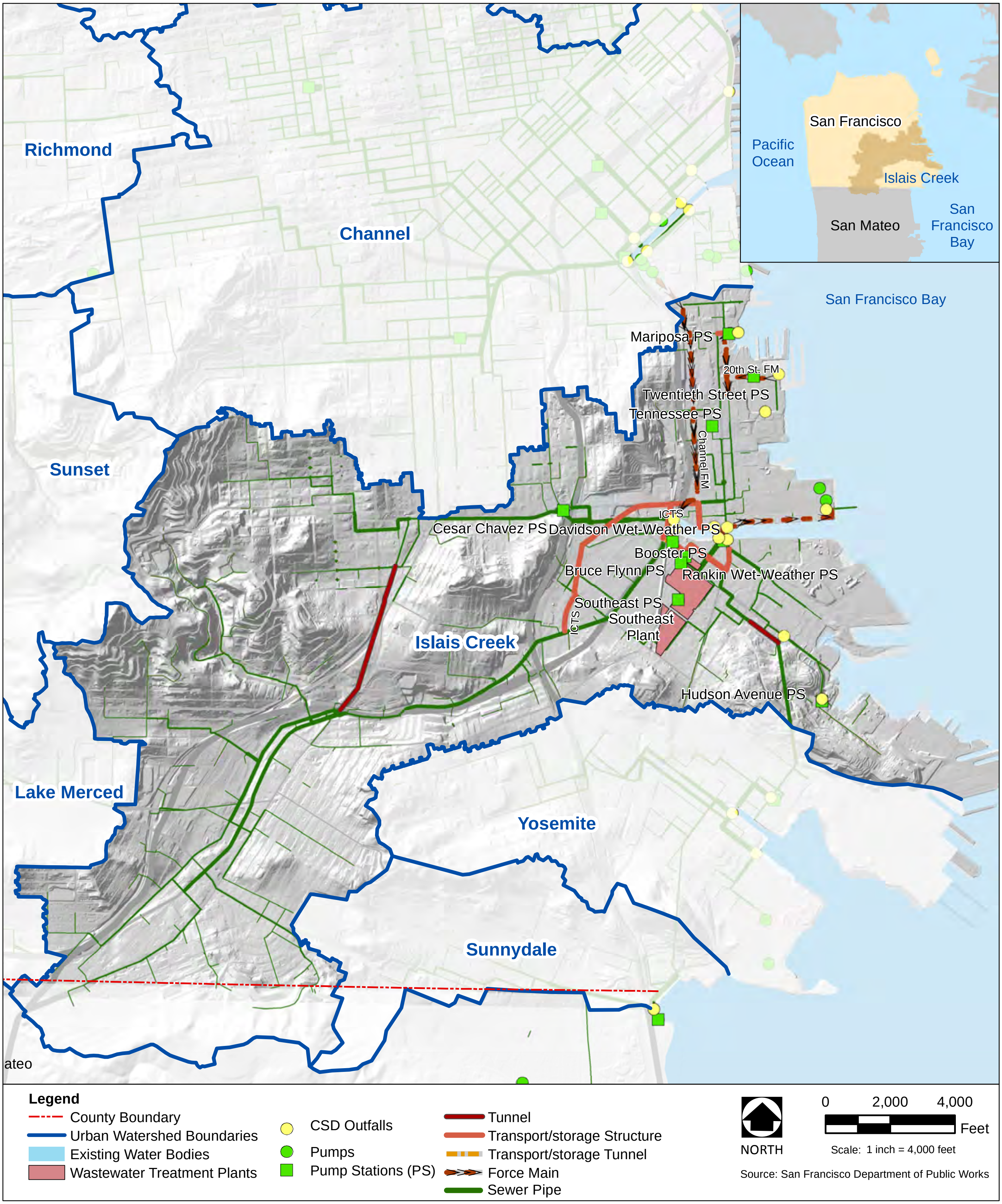

Figure 2.5c: Major CSS Components in the Islais Creek Urban Watrershed

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Alemany Boulevard, where it is pumped to the SEP by the Bruce Flynn Pump Station. Current operational strategy also allows some dry weather flow to enter the Islais T/S Box as a means to equalize the diurnal pattern of wastewater inflow. Stormwater and wastewater from the Potrero Hill and 20th Street areas in the northeast portion of the urban watershed drain to the Mariposa/20th T/S Boxes, which feed their associated pump stations. Those pumped flows discharge to a gravity sewer at 21st and Illinois Streets, which then drains to the SEP.

During normal dry-weather operation, pumped flows from the Mariposa T/S facilities and gravity flows from the Islais Creek urban watersheds and southeast drainage area (Yosemite and Sunnydale urban watersheds) are intercepted by the lift station and pumped directly to the SEP. In wet weather, excess flows are diverted to Islais Creek T/S facilities, which then convey the flows to the Bruce Flynn Pump Station. The Bruce Flynn Pump Station pumps flows to the SEP for treatment (BCM JV 2010g).

The Hunters Point facilities limit combined sewer overflows from two locations, one on Evans Avenue and another on Hudson Street. Sewers convey wastewater flow from these locations to a central control structure at the intersection of Keith Street and Evans Avenue, where flow is directed to the Islais Creek Southside Outfall Consolidation structure and on to the SEP for treatment (BCM JV 2010g).

The CSS service area in the Islais Creek urban watershed has high sewer pipe density in most of urban watershed, although there are some open areas with natural drainage near the western border. Steep terrain prevails throughout most of the interior urban watershed, with flatter areas in the lowlands near the Bay shore. As is common across the Bayside Drainage Basin, there are severe elevation transitions from the peripheral hills down to the interior valleys, which may result in episodic localized ponding and surcharge at the base of hillsides during heavy storms. Local ponding and surcharge in the Islais Creek urban watershed also occur along the alignment of the historical creek channels, especially at the convergence of the two branches of Islais Creek.

Yosemite Urban Watershed

Approximately 76% of the Yosemite urban watershed is serviced by the CSS. The remaining 24% is located mostly in the Hunters Point neighborhood and Candlestick Point, with a small portion on Port properties. Most of these areas drain stormwater to the Bay through MS4 systems, while some piers outside of SFPUC and SF Port jurisdictions drain directly to the Bay.

Stormwater and wastewater from the CSS area are conveyed easterly by the sewer network to the Yosemite T/S Box, which wraps around Yosemite Slough. Dry-weather flow from the upper Yosemite urban watershed flows to the Islais Creek urban watershed via the Hunters Point Tunnel. Dry-weather flow from the lower Yosemite urban watershed combines with dry-weather flow from Sunnydale and is pumped to the Islais Creek urban watershed by the Griffith Pump Station (Figure 2.5d). The Griffith Pump Station also pumps wet-weather flows from Yosemite and Sunnydale to the Islais Creek urban watershed. Flows from the Griffith Pump Station are

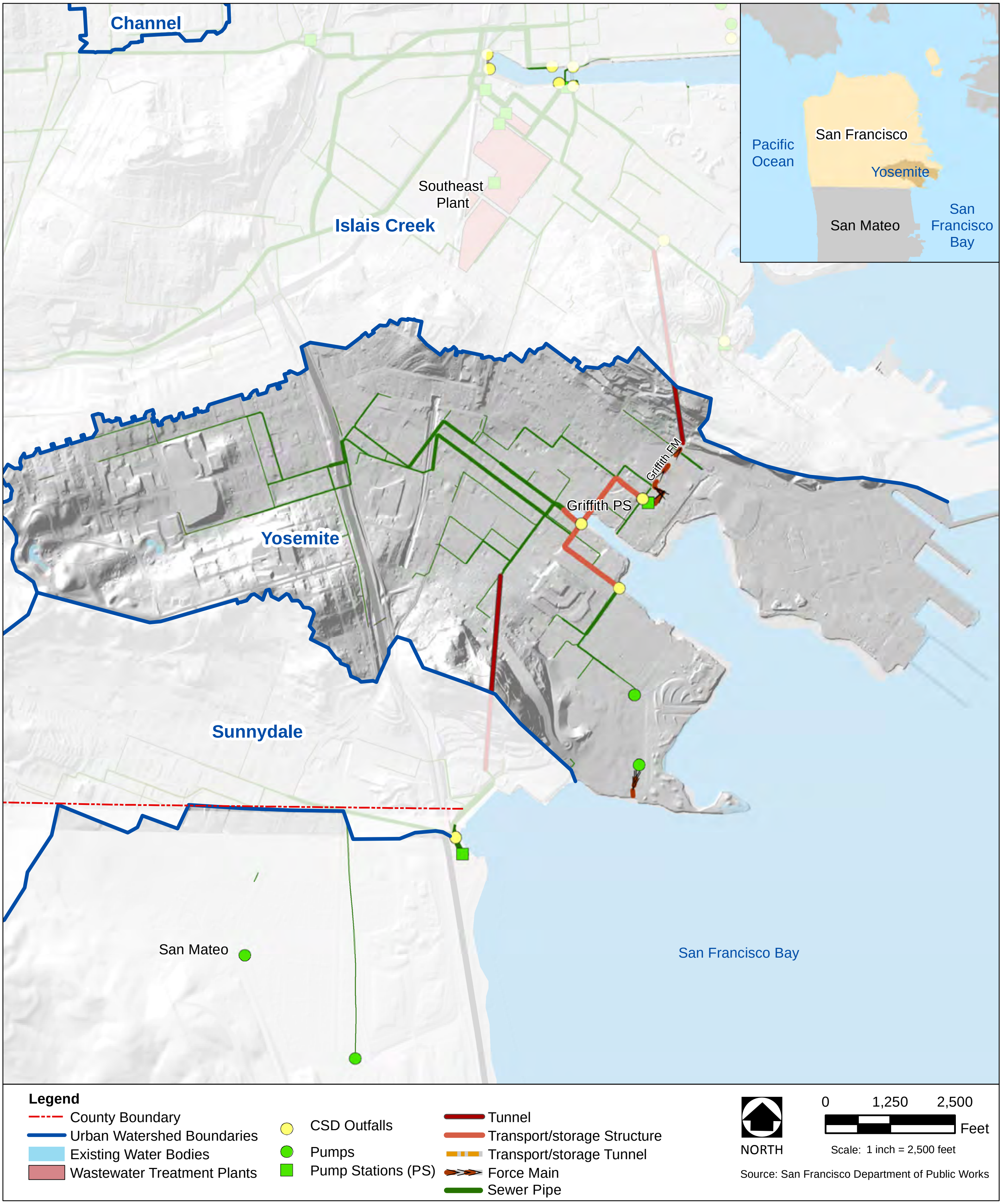

Figure 2.5d: Major CSS Components in the Yosemite Urban Watershed

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discharged to the Islais Creek urban watershed where they flow by gravity to the Southeast Lift Station; they are then lifted to the SEP for treatment (BCM JV 2010g).Major CSS components in the Yosemite urban watershed are depicted in Figure 2.5d. The CSS service area in the Yosemite urban watershed has lower sewer pipe density than the central and northeast Bayside Drainage Basin urban watersheds. Natural drainage prevails in McLaren Park and on much of Bayview Hill. Flooding in the Yosemite urban watershed occurs mostly in the Candlestick Point low-lying areas.

The Yosemite T/S Box and Pump Station provide a large volume of storage and pumping capacity, respectively, to combined flows from the Bayview/Hunters Point and Candlestick areas. CSD events in this urban watershed are relatively infrequent and have very low volumes.

Sunnydale Urban Watershed

Virtually 100% of the Sunnydale urban watershed is serviced by the CSS. Only a negligible area along the shore drains directly into the Bay.

During normal dry-weather operation, flow bypasses the Sunnydale T/S Facilities and drains by gravity to the Yosemite system where it combines with dry-weather flow from that urban watershed. During wet weather, combined flows are diverted from the gravity system to the T/S structure and then conveyed to the Sunnydale Pump Station. Wet-weather flows are pumped to the upstream end of the Candlestick Tunnel and then flow to the Yosemite T/S Box by gravity (BCM JV 2010g).

Figure 2.5e depicts the major CSS components in the Sunnydale urban watershed. The CSS service area in the Sunnydale urban watershed has the lowest sewer pipe density of any Bayside Drainage Basin urban watershed primarily because natural drainage prevails in McLaren Park and Visitacion Valley has low development density. However, Sunnydale is the steepest urban watershed on the Bayside, and severe transitions in grade may lead to episodic localized ponding and surcharge at the base of hillsides.

The Sunnydale facilities provide adequate storage and pumping capacity, and the Yosemite urban watershed does not experience any CSD events during a typical year.

Collection System Performance

On a typical dry weather day, the system collects and treats more than 80 MGs of wastewater. These flows are primarily a combination of municipal sewage and groundwater that infiltrates the sewer network; the latter is referred to as "base flow." All dry-weather flows from the five Bayside Drainage Basin urban watersheds, as well as bayside municipal customers located outside the city limits, are treated at the SEP, from which the effluent is pumped by the Booster Pump Station for discharge into the Bay. The SEP has a maximum secondary treatment capacity of 150 MGD so the CSS has more than enough capacity to provide full treatment to dry-weather flows.

Because the CSS is a combined collection and treatment system, large amounts of stormwater are also managed by the system during rainfall events. Intense storm

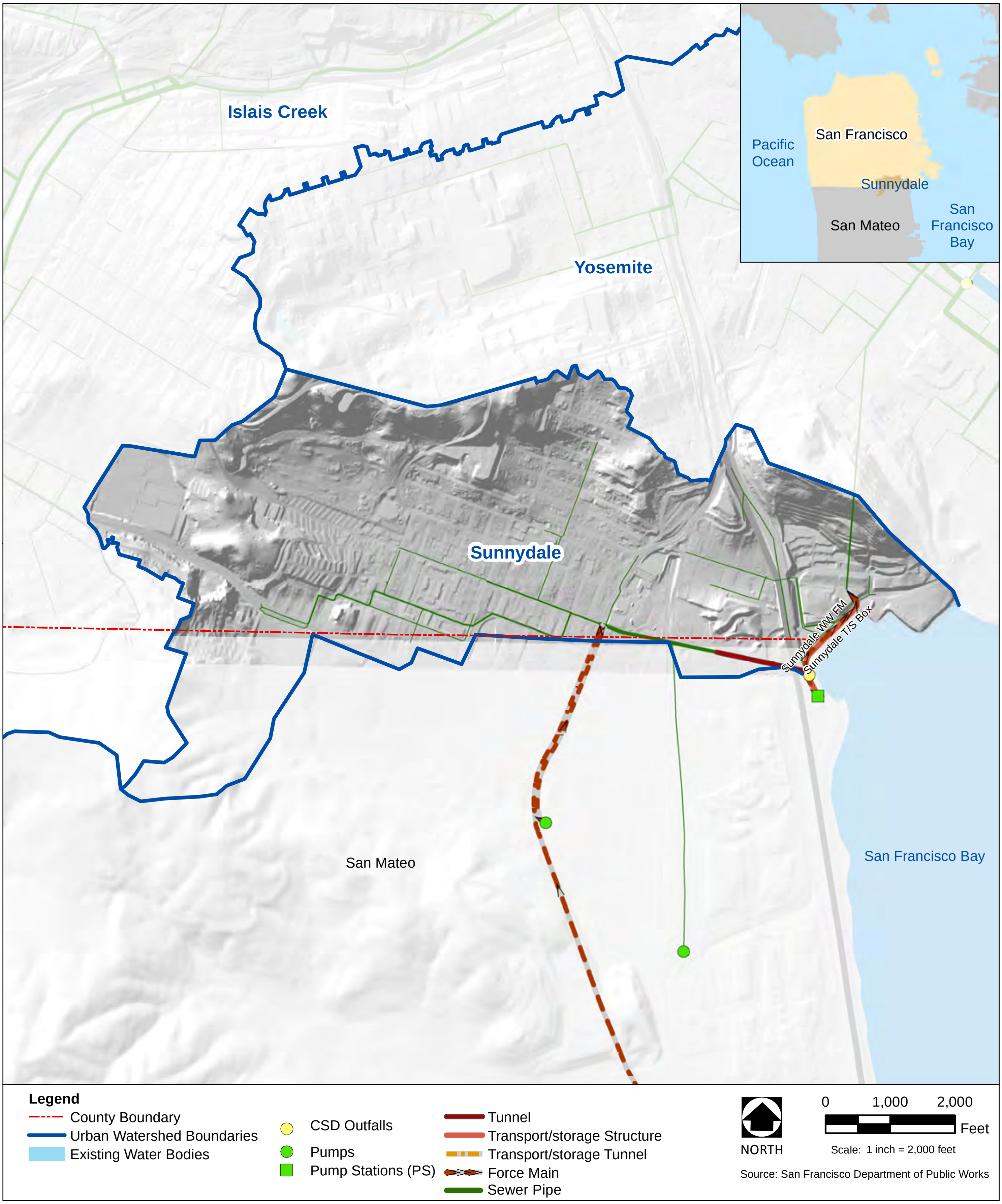

Figure 2.5e: Major CSS Components in the Sunnydale Urban Watershed

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events can overwhelm the hydraulic capacity of the system, resulting in localized flooding. Intense and/or sustained rainfall events can overwhelm the storage and treatment capacity of the system, resulting in CSDs to the Bay. During wet-weather events, the SEP provides secondary treatment up to a maximum flow rate of 150 MGD and primary treatment up to a maximum flow of 250 MGD. When the SEP approaches its secondary treatment capacity and the T/S box levels increase, WWE Operators divert a portion of the the flow from North Shore urban watershed by way of the North Shore Pump Station to the NPF for primary treatment. The bayside plants have an aggregate treatment design capacity of 400 MGD (BCM JV 2010a). Additionally, the sewers and T/S structures provide 130 MG of storage, as measured from below the set weir elevations.

Combined Sewer Discharges

When the pump rates to the respective treatment plants are maximized and incoming stormwater depletes the storage in the system, excess flows are decanted and baffled in the T/S structures and discharged to the Bay through the permitted CSD outfalls. Decanting refers to some sedimentation that occurs while flow experiences more quiescent conditions within the T/S structures. Baffling refers to trapping floatables as the water rises in the T/S structures so that they are not discharged as CSD. watershed and drains by gravity to the NPF, up to the main's hydraulic capacity of approximately 75 MGD (SFPUC 2010a).

The CSS service area in the North Shore urban watershed has the highest sewer pipe density, as measured by feet of pipe per acre of drainage area, of any Bayside Drainage Basin urban watershed. Also, there are severe elevation transitions from Pacific Heights, Russian Hill, and Telegraph Hill down to the Marina, Fisherman's Wharf, North Beach, Barbary Coast, and Jackson Square neighborhoods. The dense pipe network and steep slopes combine to strain conveyance capacity in low-lying, flat areas during heavy storms, resulting in episodic localized ponding and surcharge along the near shore area from Palace of Fine Arts to Fisherman's Wharf.

Table 2.5 summarizes the typical year flows, both dry-weather and wet-weather.

Ponding and Surcharge

Local surcharge can have many different causes, but they all generally occur when the hydraulic grade line (HGL) of water flowing in the pipe exceeds the gradient of the top of pipe. This concept is illustrated in a series of graphics below (see Figures 2.6 through 2.11). Each one is accompanied by a brief discussion of how the hydraulic deficiency illustrated in the graphic causes local surcharge.

Figure 2.6
Flooding Caused by Extreme Rainfall Event

As shown in Figure 2.6, extreme rainfall events can result in runoff that exceeds the design capacity of the underground pipe network. The runoff may exceed the capacity of the catch basin inlets and/or the sewer conveyance facilities. During extreme rainfall events, the streets are intended to act as part of the CSS, where the goal of the system is to minimize personal injury and property damage by containing excess runoff within the street.

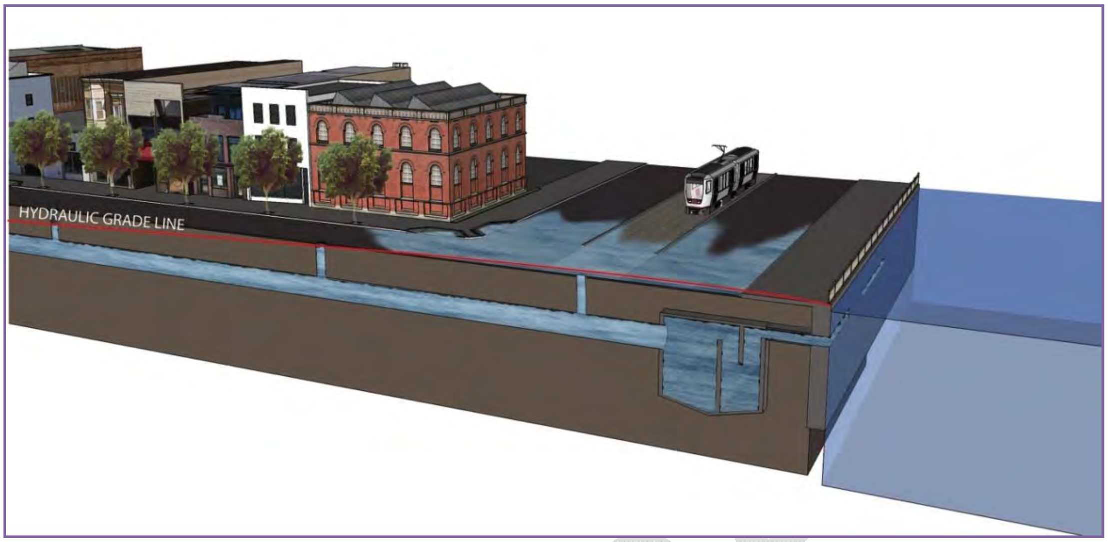
Figure 2.7
Flooding Caused by Increased Upstream Imperviousness

Development and/or redevelopment in upstream tributary areas can increase overall imperviousness, resulting in increased runoff volumes and peak flows to downstream facilities (see Figure 2.7). Flooding may occur if the downstream facilities were not designed to accommodate these increases in runoff. For example the tributary area used to design a sewer may have changed in many different ways over the years which can alter the tributary area's imperviousness, topography and other physical conditions which lead to increases in volume and peak runoff. To help address this issue, the SFPUC has implemented the Stormwater Management Ordinance, which requires that redevelopment projects greater than 5,000 square feet (ft^2) implement BMPs to control runoff. Other means of addressing this type of flooding include: replacing older sewers with new larger-capacity sewers to reflect current land use and development, and lowering of the friction factor in major concrete trunk sewers to increase capacity.

Figure 2.8
Flooding Caused by Pipe Slope Transition

San Francisco's hilly topography results in several locations where steep pipes abruptly connect to pipes with milder slopes (see Figure 2.8). These situations can result in situations that may cause the HGL to exceed ground elevation.

Figure 2.9
Flooding Caused by Downstream Conditions



Some areas of the City experience higher HGL levels within the sewers. These are caused by water levels at the downstream control points such as trunk sewers, T/S boxes, and associated weirs. When downstream HGLs rise, local sewers in low-lying areas may back up, causing flooding on the surface (due to flow exiting the sewer system or surface drainage unable to enter the sewer system because it is at capacity) until the levels within the trunk sewers and T/S boxes recede (see Figure 2.9).

Figure 2.10
Flooding Caused by Street Subsidence

As noted earlier, many of San Francisco's bayfront areas were once open marshlands that have since been filled in. Soil materials used for Bay fill are still consolidating, resulting in surface settling. However, because main sewers in these areas were typically built on piles, they remain at their original elevation along with the roadway crown. Beyond the sewer-on-pile zone, the surrounding land, roadway, sidewalks, and buildings have settled in some cases lower than the inlet and manhole elevations. This can result in the main sewer HGL being higher than adjacent sidewalks, parcels, and connected drainage systems (see Figure 2.10). Remedies to flooding caused by this issue include, but are not limited to, a combination of storage, pumping, and backflow prevention or raising of subsided land. In addition, development standards have also been established in San Francisco (Floodplain Management Ordinance; Ordinance No. 188-08) which require the first floor of structures in flood zones be constructed above the floodplain or be flood-proofed.

Figure 2.11
Flooding Caused by Debris

The initial runoff from major storm events often carries sand/grit debris into catch basins. As shown in Figure 2.11, debris that builds up within the sewer reduces its capacity. Similarly, partially deteriorated pipes that require repair or replacement also reduce pipe conveyance capacity. This compromised capacity may result in sewer backups and flooding during larger storm events. Flooding caused by this issue is primarily addressed through sewer maintenance and associated programs, such as the SFPUC's Renewal and Replacement (R&R) program and Sewer Lateral Policy.

The causes of flooding described above result in certain areas of the Bayside Drainage Basin being more susceptible to flooding. Several of these areas were touched on earlier as part of defining the collection system characteristics in each of the urban watersheds. A more comprehensive summary of these areas, including their associated drainage challenges, is provided in Table 2.6. These locations represent preliminary areas of concern identified during existing conditions documentation. However, subsequent to defining existing conditions, drainage issues within the Bayside Drainage Basin were more thoroughly evaluated and defined as documented in Section 3.1, Existing Wastewater Enterprise Challenges.

Table 2.6
Existing Collection System Areas with Hydraulic Challenges

Area	Surface Drainage/Collection System Hydraulic Challenges	Potential Causes
North Shore		
Mason and Powell streets	Aging sewers potentially in need of upsizing and structural improvements[1] High flows from steep slope sewers discharging to flatter trunk sewer Low-lying area with downstream HGL constraints[1]	Land Use Changes Debris/Obstructions Pipe Slope Downstream HGL
Jefferson and Beach streets	Low-lying area with downstream HGL constraints Oil and grease from restaurants along wharf exacerbates sewer capacity issues Future sea level rise may exacerbate downstream hydraulic constraints Increases in capacity would likely require Beach Street outfall upgrades Odor	Debris/Clogging Downstream HGL
Steiner and Union	High flows from steep slope sewers discharging to flatter trunk sewer can result in significant surcharge at manholes	Land Use Changes Pipe Slope Debris/Clogging
Channel		
Panhandle	Poor surface drainage (e.g., clogged catch basins) and some surcharged pipes along Panhandle Parkway between Oak and Fell streets Surcharging of pipes in the vicinity of Haight and Pierce streets	Land Use Changes Debris/Clogging
South of Market and Design District	Low-lying areas receive high flows from the upper Channel major drainage basin area Former marsh area built on fill, subsidence exacerbates HGL constraints Future sea level rise may exacerbate downstream hydraulic constraints Sediment in pipes, especially North Point Main	Land Use Changes Debris/Clogging Downstream HGL Subsidence
Mission	Located in area of former Mission Creek Low-lying areas receive high flows from the upper Channel major drainage basin area Downstream hydraulic constraints in Division Street sewer Future sea level rise may exacerbate downstream HGL constraints	Land Use Changes Debris/Clogging Downstream Capacity Subsidence Pipe Slope Changes

Area	Surface Drainage/Collection System Hydraulic Challenges	Potential Causes
Western Addition	Land use changes resulting in slightly undersized pipes in the Western Addition and Hayes Valley portion of 10^{th} Street Sewer System Slope change and downstream capacity constraints as system approaches Market Street near Van Ness Avenue	Land Use Changes Downstream Capacity Pipe Slope Changes
Islais Creek		
Cesar Chavez	High flow from the Noe Valley vicinity in the upper Islais Creek major drainage basin area	Land Use Changes Downstream Capacity Debris/Clogging
Lower Islais Creek	Subsidence surrounding Islais Creek Downstream HGL constraints due to rising sea level and levels in Selby Box; also results in saltwater entering sewer system which compromises biological treatment processes Subsidence and HGL constraints can result in sewer backups and ponding in areas around creek, such as on Marin Street and at the Toland-Hudson intersection	Land Use Changes Downstream HGL
Cayuga/Alemany	Surcharging and ponding along Cayuga sewer, as well as surcharging farther downstream in Alemany sewer near Highway 101 and I-280 junction Low-lying area in historical stream reach along Cayuga Avenue Changes to land use, impacts to natural flow patterns due to construction of Highway I-280 Downstream hydraulic constraints within Alemany sewer	Land Use Changes Downstream Capacity
Yosemite		
Candlestick Parking Lot	Low lying area with poor surface drainage	Land Use Changes Downstream HGL Land Subsidence
Sunnydale		
Visitation Valley[1]	Sewers upstream of new Sunnydale Tunnel are undersized for current land use	Land Use Changes

Note:
[1] Improvements are in planning or design phase as part of SFPUC's interim capital improvement program (CIP), see Section 2.8, Planned Projects, for more details.

2.2 Operational Characteristics

This section describes the ways in which the Urban Watershed Assessment can consider operational issues and coordinate with operations staff to integrate proposed projects into existing and potential future system operations. Interviews with operators also identified areas of known system-wide and location specific challenges, which supplements modeling information to identify needs and if they can be addressed with capital projects, operational controls, or a combination of both.

2.2.1 Background

The City's CSS is operated to maintain compliance with its NPDES permit requirements. Section 3.2 of the *Wastewater Facilities Operations and Performance*, of the June 15, 2010 *Sewer System Master Plan* (SSMP) Final Draft Report, *Operating Strategies*, provides a summary overview of both the Bayside and Westside drainage basin operations (BCM JV 2010h). Finally, Appendix M of the same report provides the most recent Bayside and Westside operating strategies including T/S, pump stations and CSD facilities (BCM JV 2010b).

2.2.2 Impact of Sewer System Improvement Program on Operations

The SSIP Urban Watershed Assessment Task will continually examine existing conditions, document existing challenges, identify the opportunities, and develop alternatives for different aspects of the surface drainage and collection system. Aspects that will have an impact on Operations include:

1. Infrastructure Design. The design of the network and the facilities (e.g. sewer network, pump stations, storage/transport boxes, etc.) has an impact on the ability to operate the sewer system. Infrastructure design can impose limitations to the operational capabilities, or allow for better opportunities for control.
2. Final Control Elements. Control of the sewer system is executed through the final control elements such as gates, pumps, and weirs. Some final control elements are “static” (e.g. a fixed weir), and some control elements are “dynamic” (e.g. a gate that can be opened or closed). The design and the characteristics of the final control elements will have an impact on operation.
3. Communications and Data Acquisition. Since the sewer system is a network, with elements and facilities distributed over a large geographic area, measurements from different locations are needed to assess the system-wide conditions of the sewer system. Communications and data acquisitions systems provide tools to collect and aggregate information from different sources, and provide a platform for system-wide analyses and control.
4. Real-Time Control Modes. Operation of the sewer system can be implemented through different “modes” of control. The difference between control modes is in the different roles that can be played by the operators, and the degree of automation. Typical modes include supervisory control (where the operators make the operational decisions), automatic control (computer algorithms make the operational decisions), and a hybrid mode where some operational decisions are made by operators, and some operational decisions are automated.

5. **Real-Time Control Strategies.** The specific rules for operating the sewer system (in real time) are referred to as control strategies. The control strategies come in many different forms, and can range from simple to highly complex.

6. **Data Management.** There is a broad range of information related to sewer system operation; this information resides in different systems including DCS, SCADA, Geographic Information Systems (GIS), hydraulic models, and Maximo. Operation of the sewer system can be improved if information from these different sources is accessed, and if operators leverage this information in their decision-making process.

7. **Decision Support Systems (DSS).** If the data from network-wide monitoring sources is available and accurate, and different additional data sources and systems can also be accessed, a DSS provides the capability to analyze and present this information in a format that is most useful to operators.

It is important to note that the operation of the collection system is best examined and analyzed using a methodology that considers operational issues and performance in a system-wide context. The collection system is a network, and changes to one part of the system have an impact on other components and locations. For example, if a pump is changed, or a gate is operated differently, there will be impacts both upstream and upstream of the location where the change is made.

Within the Urban Watershed Assessment, a number of different infrastructure design alternatives will be proposed and evaluated. Impact on operations will be in the context of the seven aspects presented above to be considered during the development of alternatives, and established as part of the evaluation methodology.

2.3 Hydrogeologic and Geotechnical Characteristics

The Bayside Drainage Basin includes a variety of conditions which may limit certain types of infrastructure projects (e.g., a green infrastructure project that would infiltrate captured rainwater should not be located at a site with high groundwater). To better understand potential geologic limitations, this section describes hydrogeologic characteristics, including hydrologic soil types, liquefaction potential, Maher Zones and historical fill areas, as well as groundwater and bedrock depths. Knowledge of these characteristics is essential for proper sitting of green and grey infrastructure projects and informs the selection of technologies to be used within each project. This characterization summarizes data from city-wide GIS data (see Appendix A). These sources provide planning level information that identifies the general characteristics that influence which areas are most appropriate for different types of green and grey infrastructure.

2.3.1 Hydrologic Soil Groups

Soils are typically classified into four hydrologic groups as defined by the National Engineering Handbook (NEH) based on measured and projected stormwater runoff characteristics. Using these classifications, the runoff and potential infiltration characteristics of the various soil types were assessed throughout the City and County of San Francisco. The hydrologic groups are defined by Chapter 7 of Part 630 of the NEH as follows:

- Soil Group A - Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10% clay and more than 90% sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35% rock fragments.
- Soil Group B - Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10% and 20% clay and 50% to 90% sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35% rock fragments.
- Soil Group C - Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil can be restricted. Group C soils typically have between 20% and 40% clay and less than 50% sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35% rock fragments.
- Soil Group D - Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40% clay, less than 50% sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, if they can be adequately drained.

The properties of the prevailing soil group influence the hydrologic characteristics of the urban watersheds as detailed in Section 2.1, Drainage Characteristics, as well as what types of green infrastructure methodologies will be most applicable in a given location. Soils of groups A and B are best suited for the application of infiltration-based green infrastructure projects. Soils of groups C and D limit infiltration potential and require flow-based treatments to detain stormwater and reduce peak flows to the CSS. GIS Analysis was performed to remove or define the surface soil types as described in Section 2.3. As shown in Figure 2.12, the soil type correlates to the topography of the Bayside Drainage Basin. Locations of hills and steep terrain are often on type D soils, and the type A and B soils are often found in the lower-lying areas of the basin. The Channel and North Shore urban watersheds have large areas of A and B soils, but the Islais Creek, Sunnydale, and Yosemite urban watersheds are primarily C and D soils, with the exception being along the historical alignment of Islais Creek itself.

2.3.2 Liquefaction

In an area at risk of such extreme seismic activity as San Francisco, infiltration of water should be avoided in areas where liquefaction is a concern. In seismic events, loose sands and silts that are saturated with water can respond as a liquid when shaken, losing the strength and stiffness necessary to bear weight and support structures. This can cause significant damage to property and infrastructure. Liquefaction hazard zones have been mapped within San Francisco and are shown on Figure 2.12. Much of the low-lying and historical marsh areas on the Bay side are within these liquefaction zones.

2.3.3 Maher Zone and Historical Fill Area

In an effort to account for the historical contamination of soils unearthed by several construction projects, the City has adopted Article 20 of the San Francisco Public Works Code, commonly referred to as the Maher Ordinance. This ordinance outlines requirements in dealing with contaminated soils and specifies locations where there is a higher likelihood of existing soil contamination. The ordinance requires soil sampling and analysis for projects that disturb greater than 50 cubic yards of soil or are located within areas of Bay fill or other areas as designated by the DPH. These zones are areas where the potential of stormwater infiltration is very limited, regardless of soil type, and the soil will need to be analyzed at specific project locations if infiltration is to be explored. DPH and the SFPUC are working to redefine the Maher zones, but the current established extents of the Maher zones are also shown on Figure 2.13.

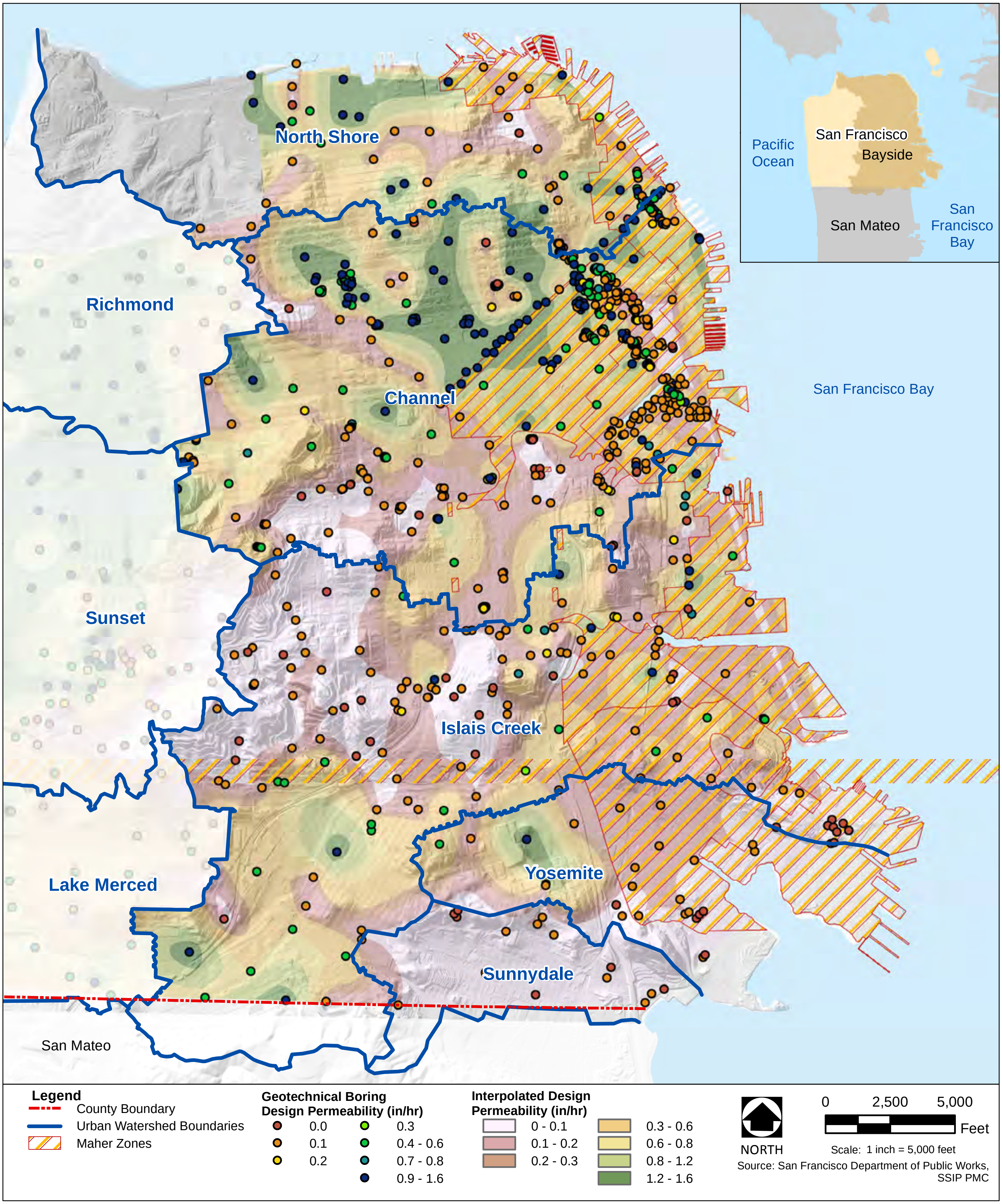
2.3.4 Groundwater and Bedrock

The presence of groundwater and bedrock and their proximity to the ground surface is another potential constraint to review when evaluating green and grey infrastructure applications. Without proper clearance between the bottom of a green infrastructure element and the water table or bedrock, there will not be sufficient storage for the design storm and stormwater will not be sufficiently treated. Figure 2.14 shows locations and depths at which bedrock was encountered in borings throughout the city and Figure 2.15 shows locations and depths at which groundwater was encountered in borings throughout the city, as well as areas where groundwater is known to be within 10 feet of the ground surface.

Figure 2.12: Soil Properties

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

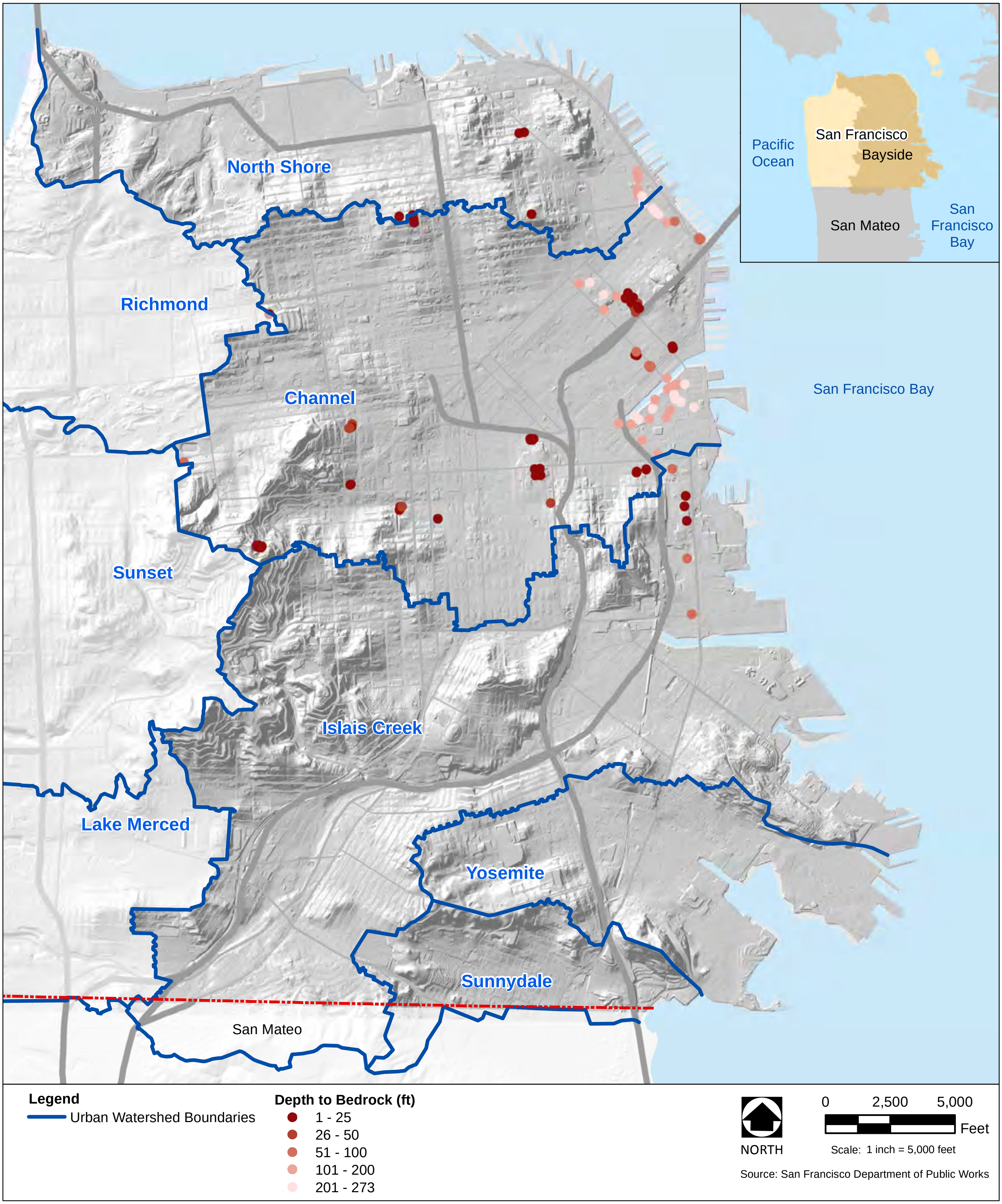
San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)



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

Figure 2.13: Soil Permeability and Maher Zone

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)



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

Figure 2.14: Depth to Bedrock

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

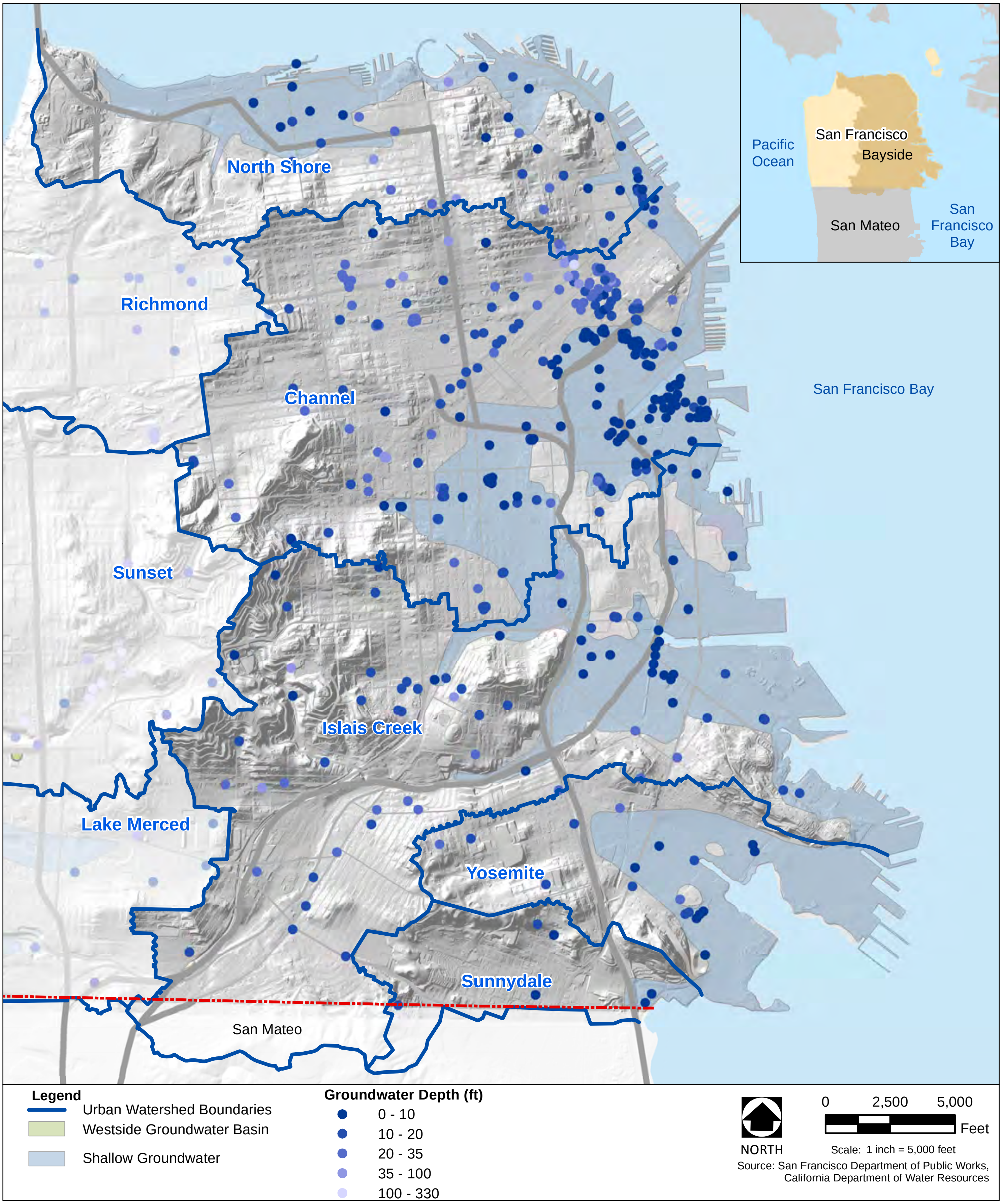


Figure 2.15: Depth to Groundwater

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

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

2.3.5 City-Wide Soil Boring Database Analysis

Using soil boring logs compiled from an extensive library of geotechnical reports provided by the San Francisco Department of Public Works (SFDPW) and the Department of Building Inspections (DBI), a new soil cover dataset was created to assist in the refinement of hydrologic model input by defining the surface soil types. Additionally, a soil permeability analysis was conducted to determine the design infiltration rates for potential green infrastructure applications. This permeability layer covered the entirety of the City and County of San Francisco. See Figure 2.13 for the results of this analysis.

Methodology

The surface soil layer was created by first classifying each point for which soil data were available (i.e., soil boring locations) by the maximally constraining soil type found within the first three feet below the ground surface. Impermeable surfaces were not considered as the output layer was to be utilized to identify runoff rates on pervious surfaces only. The hydrologic model already adequately accounts for the location of impervious surfaces. Once each point was classified by Unified Soil Classification System (USCS) soil type, Thiessen[8] polygons were created such that all locations were associated with the nearest point location. This triangulation met the Delaunay[9] criterion for triangulation.

The permeability analysis was conducted through the first fifteen feet below the ground surface. The first three feet below the ground surface were removed from the analysis in anticipation of excavation for selected BMPs occurring to a minimum of three feet below the existing ground. The total depth of fifteen feet was determined through analysis by the project team based on the City's *Stormwater Design Guidelines* (SDGs) (SFPUC 2009b) and precedent studies. Using representative values of 33% soil porosity and 50% water content for antecedent soil moisture, every foot of soil depth can absorb 2" of stormwater over its footprint before saturation. With a BMP sizing ratio of 10%, that translates to 0.2-inch rainfall over the full tributary area. Under those circumstances, every 5-foot increment of soil depth has the capacity to absorb a 1-inch storm by itself. This methodology ignores lateral migration, which would allow for significantly more absorption in any given surface soil horizon. Assuming all tributary area is impervious with a 1.0 runoff coefficient, a BMP would need to retain 0.75 inch of a rainfall event to capture 90% annual runoff and comply with the SDGs. The ability to retain/absorb a 1-inch storm correlates to 96% annual capture, which seems a reasonable high-end of the performance range for this analysis. Given that the bottom of a BMP facility will be 5 feet or less below grade in the vast majority of cases, using the top 10' feet of the soil profile to estimate the infiltration rate seems ample for most BMPs. However, to account for infiltration-based BMPs with a 5% run-on ratio, it is advisable to extend the depth of

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[8] Thiessen (Voronoi) polygons define individual areas of influence around each of a set of points. Thiessen polygons are polygons whose boundaries define the area that is closest to each point relative to all other points. They are mathematically defined by the perpendicular bisectors of the lines between all points.
[9] Delauney triangulation minimizes the interior angles of triangles, producing polygons that are less elongated. The interior points of these triangles are therefore closest to the point to which they are associated.

analysis. The bottom of these facilities will almost always be 5' feet or less (no under drain needed in these cases, but infiltration trenches are generally ~4' feet deep), but the lower BMP sizing ratio would require twice the depth to absorb a 1-inch storm within its footprint per the methodology herein. Subsequently, the project team has reviewed the top 15 feet of soil profile for infiltration-based BMPs with a 5% run-on ratio.

Only borings whose depth met or exceeded the depth of analysis were used for interpolation. Soil strata that were composed of unnatural materials such as asphalt or concrete were removed from the analysis in order to replicate design conditions for BMPs. Permeability values were assigned by soil class of the USCS on the basis of the Barr memo.[10] Permeability values were then interpolated between each point within a grid using a Sibson[11] interpolation method to assign values based on the closest input values and thus reducing the influence of points not located directly near the point in question. This minimized irregularities within the interpolation based on the irregularity of the spacing of the boring locations.

2.4 Street and Land Use Characteristics

The Bayside Drainage Basin contains a system of streets with a range of sizes, uses, and needs; from wide ceremonial arterials[12] such as Market Street and The Embarcadero to a variety of local roads, alleys, and highway overpasses. To better understand this complex and diverse network, available data was utilized to organize the streets into a suite of categories based on characteristics pertinent to the Urban Watershed Assessment. These street categories provide a framework for identifying the general characteristics of the street network and locating areas which might offer greater opportunities for implementation of green and grey infrastructure stormwater facilities.

The nine street categories that resulted from this analysis include:

- Residential Street with Narrow Sidewalk Zone
- Residential Street with Wide Sidewalk Zone
- Residential Street with Wide Right-of-Way
- Commercial Street with Narrow Sidewalk Zone
- Commercial Street with Wide Sidewalk Zone
- Alley
- Industrial Street

[10] The Barr memo provides a summary of readily available natural vegetation and soils types. The compilation of multiple soil data sets and sources was used to establish the classifications used by the USCS.
[11] Sibson interpolation, also referred to as natural neighbor interpolation, is a method of interpolation that uses the nearest sample data around a point. The output values will be within the range of these nearest sample data points, removing the possibilities for peaks, pits, ridges, or valleys not contained within the input data.
[12] The arterial street category includes ceremonial, standard, and other unique categories. Arterials will be evaluated in subsequent phases of the Urban Watershed Assessment on a case-by-case basis.

- Arterial
- Park Interior Street

2.4.1 Arterial Analysis

Previous City efforts have produced information which was used as a starting point for the development of these categories.

- The *Better Streets Plan* is a set of guidelines and strategies focused on the development of preferred streetscapes, with an emphasis on the pedestrian environment (San Francisco Planning Department et al. 2010). The *Better Streets Plan* contains a street typology based on land use and transportation characteristics, with detailed guidance for the design of each street type. The *Better Streets Plan* assigned these street types to the City's existing street database through a process which involved determining the land use context (such as commercial or residential zoning) and adding special designations to distinctive streets such as throughways (with high volume/speed traffic) or alleys. Each street type represents future redevelopment goals based on context and does not reflect the existing layout of the streets; however, the *Better Streets Plan* promotes the incorporation of stormwater management facilities within each street type but does not provide specific technical guidance on how or where to apply the facilities.
- The *San Francisco General Plan* contains a street classification system, based solely on vehicle movements and transportation function, which is illustrated in a Vehicular Streets Map (San Francisco Planning Department 2010). This map identifies highways, arterials, and other streets within the city.

Both of these street classification systems provide comprehensive descriptions of the City's street network based on the needs and goals of both pedestrians and vehicles. It was not the intent of the *Better Streets Plan* to incorporate stormwater management and the *San Francisco General Plan* has not yet addressed stormwater management techniques in the street classification system; however, by starting from the groundwork laid by these plans, and overlaying additional pertinent information such as excess space within the right-of-way, a new set of categories was developed.

Drawing from the *Better Streets Plan*, streets were classified according to the adjacent land use as Residential, Commercial, Industrial, or Park. Commercial areas feature streets with wide rights-of-way, transporting a continuous flow of traffic and pedestrians, interspersed with narrow alleys. Commercial areas also tend to contain a higher proportion of impervious surface and fewer trees, often resulting in increased runoff potential. Residential neighborhood streets range from broad parkways to compact winding lanes. The prevalence of backyards, occasional front yards, and community open spaces within residential areas tends to decrease the amount of impervious area and corresponding runoff potential. Mixed in with the dominant commercial and residential land uses of the City are industrial areas to the southeast and mixed-use developments in areas such as Mission Bay. For the purposes of this analysis, mixed-use zones were considered to be part of the

Commercial designation, since their streetscapes would closely resemble those of Commercial areas. Parks within the Bayside Drainage Basin tend to be at a smaller scale, and distributed throughout the urban watershed, with the exception of the large open spaces to the north within the Presidio and a few larger parks in the southeast such as John McLaren Park.

Available geospatial data was used to determine the street geometry, including total right-of-way width, sidewalk zone width, and curb-to-curb road width. Based on the geometry of these zones, the Residential and Commercial streets were divided into categories representing the varying potential for excess width[13] to be used for stormwater management. Streets within the Industrial and Park areas were given only a single category. Streets which are characteristically unique, independent of adjacent land use, maintained separate designations; routes with high traffic were identified as arterials and minor streets with the narrowest rights-of-way and least traffic were identified as alleys.

Sidewalk zones were classified as either narrow or wide. Narrow sidewalks, typically either 8 feet or 10 feet, are more confined and offer less opportunities, as the bulk of the width must be reserved for pedestrian travel and furnishings. The accessible pedestrian path of travel is required to be at least 5 feet wide, and street furnishings take up an additional few feet of space. Wide sidewalk zones, considered 12 feet or greater and most commonly either 12 feet or 15 feet, have more flexibility to reconfigure portions of the sidewalk or landscaping into surface stormwater facilities. Approximately 48% of the streets within San Francisco fall into the various wide sidewalk categories.

Table 2.7 summarizes the typical dimensional characteristics for each of the street categories. These values represent the most common dimensions found in existing streets, as well as the general proportions of these streets within the Bayside Drainage Basin.

Table 2.7
Street Characteristics Summary

Street Categories	Typical Dimensions			Approx. Proportion[1]
	Sidewalk	Road	Right-of-Way	
Residential - Narrow Sidewalk	8' - 10'	24' - 48'	42' - 68'	19%
Residential - Wide Sidewalk	12' - 15'	30' - 42'	54' - 70'	30%
Residential - Wide Right-of-Way	12' - 15'	46' - 56'	70' - 82'	3%
Commercial - Narrow Sidewalk	8' - 10'	50' - 62'	68' - 82'	5%
Commercial - Wide Sidewalk	12' - 15'	34' - 50'	64' - 80'	8%

[13] Excess width of a street is space that is not needed for vehicle traffic (reduction in the number of travel lanes) or on-street parking. Routes with a roadway (i.e., the area from curb to curb) wider than 46 feet (enough for parking, a bike, and a vehicle lane in each direction) that were not identified as either thoroughfares or arterials in the *Better Streets Plan* or *San Francisco General Plan* have the most potential to narrow the road width.

Street Categories	Typical Dimensions			Approx. Proportion[1]
	Sidewalk	Road	Right-of-Way	
Alley	4' - 7'	12' - 25'	20' - 35'	8%
Industrial	8' - 15'	35' - 50'	60' - 80'	4%
Arterial	10' - 15'	48' - 90'	68' - 120'	18%
Park Interior	0' – 12'	24' - 56'	varies	5%

Note:
[1] The percentage of the street category within the City compared to the total length of all streets in the City.

2.4.2 Street Categories

The categorizing of City streets into the identified categories is intended to provide a layer of data to better inform the implementation of "green street" style stormwater control facilities. For this reason, the characteristics that have been utilized to differentiate categories are those which most influence the ability to implement typical stormwater BMPs. The practices that are most applicable within a street right-of-way include; pervious paving in parking lanes or sidewalk/pathways, landscape based bioretention facilities (rain gardens), structured bioretention facilities (flow-through planters), vegetated conveyance swales, and vegetated filter or buffer strips.

Table 2.8 summarizes the stormwater opportunities considered to be most typically applicable for each category.

Table 2.8
Stormwater Opportunities Summary

Street Categories	Primary Stormwater BMP Opportunities					
	Pervious Paving	Bioreten-tion[1]	Flow-through Planter	Vegetated Swale	Infiltration Gallery	Vegetated Buffer
Residential - Narrow Sidewalk	x	-	x	-	-	-
Residential - Wide Sidewalk	x	x	x	-	x	-
Residential - Wide Right-of-Way	x	x	x	-	x	-
Commercial - Narrow Sidewalk	x	-	-	-	-	-
Commercial - Wide Sidewalk	x	-	x	-	x	-

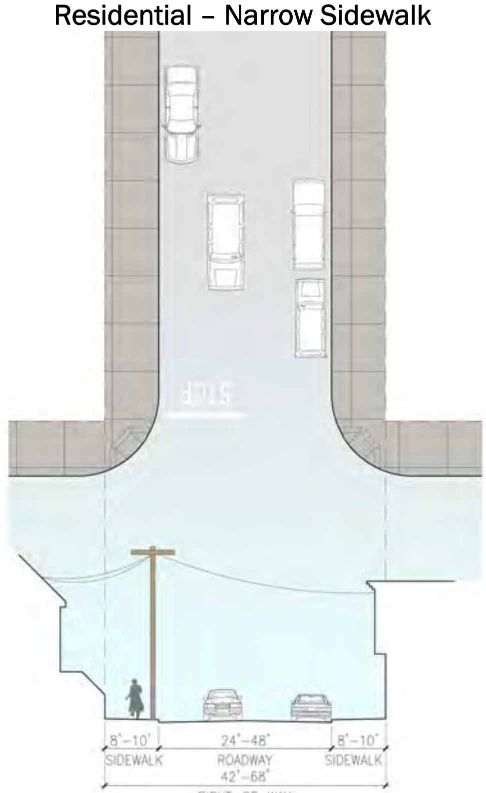
Street Categories	Primary Stormwater BMP Opportunities					
	Pervious Paving	Bioretention[1]	Flow-through Planter	Vegetated Swale	Infiltration Gallery	Vegetated Buffer
Alley	x	-	x	-	x	-
Industrial	x	x	x	x	x	-
Arterial	-	x	x	-	-	-
Park Interior	-	x	x	x	x	x

Note:
[1] Bioretention includes multiple applications including rain gardens, stormwater planters, tree trenches and commercially available modular systems that all perform the same function of retaining stormwater runoff.

2.4.3 Residential Streets

Streets within medium and low density residential areas frequently have opportunities to introduce stormwater features. Sidewalks are often wide with adjacent front yard setbacks, minimizing frontage area[14] required within the sidewalk zone. Traffic volume and speed are typically low in residential areas and pedestrian activity is limited; this creates opportunities for conversion of both road and sidewalk zones. Residential streets usually have frequent driveway cuts and existing street trees, both of which can limit the potential to install linear features such as swales or bioretention areas. With available width, however, it is still possible to locate vegetated features of adequate size within the sidewalk. Pervious paving is generally a viable option, especially in parking lanes, due to less frequent parking movements.

Figure 2.16a
Residential – Narrow Sidewalk



In order to represent this stormwater BMP potential, residential streets were divided into three categories. Streets with narrow sidewalks, as shown in Figure 2.16a, are common in hilly areas such as Glen Park or neighborhoods with smaller blocks such as

[14] The frontage area is the area adjacent to the property line where transitions between the public sidewalk and the space within buildings occur. Where there is relatively little pedestrian traffic, or where there are continuous building setbacks, the frontage zone may be decreased, or eliminated altogether, as determined on a case-by-case basis. Adjacent uses may occupy this zone for outdoor displays, café or restaurant seating, and plantings, with appropriate permits.

Bernal Heights. There may be room within narrow sidewalks to construct structured bioretention, and pervious paving within parking strips is generally viable, but these streets generally have the least BMP potential within residential areas. Streets with wide sidewalks, as shown in Figure 2.16b, have more opportunities and are located throughout the Bayside Drainage Basin. The subset of streets that potentially have excessive width within the road were classified separately. Routes with a roadway (i.e., the area from curb to curb) wider than 46 feet (enough for parking, a bike, and a vehicle lane in each direction) that were not identified as either thoroughfares or arterials in the *Better Streets Plan* or *San Francisco General Plan* have the most potential to narrow the road width. These streets with wide rights-of-way, as shown in Figure 2.16c, offer the best opportunities to create additional area for stormwater management elements.

Figure 2.16b
Residential – Wide Sidewalk

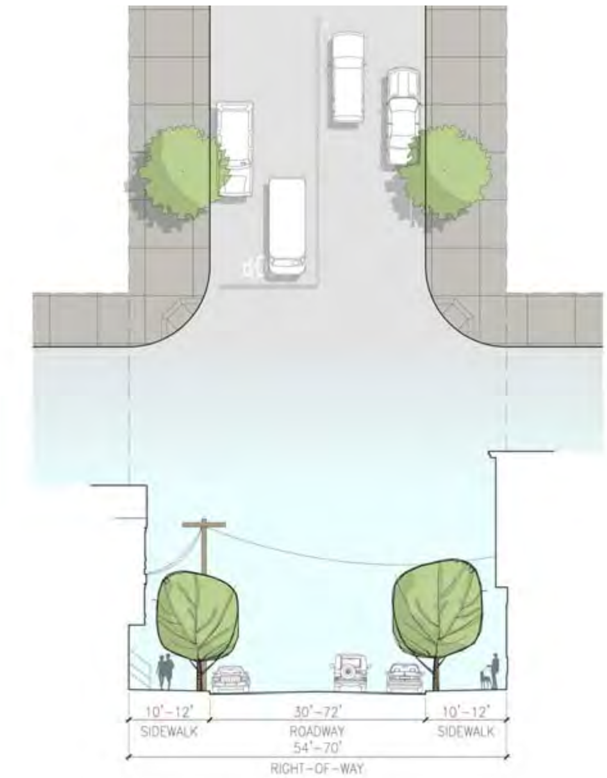
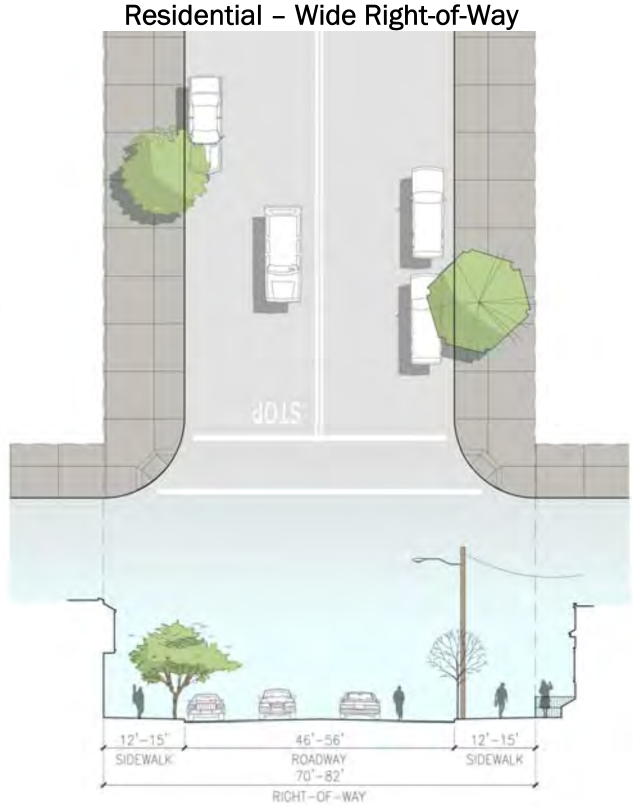


Figure 2.16c
Residential – Wide Right-of-Way



2.4.4 Commercial Streets

Though individual commercial corridors are located throughout the City, the highest density of commercial streets is located in the downtown area to the northeast. These streets often have a higher volume of traffic and higher potential loading, which occurs more consistently throughout the day, as compared to other areas. As mentioned above, mixed use zones with higher density residential buildings were included as commercial streets for this exercise. Parking lanes are limited to short term use, which results in frequent movement in and out of parking space, and access must be unrestricted between the parking lane and business entrances. Additionally, the need for certain parking lanes to be used for traffic during rush hour limits some of the opportunities for streetscape changes. Commercial streets generally have denser traffic lanes which offer less opportunity to modify the curb to narrow the roadway for other purposes. Commercial sidewalks typically have a high amount of pedestrian activity, and often serve as an important interface with adjacent businesses.

Though space within the sidewalk is used differently in commercial areas as compared to residential areas, the presence of a wide sidewalk zone is the primary characteristic which creates opportunities for stormwater BMPs. For this reason, commercial streets were divided into two categories, differentiated by the sidewalk width. Commercial streets with narrow sidewalks, as shown in Figure 2.16d, are very unlikely to have space available for conversion to vegetated stormwater features of any kind, and are likely limited to pervious paving within the parking lane as the only potentially viable option. Many of the streets in the South of Market area have narrow sidewalks. Commercial streets with wide sidewalks, depending on the level of activity they must support, may have the potential to incorporate structured linear bioretention areas (see Figure 2.16e). The lack of driveway cuts can allow longer contiguous lengths, provided adequate sidewalk access and functionality are maintained.

Figure 2.16d
Commercial - Narrow Sidewalk

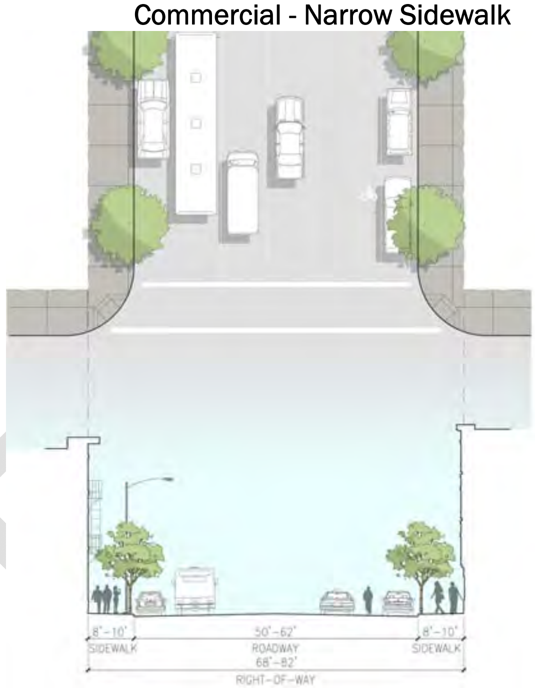
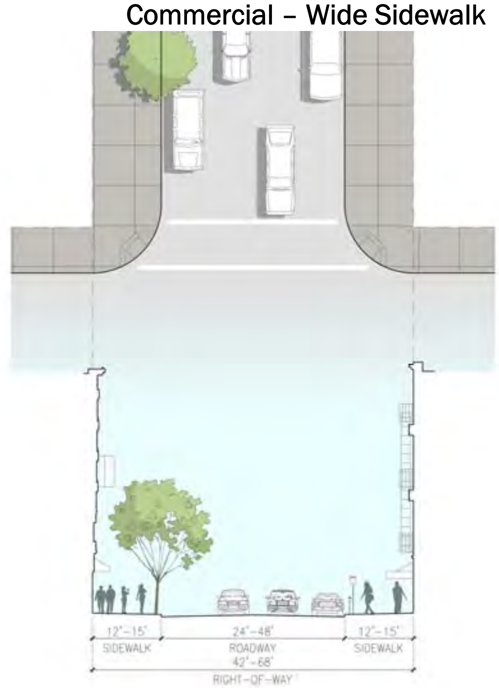


Figure 2.16e
Commercial – Wide Sidewalk



2.4.5 Other Streets

Alleys are most commonly found in commercial areas where they serve an important role as service access points for businesses (see Figure 2.17). Alleys have the narrowest of rights-of-way and limited sidewalk space. They get minimal vehicle traffic, and at times are limited to pedestrian-only access. Though the lack of space (both width and length) can limit stormwater opportunities, there are instances, where alleys have been retrofitted to provide infiltration or detention using permeable surfaces. In cases where vehicular traffic is removed, alleys can be redeveloped as valuable amenities with the incorporation of landscaping and surface treatments for stormwater management (e.g. Mint Plaza).

The few remaining industrial zones, located in the southeast parts of the City, feature streets with opportunities which differ from the more common land use types (see Figure 2.18). Industrial streets have minimal traffic and transit activity, but must support large trucks and service vehicles and thus roadways and traffic lanes are often much wider than average. Though driveway cuts are infrequent, when present they can be very wide in order to serve loading docks or other facilities. Pedestrian activity is relatively low as well and generally necessitates only minimal sidewalk area. Industrial streets are less likely to have street trees and landscape strips, which allows the addition of these features to reduce runoff in addition to improving aesthetics and the pedestrian realm. Streets with minimal interruptions for parcel access, especially those with wider sidewalks, are very good candidates for most street BMPs. Less frequent traffic and parking movements also create good conditions for pervious pavement - however the potential presence of increased pollutant levels as a result of industrial uses must be recognized and accounted for.

Figure 2.17
Alley

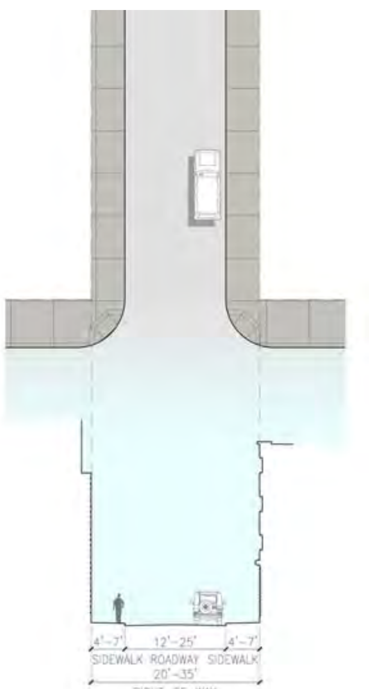
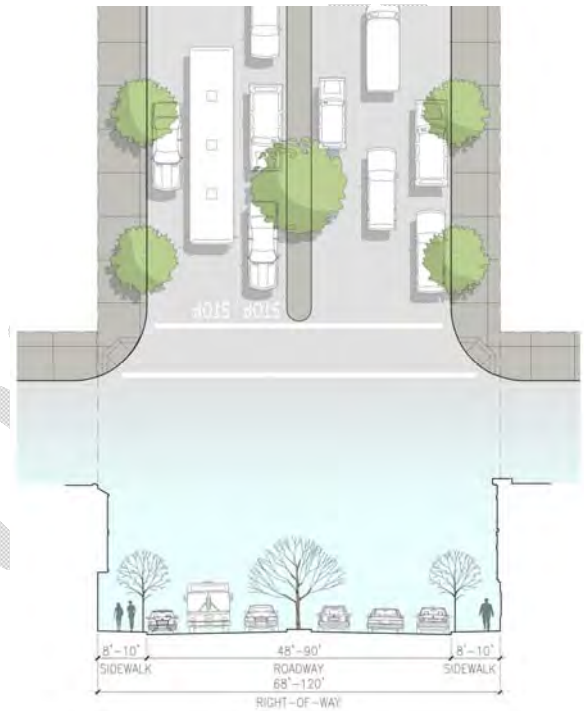


Figure 2.18
Industrial

The transportation corridors that carry traffic throughout the city have been designated as arterials, as shown in Figure 2.19 on the following page. These streets generally have vehicles traveling at higher speed and larger traffic volumes, along with frequent bus and or light rail transit service. The layout and characteristics of arterials tends to vary much more than the other street categories, and this generally requires that they be investigated on a case-by-case basis to understand specific stormwater opportunities. Some arterials have wide sidewalk areas or landscaped medians which offer prime locations for BMP incorporation, while others have a constant flow of high speed traffic throughout the day which could adversely affect pervious paving lanes and make routine maintenance activities very difficult. Sidewalk widths tend to be narrower, as more right-of-way is dedicated to vehicular needs, and this can make landscape based BMPs difficult. This lack of space can be compounded when the high level of pedestrian activity on many arterial streets is accounted for, resulting in a lack of any reconfigurable area.

Figure 2.19
Arterial



The remaining streets in the city are those located within parks and open spaces. Although these roads come in many sizes and layouts, the commonality between the park interior streets is that they are bordered on both sides by pervious vegetated area. This means that the expected runoff from these areas will be lower, and there is less of a need to manage stormwater within the street. Pervious paving may face maintenance challenges due to higher sediment load in runoff from these pervious areas. At the same time, the lack of driveways and the unconstrained character of park streets do create many opportunities for landscaped stormwater features. Longer vegetated swales could replace traditional stormwater piping and grassy filter strips can slow and infiltrate runoff - features that are much more difficult to incorporate in almost all other street settings

Figure 2.20 on the following page illustrates how the various street categories are located throughout the Bayside Drainage Basin. Streets have been assigned the most appropriate category based on available information.

2.5 Ecological Characterization

This section describes the ecological conditions of the Bayside Drainage Basin because habitat restoration, enhancement, and stewardship are objectives of the *San Francisco General Plan* and are important goals for several San Francisco

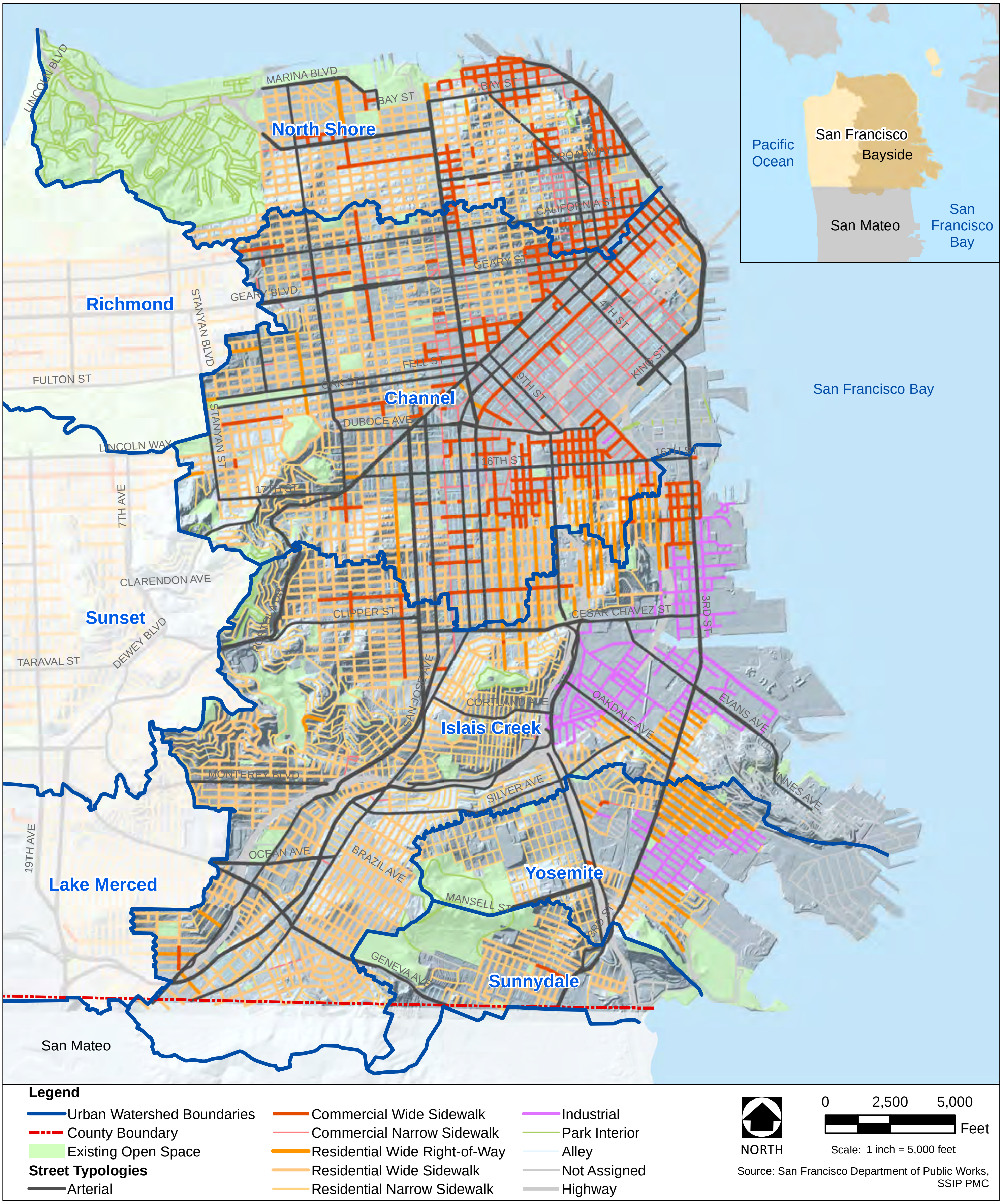


Figure 2.20: Street Categories Map

agencies, including the Port of San Francisco, San Francisco Planning Department, and SFRPD as well as Golden Gate National Recreation Area (GGNRA), and various community groups. The Urban Watershed Assessments utilizes an urban watershed-wide approach and seeks to provide multiple benefits, a description of ecological conditions provides a spatial understanding of whether green infrastructure projects identified for stormwater management purposes can also contribute to wider habitat goals either by their potential sitting, design, or plantings. The following ecological characteristics that influence the potential for ecological enhancement are identified in this section:

- Urbanization
- Hills
- Creeks and Streams
- Wetlands and Marshes
- Ecological Diversity
- Planned Development

San Francisco's diverse landscape supports a range of ecological conditions and habitats, from urban to natural. This special environment has been recognized by United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and the Biosphere (MAB) designation, within the Golden Gate Biosphere Reserve. MAB's original aim was to establish protected areas representing the main ecosystems of the planet in which genetic resources could be protected, researched, and monitored. The Golden Gate Biosphere Reserve is unique in that it spans marine, coastal, and upland resources including the San Francisco metropolitan area, and thus provides easy access to outdoor education and recreation for inhabitants. The Reserve's ecological functions are also influenced by this intensive urban land use and its urban ecology.

This ecological basis for infrastructure strategies emphasizes habitat and biodiversity and provides a comprehensive ecosystem-based characterization combining soils, microclimate, topography, hydrology, landscape, and habitat to identify ecological opportunities and constraints for infrastructure solutions. Habitat restoration, enhancement, and stewardship are important goals for the Bay Area championed by the Port of San Francisco, GGNRA, San Francisco Planning Department, SFRPD, and various community groups among others. Objectives of the *San Francisco General Plan* include to "protect and enhance the biodiversity, natural habitats, and ecological integrity of open space," and to "develop public and agency awareness of local biodiversity and natural habitats, and foster community-based ecological and natural areas stewardship." Today, the Bayside Drainage Basin includes a highly urbanized downtown core and expansive high density neighborhoods, significant remnant natural areas in Twin Peaks, Glen Canyon Park and McLaren Park, and a range of smaller neighborhood parks, open space, streetscapes, urban forest, and backyards that provide ecosystem services[15] and habitat for many local and migratory native species.

SSIP projects may contribute substantially to the enhancement and resilience of biodiversity and ecosystem services in the City. Much of the City has been transformed into a highly built environment, yet several of the original ecosystem components still remain, including soils, topography, microclimates and habitat patches, that can be leveraged and enhanced as resources to provide stormwater retention, pollution remediation, aesthetics, education, habitat connectivity, and other LOS and co-benefits. As is being done in other major cities such as Portland, Oregon, Vancouver, British Columbia, and Philadelphia, Pennsylvania, ecology can serve as a guide to evaluate and maximize performance of green and grey infrastructure solutions (City of Portland 2010; Philadelphia Water Department 2013; Metro Vancouver 2011).

In the following sections, the ecological characteristics of the Bayside Drainage Basin are described in terms of the historical conditions, remaining ecology, and the value of remaining ecology and habitat. Additionally, the concepts of green infrastructure and ecological resiliency are described as a tool for improving Bayside Drainage Basin ecosystem services and biodiversity. Finally, specific ecological opportunities for individual urban watersheds of the Bayside Drainage Basin are described.

2.5.1 Historical Ecology

Understanding the historical ecology of San Francisco and the Bayside Drainage Basin provides a valuable benchmark for evaluating future infrastructure solutions. Historical ecology can act as a planning framework for biodiversity, habitat, and ecosystem services in urban watersheds; as a benchmark for measuring the current condition and improvements; and as a source of design ideas for green and grey infrastructure concepts in the SSIP. In this way, historical ecology may serve as a resource in developing biomimicry[16] solutions for the SSIP.

The pre-colonial ecology of San Francisco included a diverse assemblage of ecosystems, driven by the high concentration of microclimates, the unique sand dune complex that covered much of the city, and the location of the City adjacent to a large, ecologically rich estuary. Natural landscapes included coastal sage scrub assemblages, serpentine and other types of grasslands, willow thickets near springs and creeks, and oak woodlands. A variety of wetlands including salt marsh, brackish and freshwater wetlands also existed along the Bay, swales were located within the sand dune complexes, and occasional vernal pools, isolated lakes, and small riparian floodplains could be found. Urbanization transformed much of the hydrology and vegetation characteristics of the City's ecosystems; however, most of the City still retains other more permanent ecosystem characteristics such as microclimates, topography, and soils.

[15] Ecosystem services are benefits that nature provides for free – such as clean air, clean water, climate control, soil for growing food, biodiversity, spaces for recreation and rejuvenation, and natural resources that support the economy.
[16] Biomimicry is the concept of designing infrastructure and technology modeled after nature.

The major climate zone map (Figure 2.21) and the historical major landscape zone map (Figure 2.22), which combines soil information, topography, landform, microclimates, and previous historical ecology mapping by Nancy Morila (Morila 1992), provide a high level organization of the major landscapes in the city that were the foundation of historical biodiversity. Historical drainage courses and wetland areas are also shown for Bayside Drainage Basin in Figure 2.23.

2.5.2 Remaining Historical Ecology

Few areas in the city retain fully intact ecosystems. Those that do – primarily the large hilltop parks, the Presidio, and the Lake Merced area – include rare and endemic species and high levels of biodiversity relative to other cities and regions. The City's "habitat hubs," identified in Figure 2.24, are the contiguous open spaces that contain these remnant ecosystems. Hubs are defined as those parks and open spaces that contain remnant "natural" areas as mapped within the SFRPD *Significant Natural Resources Area Management Plan* (SNAMP), and any large landscapes – either native or non-native – that occur directly adjacent to them. The SNAMP classifies all major open space in the City as Natural, Naturalistic, or Park Facilities and Other Sites (hereafter: Other), based on its vegetation composition. Natural landscapes harbor native, often rare, species of flora and fauna in original or restored habitat. Naturalistic landscapes can provide important habitat for more common native species, but are generally non-native vegetation. Other is a catchall term for athletic fields, lawns, playgrounds, stadiums, plazas, and other minimally landscaped recreational open spaces.

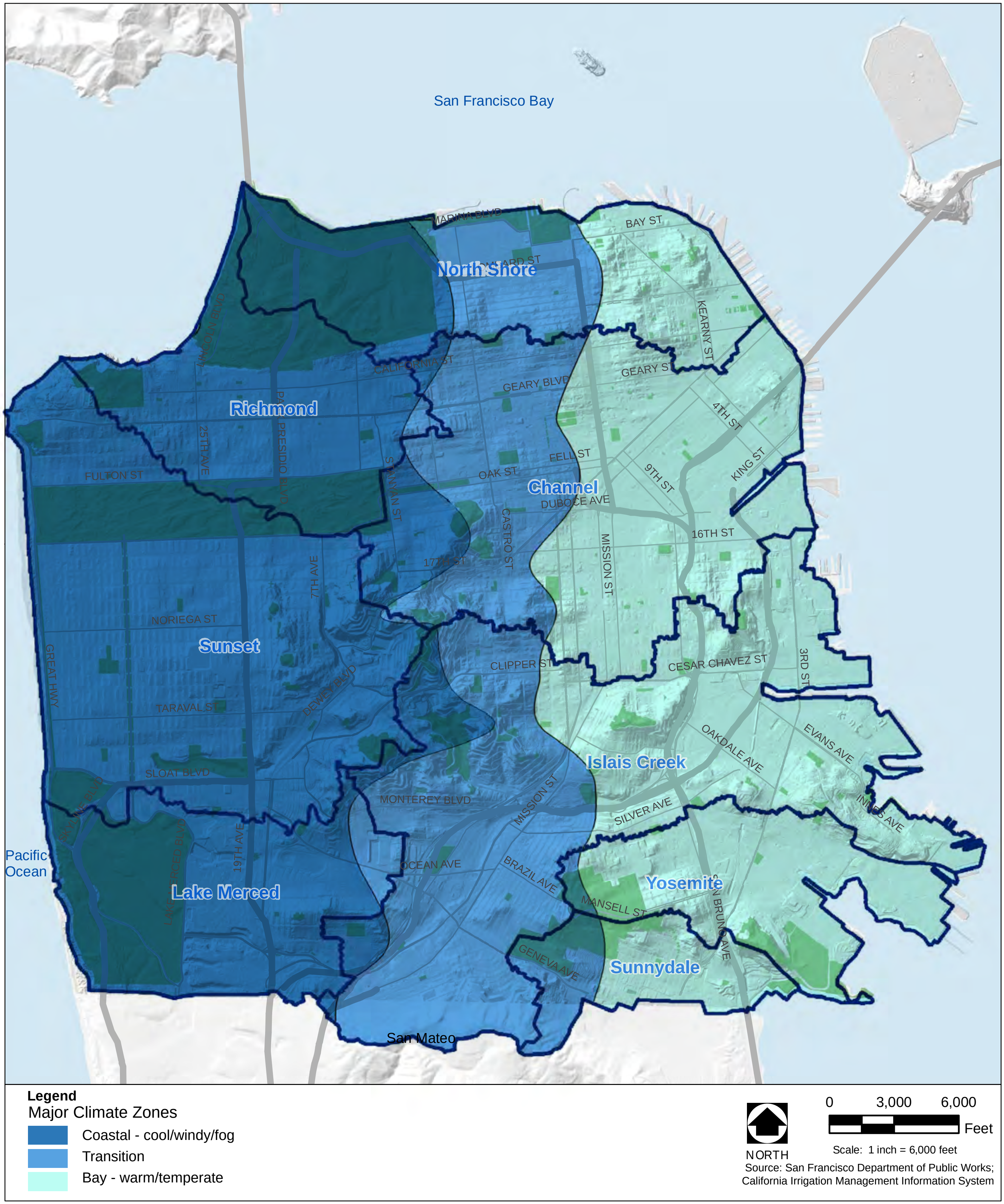


Figure 2.21: Major Climate Zones

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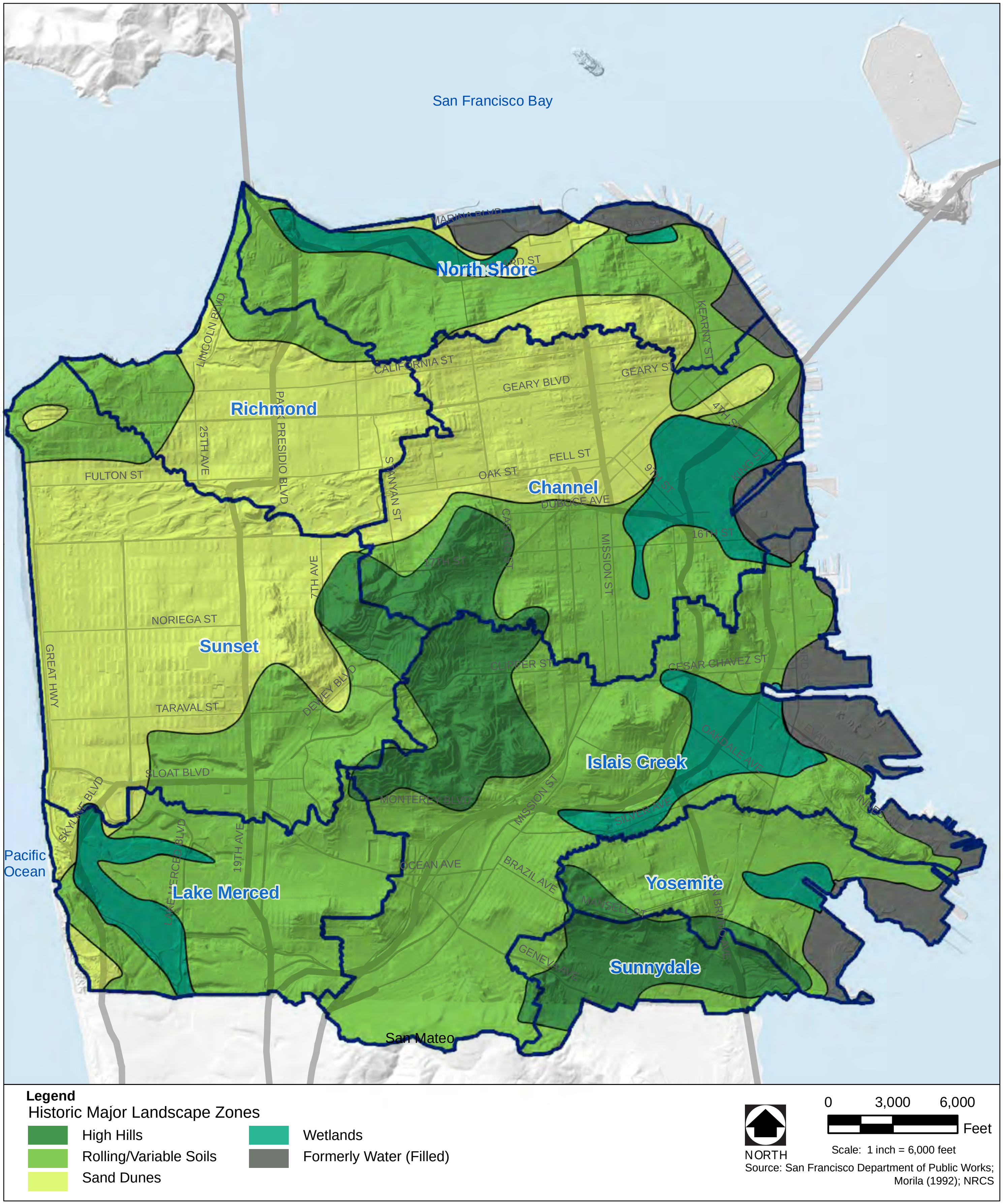

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Figure 2.22: Historic Major Landscape Zones

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Figure 2.23: Historic Drainage Courses and Wetland Areas

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Figure 2.24: Habitat Hubs

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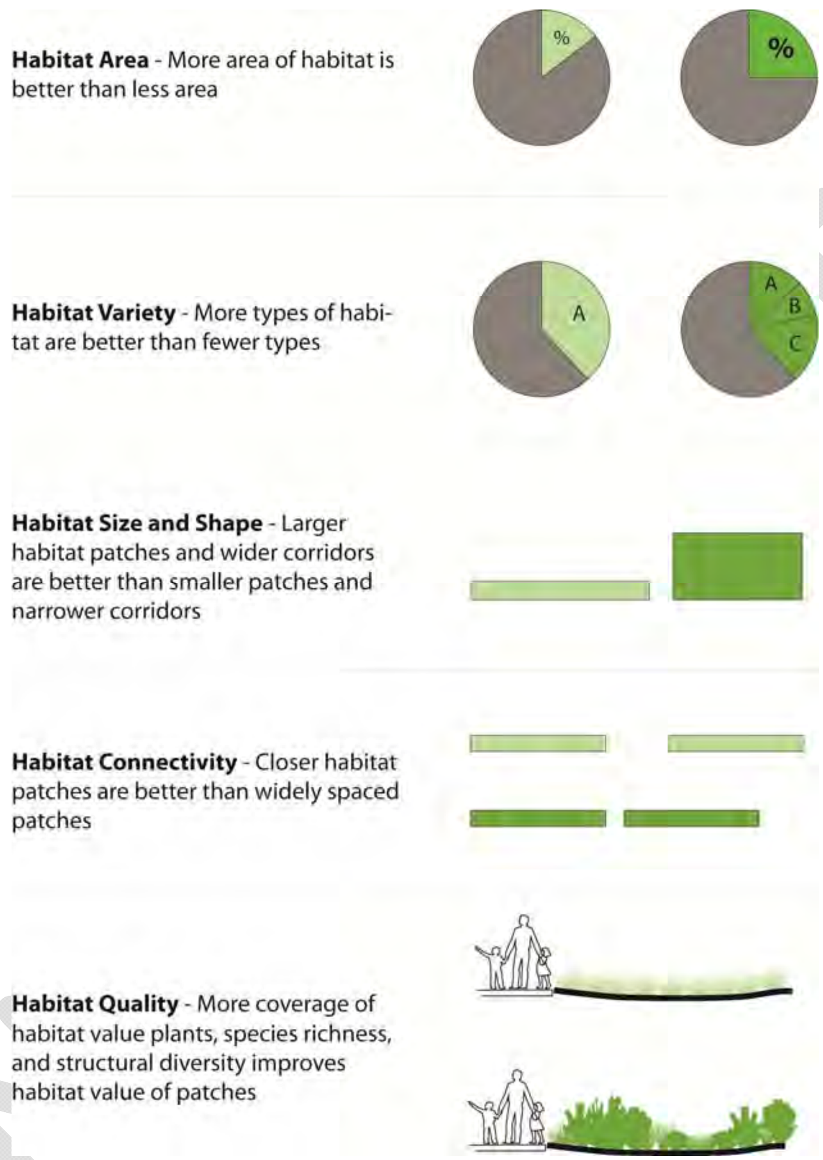
In addition to local resident species, the City is located along the Pacific Flyway and acts as barrier to migratory species. Hubs, parks, coastlines, and smaller landscapes provide important "habitat stepping stones[17]" for species moving through the City (see Figure 2.24). Improving habitat quality and connectivity between parks and along the Pacific Flyway is a widely held objective within City agencies and stakeholder groups per the initiatives and policies described above, and is a potentially valuable climate resiliency measure for resident and migratory biodiversity. Climate change is anticipated to affect species ranges over the coming century, potentially adding further stress to migrating species and shifting the ranges of resident populations within the region.

2.5.3 Landscape Ecology and Green Infrastructure

Landscape ecology is the study of ecological patterns and processes and provides a useful framework for evaluating the ecological character of the City (Dramstad et al. 1996). The concepts of habitat connectivity, hubs, stepping stones, corridors/links, patches, and networks are all foundational to landscape ecology and the related field of conservation biology, particularly within urban contexts (Portland Metro 2010). The landscape ecology principles discussed below are useful for characterizing the existing condition and opportunities for improvement, as well as assessing the landscape ecological benefits of green infrastructure solutions at the urban watershed level (see Figure 2.25).

[17] Habitat stepping stones are smaller habitat patches that provide a stop-over point for species moving between larger habitat patches. Habitat patches are distinct areas of habitat that provide various lifecycle functions for species. Larger more diverse patches typically provide habitat for more species and a greater suite of lifecycle functions. The spacing, size, and structural quality of stepping stones are important factors in their connectivity value. A series of large constructed wetlands, swales along a green street, green roofs, backyard rain gardens, or even a series of individual plants may act as stepping stones between habitat patches.

Figure 2.25
Landscape Ecology Principles for Green Infrastructure



Connectivity is critical to enhancing and sustaining urban habitat for flora and fauna for three primary reasons:

1. Connecting habitat patches, such as parks, through improved linkages allows safer and more frequent movement of resident and migratory species between patches.
2. Connecting habitat patches increases the resilience and sustainability of populations. In an isolated habitat such as a park, if an incident kills all (or a significant portion) of the population, the population may not reestablish without a connection to allow new individuals to repopulate the area. Especially given the pressures of climate change on species, connecting many habitat areas supports resiliency in the network.
3. Connecting habitats allows more natural processes to occur. Within enhanced habitat linkages, movement of sediment, moisture, seeds, or nutrients from one area to another, by wind, water, or organisms, supports resiliency and ecosystem function of 'networked' habitats.

Both continuous corridors and well-placed stepping stones allow species to move more easily through an urban landscape, creating a more resilient habitat network. Habitat connectivity may take the form of actual contiguous corridors, such as a creek daylighting, a partial corridor such as a series of swales along a green street or green alley, or a pathway of 'habitat stepping stones' such as a series of backyard rain gardens or green roofs. Backyards and streetscapes, green roofs, and other built habitats can provide home range for some native species, such as Anna's and Allen's Hummingbirds and many native insects. Backyards and streetscapes are also the primary corridors and stepping stones that many bird and insect species use to move between larger open spaces and habitat hubs. Campuses and master planned districts can also include highly programmed landscapes that may be designed to provide substantial habitat connectivity benefits.

Certain types of urbanized areas and infrastructure can also negatively impact habitat by inhibiting species movement or by acting as habitat "sinks." Loud, commercial streets, high traffic volumes, bright lights at night, litter and pollution, and reflective glass and signs (bird kills) can reduce habitat value of adjacent high quality habitat, inhibit connectivity, and cause mortality. Prioritizing habitat interventions toward the most habitat-compatible urbanized areas, while balancing other connectivity objectives, and mitigating negative urban "edge effects" is an important consideration.

2.5.4 Benefits of Enhanced Ecosystems

In addition to habitat benefits, other ecosystem services can be gained by optimizing infrastructure solutions within the City's ecosystems.

Water Quality – Trees and vegetation intercept and transpire rainwater, providing stormwater reduction benefits. Vegetation and soils can also treat polluted runoff. Permeable soils provide groundwater recharge and stormwater reduction.

Air Quality – Vegetation and soils absorb airborne particulate matter, carbon dioxide, and other pollutants, and help moderate climates to reduce the urban heat island effect and building energy use.

Education and Community Enrichment – Access to nature is often limited within urban areas –particularly economically disadvantaged areas– and green infrastructure can help enhance equitable public access to nature. The educational opportunities provided are beneficial for learning and intellectual development (Kellert 2005). Knowledge of nature also improves likelihood of conservation behavior which can in turn support sustainability. Exposure to native species and landscapes increases peoples' awareness of seasonal patterns, which may in turn build awareness of climate change.

Health and Wellbeing – Landscapes and natural areas provide psychological and physical health benefits. Access and views of nature and landscapes have been demonstrated to reduce stress and promote physical healing (Kaplan and Kaplan 2003).

Urban Agriculture– Native insects can improve urban agricultural productivity and backyard gardening by supporting larger populations of pollinators which can be limited in urban contexts.

2.5.5 Specific Areas of Interest for the Bayside Drainage Basin

Bayside Drainage Basin characteristics that influence the potential for ecological enhancement include:

Urbanization: The northern urban watersheds, Channel, Islais Creek, and the eastern portion of North Shore, are the most highly urbanized and include high density, high traffic, and ground-level commercial uses, which tend to be less compatible with habitat enhancements along streets. Concentrated and larger scale solutions work best in highly urbanized zones, including: creek daylighting, constructed wetlands along the Bay, key habitat corridors between Twin Peaks and surrounding parks, habitat stepping stones on large green roofs in dense areas, and conflict mitigation such as traffic calming and screening adjacent to existing and proposed habitat areas. The southern urban watersheds, Yosemite and Sunnydale, include more remaining biodiversity within larger parks. Habitat compatible streets are more widespread, providing additional opportunities for more dispersed street and landscape enhancements within quieter neighborhoods, industrial areas, and master planned projects.

Hills: The Bayside Drainage Basin includes portions of most of the major hilltop parks with natural areas in the City including Twin Peaks, Glen Canyon, Bernal Heights Park, Buena Vista Park, Corona Heights Park, McLaren Park, and Bayview Park. Improving connectivity between these parks could be highly beneficial for habitat and communities, and is a shared objective of many initiatives in the City. Also, connecting these hilltop parks down through varying habitat conditions to the Bay can create links for multiple species. Many species of butterflies and birds have reproduction and foraging adaptations that require both ecosystems and can benefit from connectivity across topographic gradients. Creek daylighting that connects the hilltop parks to the Bay may also provide biodiversity-supportive ecological processes such as nutrient transfer, seed dispersal, and sediment transport. Sedimentation is important for adaptation of intertidal marsh restoration projects to sea level rise resulting from climate change.

Creeks and Streams: Multiple historical creeks were filled for urbanization. These include Hayes, Mission, and Arroyo Dolores creeks in the Channel urban watershed; Islais Creek, the largest historical stream in the City with its multiple tributaries including the remnant in Glen Canyon, and Precita Creek to its north; Yosemite Creek and a smaller unnamed creek to its south in the Yosemite urban watershed; and, two unnamed creeks in the Sunnydale urban watershed. Full or partial daylighting of these creeks, whether re-routed or following their historical courses, could provide increased habitat diversity and would also provide a means for connecting larger habitat patches within hilltop parks to the Bay.

Wetlands and Marshes: A variety of freshwater and intertidal wetlands occurred historically within the Bayside Drainage Basin, but few remain. Historical maps indicate multiple freshwater vernal pools and/or ponds and the freshwater Laguna Dolores within the Channel urban watershed. Within all urban watersheds, other smaller freshwater wetlands likely included small seeps, springs, swales within sand dune complexes, and perhaps larger freshwater fens near the backs of intertidal wetland complexes. Large areas of saltmarsh and other intertidal wetlands occurred within Channel, Islais Creek, and Yosemite urban watersheds. Few of these wetland features still remain except the seasonal stream in Glen Canyon and some planned intertidal wetland establishment in the Yosemite and Islais Creek urban watersheds. Establishing other patches along the Bay within Islais Creek and Channel urban watersheds could serve as habitat stepping stones for migratory species moving along Bay wetland patches through the City and region.

Ecological Diversity: In the Bayside Drainage Basin, the North Shore urban watershed has the most diverse remaining ecology, with 30% of the urban watershed comprising the Presidio with its large, diverse habitats and endemic species. Channel and Islais Creek urban watersheds were historically the most diverse due to their large size, and numerous microclimates and ecosystems including wetlands, dunes, large intertidal zones, riparian areas, and uplands. This is common in cities where initial settlements often happen where diverse and abundant natural resources are available in close proximity. In addition to the biodiversity benefits of connecting projects with remaining habitats in the large parks and along shorelines, including other more isolated locations where unique historical ecological conditions may be recaptured can further maximize biodiversity. Unique lost ecosystems such as vernal pools and upstream riparian floodplains on sedimentary soils in Islais and Channel urban watersheds could add additional ecological diversity. Reintroduction of historical dunes within the eastern portions of Channel urban watershed, that occur in warmer microclimates than remaining dunes in the Presidio and Golden Gate Park, could offer unique biodiversity opportunities not capable elsewhere in the City.

Planned Development: The Bayside Drainage Basin contains several large master planned development areas, particularly along the Bay shoreline, including Mission Bay, Pier 70 Area, and Hunters Point. These projects will incorporate large landscape features with habitat, water quality, and other ecological benefits. These sites may become important habitats in the future that would further benefit if integrated into broader urban watershed-level green infrastructure frameworks.

2.6 Socio-Demographic Characterization

This section describes the socio-demographic characteristics of the Bayside Drainage Basin. Within each urban watershed, population, housing, neighborhood, ethnicity, income, unemployment, open space, street safety, and bike and pedestrian infrastructure statistics were assessed. This information, supplemented with feedback from community engagement activities, will inform whether a project or group of projects adheres to the SFPUC's Environmental Justice and Community Benefits Policies and will influence the selection of strategies and projects that optimize multiple benefits.

2.6.1 Background

The SFPUC adopted an Environmental Justice Policy in 2009 and a Community Benefits Policy in 2011. The development of projects that adhere to these policies is also a WWE Goal. The SFPUC's Environmental Justice Policy seeks to ensure the right to a safe, healthy, productive and sustainable environment for all people impacted by the operations and delivery of wastewater services, where "environment" is considered in its totality to include ecological, biological, physical (built and natural), social, political, aesthetic, and economic environments. Further, the SFPUC's Community Benefits Policy seeks to be a good neighbor to all whose lives or neighborhoods are directly affected by the operation or improvement of wastewater services by providing positive community benefits in a transparent and sustainable manner. Therefore, a characterization of the Bayside Drainage Basin must include an understanding of the urban watershed's demographic and socio-economic characteristics. These socio-demographics were derived from census data or zip codes aggregated to the urban watershed level, as summarized in Table 2.9.

Table 2.9
Socio-Demographic Data Summary by Urban Watershed

	North Shore	Channel	Islais Creek	Yosemite	Sunnydale	SF
Area (ac)[1]	3,002	5,618	6,510	1,966	898	29,128
Percentage of City Area	10%	19%	22%	7%	3%	100%
Population[2]	92,000	233,700	167,900	31,500	20,500	789,200
Percentage of City Population[2]	12%	30%	21%	4%	3%	100%
Percentage of Population under 18[2]	8%	9%	18%	23%	24%	13%
Percentage of Population Over 65[2]	17%	12%	12%	13%	12%	13%

	North Shore	Channel	Islais Creek	Yosemite	Sunnydale	SF
Percent Minority[2]	45%	49%	65%	88%	93%	58%
Unemployment Rate[2]	7%	6%	7%	9%	11%	6%
Percent of Population in Environmental Justice Area of Concern[2]	0%	7 %	16%	57%	3%	8%
Percentage of Population[2] as Park Poor[3]	4%	13%	15%	26%	1%	13%

Notes:
[1] Includes total city area. Area is therefore larger than areas that contribute to the combined sewer system.
[2] Includes population and demographic information from the US Census American Community Survey (ACS) 2007-2011.
[3] Includes areas identified as park poor from San Francisco Planning Department, Recreation and Open Space element (ROSE).

Within each urban watershed, population, housing, neighborhood, ethnicity, income, unemployment, open space, street safety, and bike and pedestrian infrastructure statistics were assessed since each socio-demographic element will inform whether a project or group of projects adheres to the SFPUC's Environmental Justice and Community Benefits Policies and will influence strategies to optimize multiple benefits. Moreover, while each of these demographic and socio-economic statistics can be individually significant for the characterization of each urban watershed, consideration of compounded or "cumulative impacts" are necessary to understand environmental justice concerns and assess community benefit needs.

Cumulative impacts are defined as the combined incremental effects of human activity which may pose a serious threat to the environmental health of a community over time, such as neighborhood unemployment, street safety, ethnicity, available open space, and siting of industrial facilities. While cumulative impacts may be insignificant by themselves, such impacts accumulate over time, from one or more sources, and can result in the degradation of important resources. Thus, the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource no matter what entity is taking the actions.

Communities that bear a disproportionate amount of socio-economic distress resulting from such cumulative impacts are often referred to as "disadvantaged communities". In this case, disadvantaged communities are identified as census tracts with unemployment rates above 150 percent of the City unemployment rate or census tracts with incomes 80 percent or below average median income for San Francisco. Similarly, "environmental justice communities of concern" are typically defined as those communities composed predominantly of persons of color or a substantial proportion of persons below the poverty line that are subjected to a disproportionate burden of environmental health hazards and/or experience a significantly reduced quality of life relative to surrounding or comparative communities.

Additionally, and in furtherance of the SFPUC's Community Benefits Policy, assessment of socio-economic data relating to quantity and distribution of open space, crime rates, bike and pedestrian accessibility and safety is necessary to indentify community needs that will shape and define the most appropriate strategies that should be utilized to achieve WWE Goals and LOS. The socio-economic characteristics of each urban watershed will also be supplemented with feedback from community engagement.

A comprehensive examination of these socio-demographics can provide a representation of the Bayside Drainage Basin's character, people, and challenges.

2.6.2 North Shore Urban Watershed

Population

The North Shore urban watershed, with a population of approximately 92,000, represents 12% of San Francisco's population. Within the urban watershed, only 8% of the population is under 18 years of age, compared to the 13% in San Francisco overall.

Housing

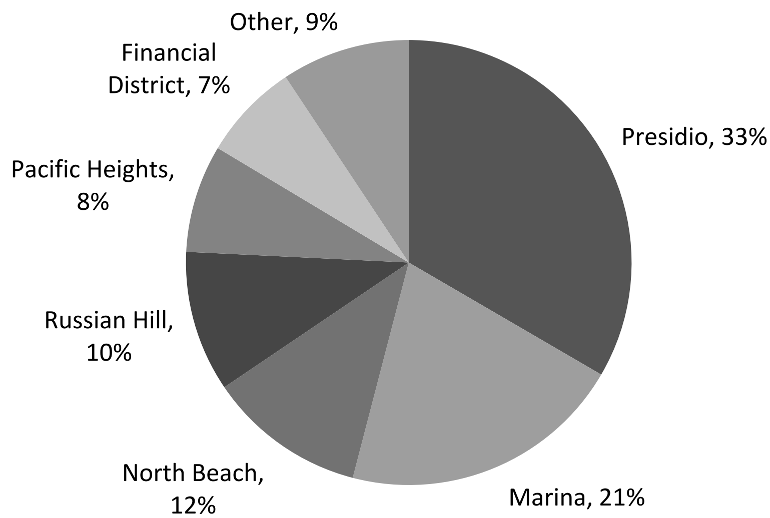
The North Shore urban watershed has approximately 49,100 households, the majority of whom rent their homes. Only 22% of households in North Shore own their own homes, compared to 38% in San Francisco overall. In terms of housing stock, of the 56,300 housing units in the urban watershed, the majority are multi-family units, with only 9% of units categorized as single-family. Compared to San Francisco where one third of homes are single-family, North Shore has a very low proportion of single-family homes.

Neighborhood Areas

The North Shore urban watershed covers 3,002 acres, or, 10% of the area of San Francisco, and intersects 10 of San Francisco's 36 neighborhoods. The Presidio and Marina neighborhoods make up the bulk of the urban watershed. North Beach, Russian Hill, Pacific Heights and the Financial District all make up approximately 10% of North Shore, as shown in Figure 2.26.[18]

[18] The fraction of area categorized as 'Other' represents the sum of all neighborhoods comprising less than 5% of the watershed's total area. These include: Nob Hill (4%), Chinatown (3%), Presidio Heights (2%), and Downtown/Civic Center (0.2%).

Figure 2.26
North Shore Urban Watershed Neighborhoods



Race and Ethnicity

Across the entire North Shore urban watershed, 45% of the population is a minority, compared with 58% in San Francisco overall. The minority population in North Shore is very unevenly distributed. The area in and around Chinatown has a significant minority concentration, but the remainder of the urban watershed is predominantly non-minority.

Income

North Shore contains predominantly higher income households earning over 120% of area median income (AMI).[19] Around Chinatown, Nob Hill, and North Beach, pockets of low-income households exist.

Unemployment

The North Shore urban watershed has double-digit unemployment in and around Chinatown, but lower unemployment rates elsewhere, as shown in Figure 2.27. At the urban watershed level, the unemployment rate is 7.2%, which is high compared to the San Francisco rate of 6.5%.

Disadvantaged Communities

In North Shore, 39% of the population lives in census tracts that are considered disadvantaged, given unemployment rates and median household incomes. These disadvantaged tracts are concentrated in and around Chinatown and North Beach, as expected given the high unemployment and low income in these neighborhoods.

[19] The dollar amount where half the population earns less and half earns more. Please see footnote 25 on page 2-77 for additional information on the AMI of San Francisco.

Since the percentage of the San Francisco population living in disadvantaged census tracts is 30%, the North Shore urban watershed, at 39%, represents a relatively high proportion of disadvantaged communities. Figure 2.28 maps the disadvantaged communities and Figure 2.29 maps environmental justice areas of concern, which do not currently occur in the North Shore urban watershed.

Quantity and Distribution of Open Space

North Shore contains 1210 acres of open space, which allows for a high open space ratio of 13.1 acres of open space per thousand residents, compared to the 7.2 acres per thousand residents in San Francisco overall. This high ratio reflects the large amount of public green space at the Presidio, relative to the total urban watershed area.

In terms of access, only 3.6% of residents live farther than a quarter mile from open space, as shown in Figure 2.30.[20] These residents live in two small pockets of high-density areas in the central Marina and in Pacific Heights neighborhoods. In San Francisco overall, 13% of residents live farther than a quarter mile from open space.

Street Safety

Approximately 5,500 street-safety related crimes[21] are reported in the North Shore urban watershed annually. Within North Shore, reports of crime are concentrated in Chinatown at the intersection of Columbus Avenue and Broadway, as shown in Figure 2.31.

Bike Network

North Shore has 28 miles of bicycle paths, routes, and lanes, accounting for 13% of all San Francisco's bicycle infrastructure, as shown in Figure 2.32. 56% of the urban watershed's bicycle infrastructure is bike routes, 18% is bike lanes, and 15% is bike paths. The relatively high proportion of bike paths is a function of the multi-use trails in the Presidio. According to the SFMTA Bike Route Network database, no new bicycle infrastructure is planned for the North Shore urban watershed.

Bike and Pedestrian Safety

North Shore has several intersections with frequently recorded bike accidents although fewer than five accidents are reported at each of these intersections, as shown in Figure 2.33. High pedestrian injury corridors exist along Columbus Avenue, Francisco Avenue, Broadway, Stockton Street, Kearny Street, Lombard Street, Van Ness Avenue, the Embarcadero, and Market Street. Potential injury corridors exist along Bay Street and Polk Street.

[20] A reasonable access distance for a resident from home to open space, as defined by the ROSE of the *San Francisco General Plan*. A quarter mile is generally equivalent to a five minute walk.

[21] Arson, assault, burglary, disorderly conduct, drug/narcotics, drunkenness, family offenses, fraud, kidnapping, liquor laws, loitering, missing persons, prostitution, robbery, sex offenses, suicide, trespassing, vandalism, vehicle theft, and weapon laws.

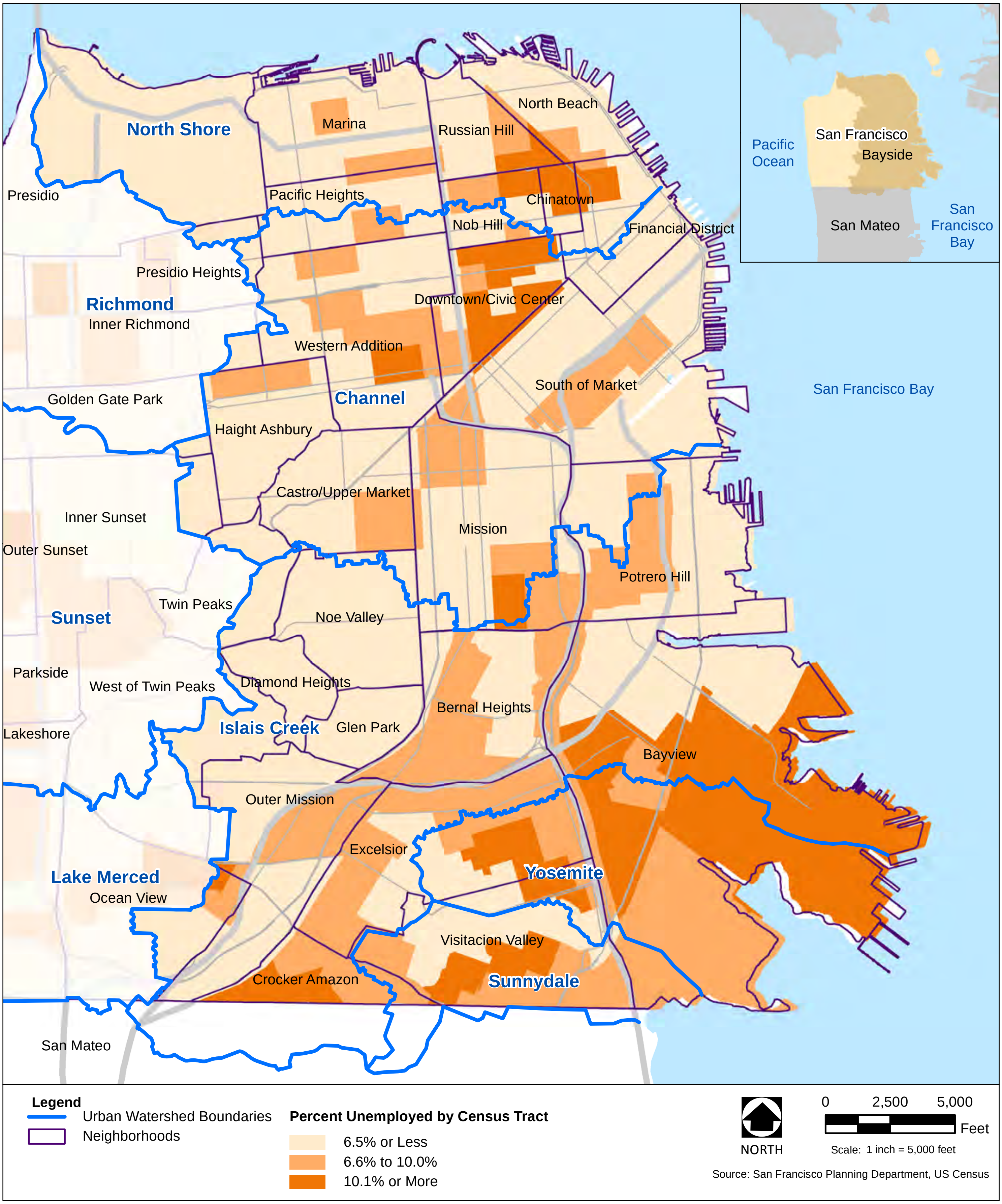


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Figure 2.27: Unemployment

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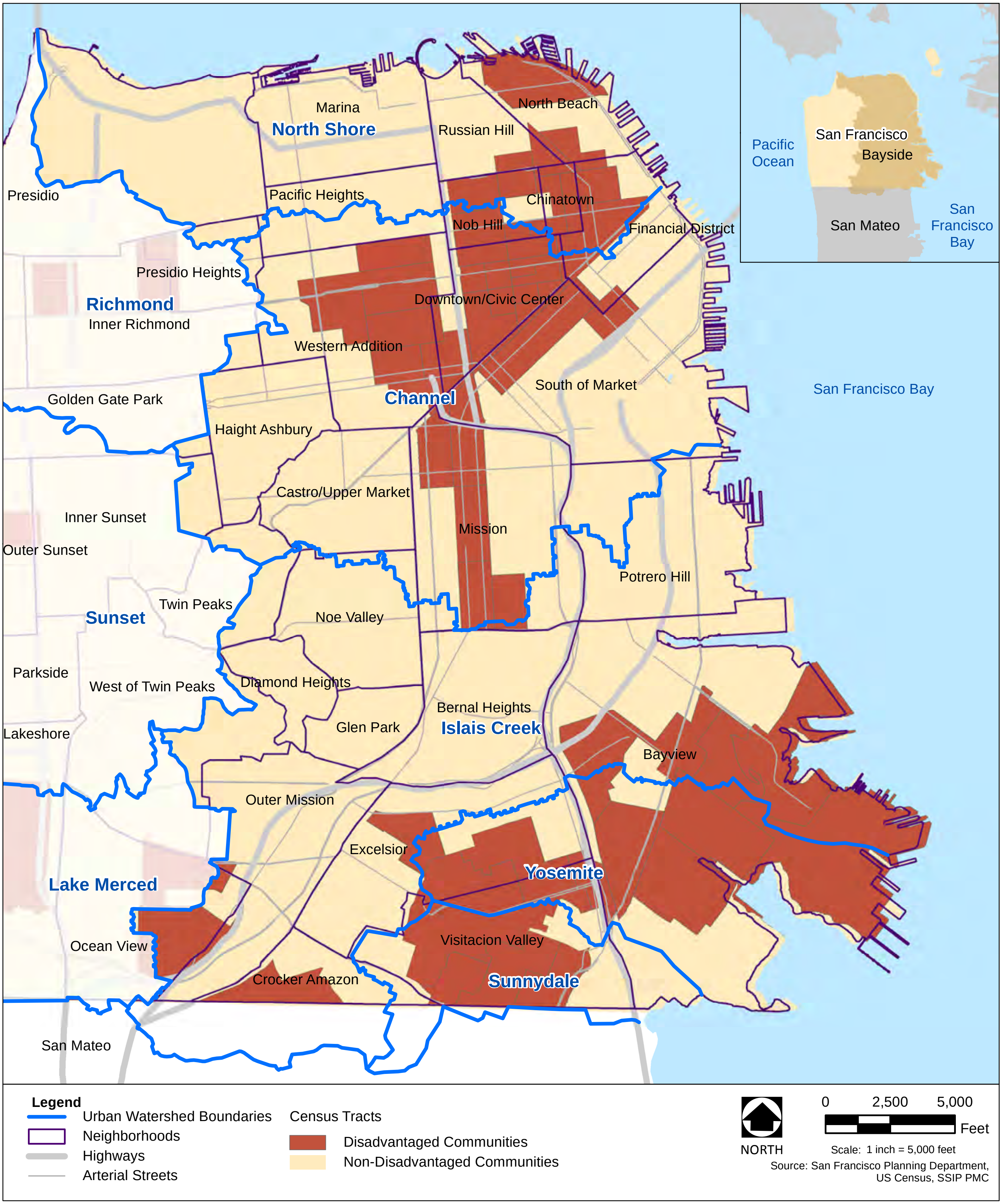

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Figure 2.28: Disadvantaged Communities

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Figure 2.29: Environmental Justice Areas

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Figure 2.30: Park Need

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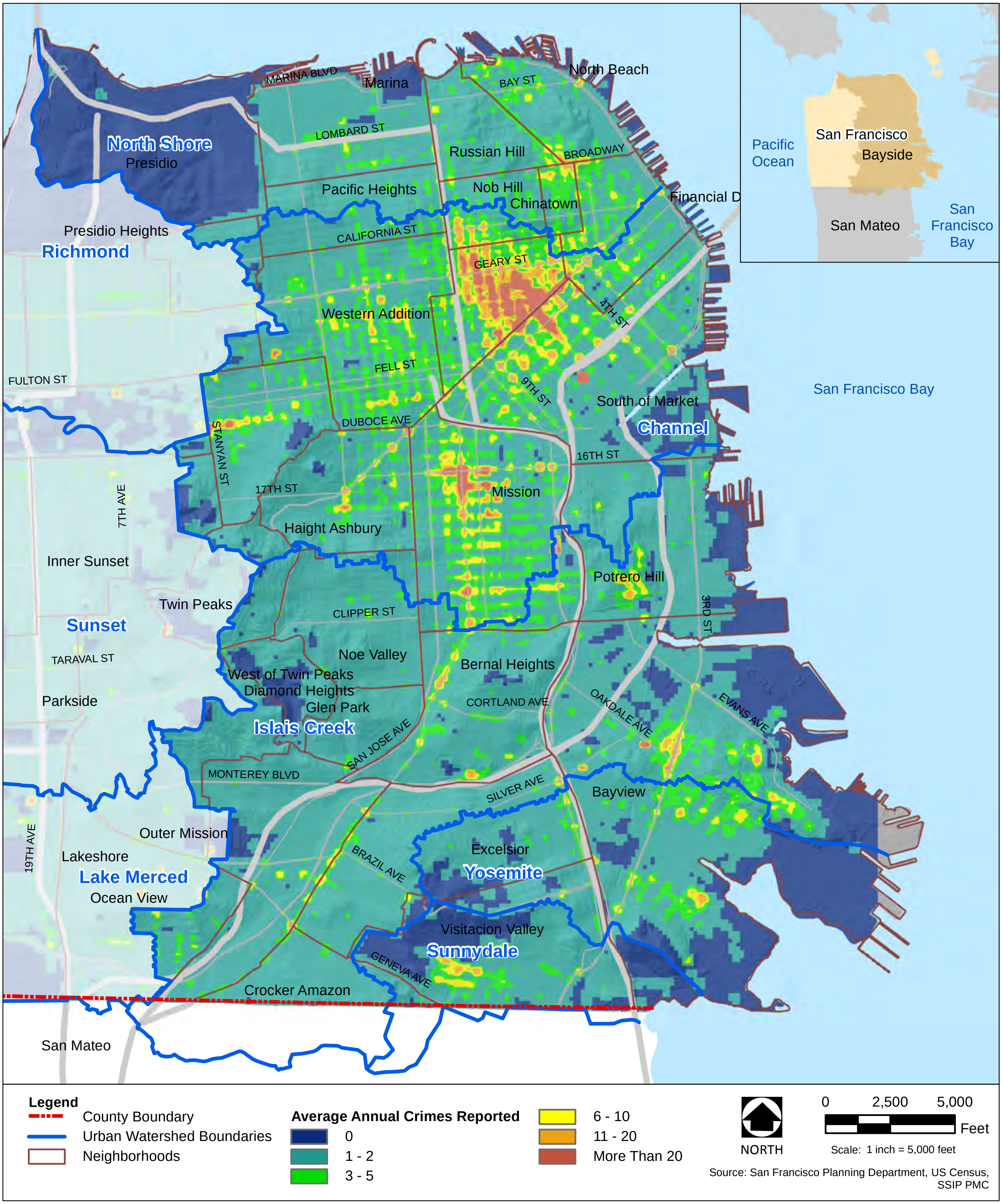

Figure 2.31: Street Safety

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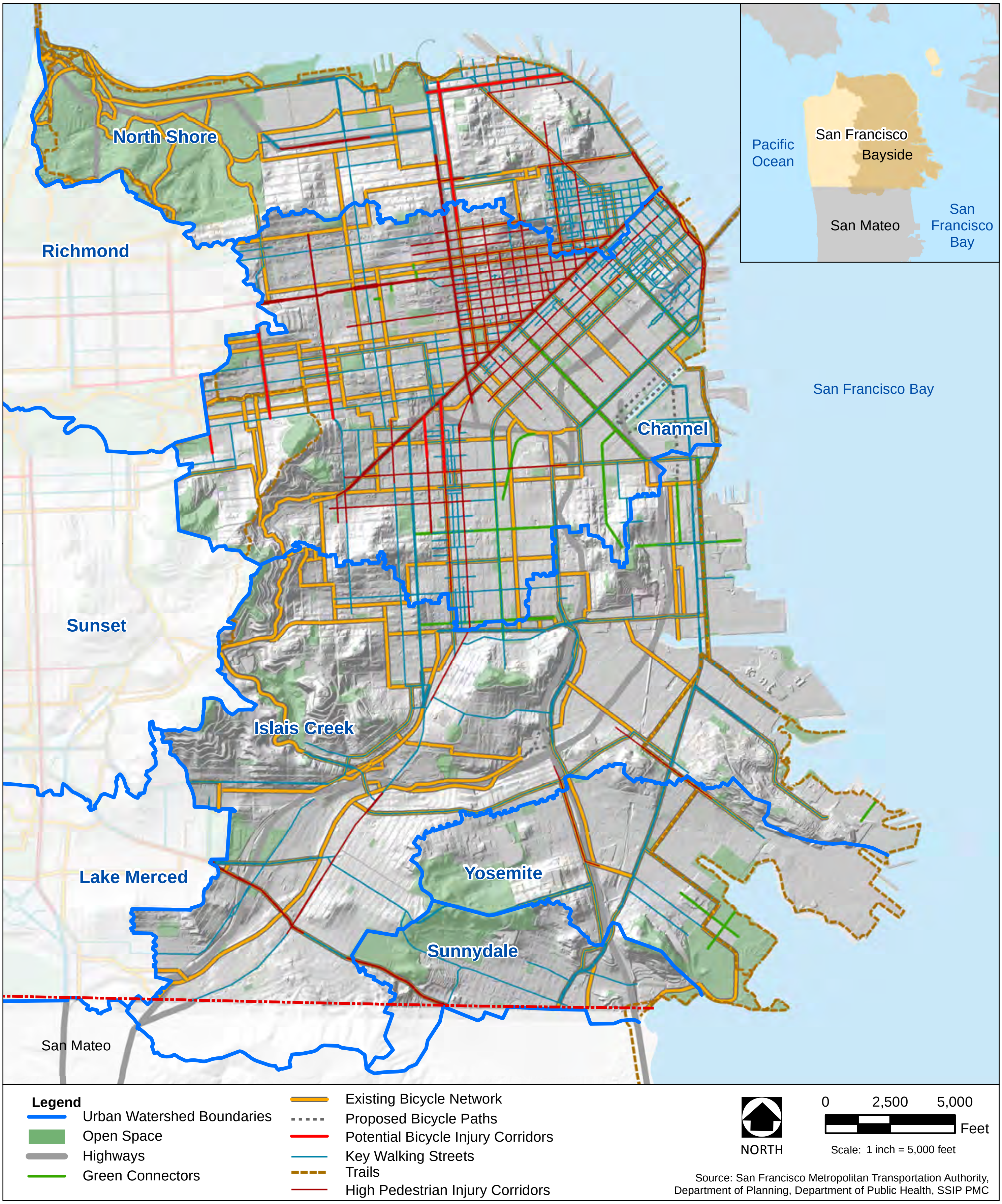

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Figure 2.32: Bicycle and Pedestrian Networks

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Legend

- Urban Watershed Boundaries
- Potential Bicycle Injury Corridors
- High Injury Corridors
- Existing Bicycle Network
- Proposed Bicycle Paths
- Key Walking Streets
- Trails
- Open Space
- Highways
- Green Connectors

Count of Bicycle Accidents

- 1 - 5
- 6 - 10
- 11 - 14
- 15 - 19
- 20 - 23

NORTH

0 2,500 5,000 Feet

Scale: 1 inch = 5,000 feet

Source: San Francisco Metropolitan Transportation Authority, Department of Planning, Department of Public Health, CHP SWITRS 2005-2010, SSIP PMC

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Figure 2.33: Bicycle and Pedestrian Safety

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2.6.4 Channel Urban Watershed

Population

The Channel urban watershed, with a population of approximately 233,700, represents 19% of San Francisco's population. Within the urban watershed, only 9% of the population is under 18 years of age, compared to 13% in San Francisco overall.

Housing

The Channel urban watershed has approximately 121,600 households, of whom 77% are renters and 23% are homeowners. Compared to San Francisco, where 62% of households rent and 38% own, the ownership rate is relatively low. In terms of housing stock, of the 138,500 housing units in the urban watershed, 13% are single-family and 87% are multi-family homes. Again compared to San Francisco, where one third of homes are single-family and two thirds are multi-family, the number of single-family dwellings is relatively low in Channel, and the number of multi-family relatively high.

2.6.5 Neighborhood Areas

The Channel urban watershed area covers 5,618 acres, or, 30% of the area of San Francisco, and intersects 17 of San Francisco's 36 neighborhoods. The South of Market, Western Addition, and Mission neighborhoods make up the bulk of Channel. The composition by neighborhood is shown in Figure 2.34.[22]

Race and Ethnicity

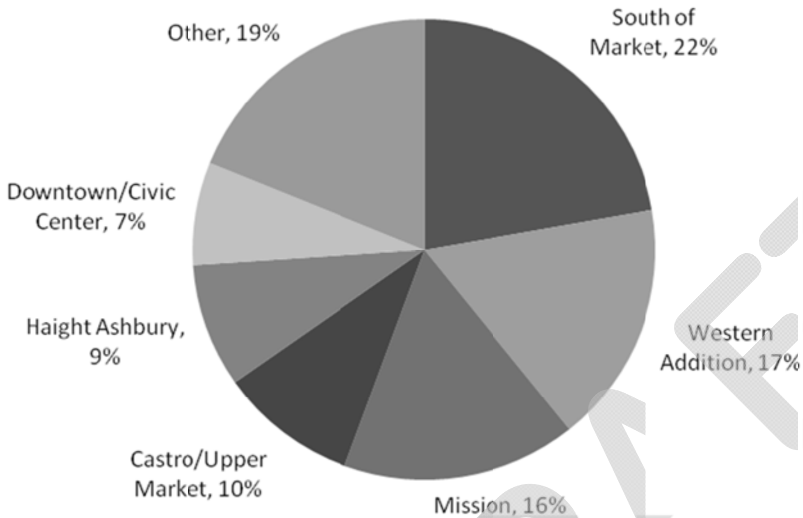
Across the entire Channel urban watershed, 49% of the population is a minority[23], compared with 58% in San Francisco overall. Within Channel, the Downtown/Civic Center, Mission, and South of Market neighborhoods have pockets of minority concentrations.[24]

[22] The fraction of area categorized as 'Other' represents the sum of all neighborhoods comprising less than 5% of the watershed's total area. These include: Financial District (4%), Potrero Hill (4%), Pacific Heights (4%), Inner Sunset (2%), Nob Hill (2%), Twin Peaks (1%), Noe Valley (1%), Inner Richmond (1%), Presidio Heights (1%), less than 1% of Golden Gate Park, Chinatown, Bernal Heights, and Presidio.

[23] An individual of non-white race and/or Hispanic ethnicity.

[24] A minority concentration is defined as an area (within San Francisco) where more than 78% of the population is a minority. [According to the Council on Environmental Quality's report 'Guidance Under the National Environmental Policy Act' concentrations of minority population should be identified where the minority population in an area is 50% or more, or where the percentage of minority residents in an area is meaningfully greater than in the general population. One metric of "meaningfully greater" can be found in San Francisco's 2010-2014 Consolidated Plan submitted to the US Department of Housing and Urban Development (HUD). This document defines an area of aggregate minority concentration as any census tract with 20 percentage points more minority residents than the City as a whole. Since 58% of the San Francisco population was minority in from 2006 to 2010, a census tract where minority residents comprise 78% or more of the population qualifies as a minority concentration.]

Figure 2.34
Channel Urban Watershed Neighborhoods



Income

Channel contains a significant concentration of low-income households[25] in the Downtown, Western Addition, and Mission (especially between South Van Ness and Valencia Street) neighborhoods. Median household income is generally above 120% of AMI at the periphery of the Channel urban watershed, where small portions of Financial District, Upper Market, Potrero Hill, Noe Valley, Inner Sunset, Pacific Heights, and Twin Peaks fall within Channel's boundaries.

Unemployment

The Channel urban watershed has a low overall unemployment rate of 6.0%, compared to the citywide San Francisco unemployment rate of 6.5%. However, unemployment varies significantly within the urban watershed, as shown in Figure 2.27 Unemployment. Portions of Downtown/Civic Center, Western Addition, and Mission have double-digit unemployment rates.

Disadvantaged Communities

In the Channel urban watershed, 45% of the population lives in census tracts that are considered disadvantaged, given unemployment rates and median household incomes[26]. These census tracts are concentrated in the Downtown/Civic Center,

[25] A household that earns less than 80% of the City's area median income (AMI). This definition is consistent with the thresholds HUD publishes each year. [For San Francisco, with an AMI of $71,309, the low-income threshold would be $57,050].

[26] A disadvantaged worker is a local resident who i) resides in a census tract with a rate of unemployment in excess of 150% of the City unemployment rate; or ii) at the time of commencing work on a covered project, has a household income of less than 80% of the AMI, or iii) faces or has overcome at least one of the following barriers to employment: being homeless; being a custodial single parent; receiving public assistance; lacking a GED or high school diploma; participating in a vocational English as a Second Language program; or having a

Western Addition, and Mission neighborhoods, as shown in Figure 2.28 Disadvantaged Communities. Channel represents a relatively high percentage of population that lives in a disadvantaged community, since the San Francisco percentage is only 30%.

Environmental Justice Areas of Concern

In the Channel urban watershed, 7% of the population lives in zip codes that are considered environmental justice areas of concern, given the cumulative negative environmental impacts that these areas experience. Please refer to Section 2.6.1 for a description of environmental justice areas of concern. These areas are concentrated in the SoMa and Mission Bay neighborhoods. Since the percentage of the San Francisco population living in environmental justice areas of concern is 8%, the Channel urban watershed, at 7%, represents a relatively equal proportion of these areas of concern. Figure 2.29 maps environmental justice areas of concern.

Quantity and Distribution of Open Space

Channel contains 270 acres of open space, which allows for only 1.1 acres of open space per thousand residents. This low ratio – compared to 7.2 acres per thousand residents in San Francisco overall – represents the relatively small size of open spaces in neighborhoods such as SoMa and Mission as compared to the high population densities surrounding them.

Despite a low quantity of open space per thousand residents, parks and open spaces in the urban watershed are distributed such that only 13% of residents live farther than a quarter mile from open space. Some of the areas further than a quarter mile from open space have low densities, such as in the SoMa neighborhood, while others have high densities, in particular areas in the Mission, Nob Hill, and Western Addition, as seen in Figure 2.30, Park Need. These specific areas of high density are notable because homes in areas with higher residential densities are less likely to have private outdoor spaces, such as yards, associated with their units, as indicated in the ROSE of the *San Francisco General Plan*. In San Francisco overall, a comparable 13% of residents live farther than a quarter mile from open space.

Street Safety

Approximately 34,000 street-safety related crimes are reported annually in the Channel urban watershed. Street-safety related crime reports are concentrated in the Downtown/Civic Center neighborhood, especially in the area south of Geary and east of Van Ness. Crime also concentrates in the Mission neighborhood, emanating south on Mission Street from the intersection at 16th Street and Mission Street. Figure 2.31 shows average annual reported crimes by concentration.

criminal record or other involvement with the criminal justice system. [This definition comes from the San Francisco Local Hiring Policy for Construction document released by the City and Council of San Francisco. For the purposes of our analysis, disadvantage will be calculated based on the first two criteria.]

Bike Network

Channel has 53 miles of bicycle paths, routes, and lanes[29], accounting for approximately 25% of all San Francisco's bicycle infrastructure, as shown in Figure 2.32. Of all San Francisco's bike lanes, Channel contains a relatively high proportion at 38%. The Channel urban watershed contains only one mile of bike paths, which is unsurprising given the lack of large open space in the urban watershed. According to the SFMTA Bike Route Network database, 3.5 miles of new bicycle infrastructure are planned for the urban watershed in the South of Market neighborhood around Mission Bay.

Bike and Pedestrian Safety

Significant bicycle and pedestrian safety concerns exist in the Channel urban watershed. Almost all streets in the Downtown/Civic Center neighborhood, between Van Ness and Market Street, are considered high pedestrian injury corridors, as well as a considerable number of streets in the Mission neighborhood, as shown in Figure 2.33. Numerous intersections have a high frequency of bike accidents, two of which report between over 20 accidents between 2005 and 2010, four of which report between 11 and 14 accidents, and many which report between one and ten accidents. Market, Polk, and Valencia Streets in particular have many problem intersections along their length.

2.6.6 Islais Creek Urban Watershed

Population

The Islais Creek urban watershed, with a population of approximately 167,900, represents 21% of San Francisco's population. Within the urban watershed, 18% of the population is under 18 years of age, compared to the 13% in San Francisco overall.

Housing

The Islais Creek urban watershed has approximately 58,700 households, of whom 43% are renters and 57% are homeowners. Compared to San Francisco, where 62% of households rent and 38% own, the homeownership rate is relatively high. In terms of housing stock, of the 62,400 housing units in the urban watershed, 61% are multi-family homes and 39% are single-family homes, which is similar to what is observed throughout San Francisco, where one third of homes are single-family and two thirds are multi-family.

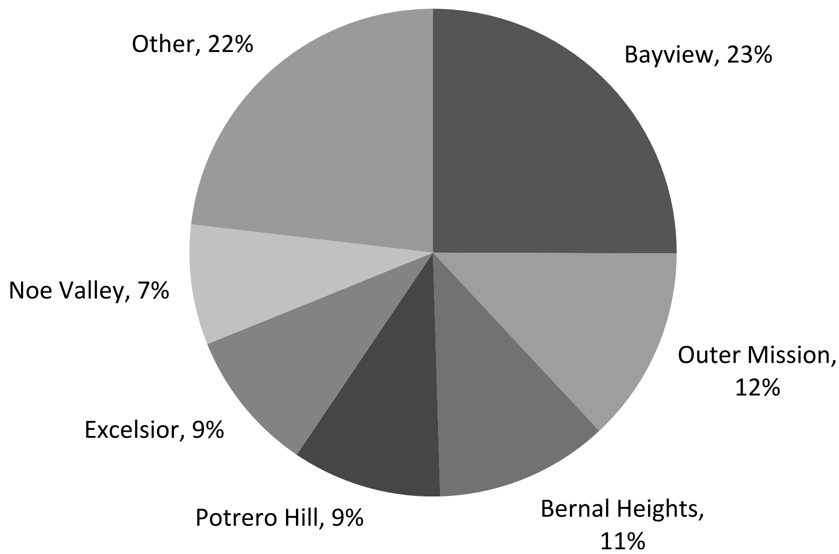
Neighborhood Areas

Islais Creek covers 6,510 acres, or, 22% of the area of San Francisco, and intersects 16 of San Francisco's 36 neighborhoods. The Bayview, Outer Mission, and Bernal

[29] Bike lanes assign a portion of the available roadway width to cyclists, while bicycle routes merely add roadshare signage, with no specific widening or other improvement; Bikes paths are typically multi-use paths in parks such as Golden Gate Park or the Presidio.

Heights neighborhoods make up the bulk of the urban watershed. The composition of the urban watershed by neighborhood[30] is shown in Figure 2.35.

Figure 2.35
Islais Creek Urban Watershed Neighborhoods



Race and Ethnicity

Across the entire Islais Creek urban watershed, 65% of the population is a minority, compared with 58% in San Francisco overall. Significant minority populations are found in the southern half of the urban watershed, with minority concentrations in the Excelsior, Crocker Amazon, Bayview, Outer Mission and Ocean View neighborhoods.

Income

The northern half of the Islais Creek urban watershed predominantly contains households earning more than 120% of AMI, in the Potrero Hill, Bernal Heights, Noe Valley, Glen Park, Diamond Heights, and West of Twin Peaks neighborhoods. The southern half of the urban watershed contains some pockets of low-income households in the Bayview, Excelsior, and Ocean View neighborhoods. Note that in the western half of the urban watershed, the gradation from higher income to lower income passes through moderate income areas (households earning 80%-100% of

[30] The fraction of area categorized as 'Other' represents the sum of all neighborhoods comprising less than 5% of the watershed's total area. These include: Crocker Amazon (4%), Glen Park (3%), West of Twin Peaks (3%), Diamond Heights (3%), Ocean View (3%), Mission (3%), Twin Peaks (2%), and less than 1% of Visitacion Valley, South of Market, and Castro/Upper Market.

AMI); in the eastern half, the transition is a stark shift from households earning over 120% AMI to those earning below 80% AMI.

Unemployment

The Islais Creek urban watershed has a moderate overall unemployment rate of 6.8%, compared to the citywide San Francisco unemployment rate of 6.5%. However, unemployment varies significantly within the urban watershed, as shown in Figure 2.27. Portions of the southern urban watershed, in the Bayview, Excelsior, Ocean View, and Outer Mission neighborhoods, have double-digit unemployment rates.

Disadvantaged Communities

In the Islais Creek urban watershed, 16% of the population lives in census tracts that are considered disadvantaged, given unemployment rates and median household incomes. These census tracts are concentrated in small pockets in the Bayview, Excelsior, Crocker Amazon, and Ocean View neighborhoods, where low-income and high unemployment rates predominate. Figure 2.28 shows these disadvantaged areas. Since the percentage of the San Francisco population living in disadvantaged census tracts is 30%, the 16% of the Islais Creek urban watershed's population living in a disadvantaged community, represents a relatively low proportion.

Environmental Justice Areas of Concern

In the Islais Creek urban watershed, 16% of the population lives in zip codes that are considered environmental justice areas of concern, given the cumulative negative environmental impacts that these areas experience. These areas are concentrated in the Potrero Hill and Bayview neighborhoods. Since the percentage of the San Francisco population living in environmental justice areas of concern is 8%, the Islais Creek urban watershed, at 16%, represents a relatively high proportion of these areas of concern. Figure 2.29 maps environmental justice areas of concern.

Quantity and Distribution of Open Space

The Islais Creek urban watershed contains 330 acres of open space, which allows for only 1.9 acres of open space per thousand residents – a low ratio compared to the 7.2 acres per thousand residents in San Francisco overall.

Despite a low quantity of open space per thousand residents, parks and open spaces in the urban watershed are distributed in such a way that only 15% of residents live farther than a quarter mile from open space- although a significant proportion of these 15% live in high density areas in Excelsior, Outer Mission, and Crocker Amazon. Figure 2.30 represents park access and population density in the Islais Creek urban watershed. In San Francisco overall, a comparable 13% of residents live farther than a quarter mile from open space.

Street Safety

Approximately 11,000 street-safety related crimes are reported annually in the Islais Creek urban watershed. Areas of high crime reporting are found along Elsie Street in Bernal Heights, along Mission Street on the border between Outer Mission and Excelsior, around the intersection of Oakdale Avenue and Third Street in the Bayview, and north of Chavez Street in Potrero Hill. Figure 2.31 shows the average annual reported crimes by concentration.

Bike Network

The Islais Creek urban watershed has 41 miles of bicycle paths, routes, and lanes, accounting for approximately 19% of all San Francisco's bicycle infrastructure, as shown in Figure 2.32. Of all San Francisco's bike lanes, Islais Creek contains a relatively high proportion at 25%. The Islais Creek urban watershed contains only 1 mile of bike paths, which is unsurprising given the lack of large open space in the urban watershed. According to the SFMTA Bike Route Network database (January 2012), 3.6 miles of new bicycle infrastructure are proposed for Islais Creek in the Potrero Hill neighborhood, heading towards Mission Bay.

Bike and Pedestrian Safety

The Islais Creek urban watershed, given its large area, has a moderate number of intersections with frequently recorded bike accidents – although fewer than five accidents between 2005 and 2010 were reported at each, as shown in Figure 2.33. Three high pedestrian injury corridors exist along Mission Street, Geneva Avenue, and Palou Avenue.

2.6.7 Yosemite Urban Watershed

Population

The Yosemite urban watershed, with a population of approximately 31,500, represents only 4% of San Francisco's population. Within the urban watershed, 23% of the population is under 18 years of age compared to 13% in San Francisco overall.

Housing

Yosemite has approximately 9,000 households, with an exact 60%/40% split between homeowners and renters respectively, similar to San Francisco's 62%/38% split. In terms of housing stock, of the 10,000 housing units in the urban watershed, the majority are single-family units. Only 19% of units are multi-family units, compared to 67% in San Francisco overall.

Neighborhood Areas

The Yosemite urban watershed area covers 1,967 acres, or, 7% of the area of San Francisco, and intersects three of San Francisco's 36 neighborhoods: the Bayview, Excelsior, and Visitacion Valley, as shown in Figure 3.36

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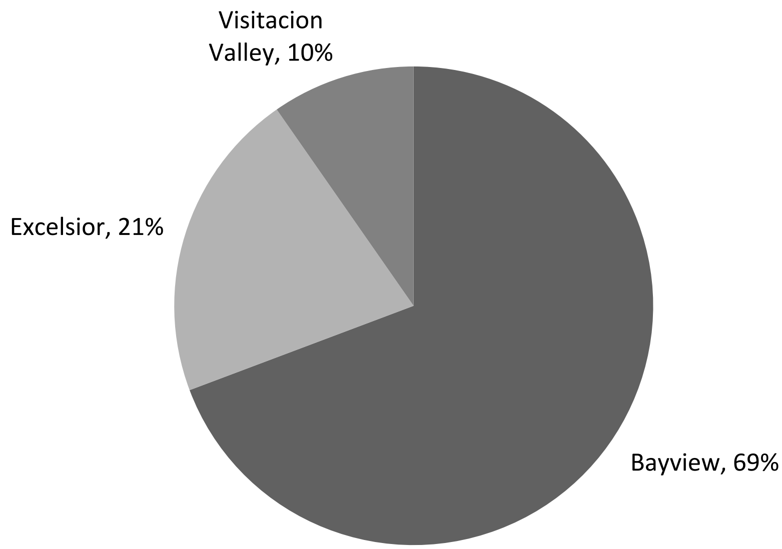
Figure 2.36
Yosemite Urban Watershed Neighborhoods



Race and Ethnicity

Across the entire Yosemite urban watershed, 88% of the population is a minority, compared with 58% in San Francisco overall. As a minority concentration is defined as an area within San Francisco where more than 78% of the population is a minority, the entire Yosemite urban watershed can be described as a minority concentration.

Income

Yosemite contains no households earning greater than 120% of the AMI. Households earning less than the AMI predominate, with a significant proportion of low-income households in the Bayview neighborhood.

Unemployment

The Yosemite urban watershed has a high unemployment rate of 9.3%, compared to 6.5% in San Francisco overall. Except for a small area east of 3rd Street, all census tracts within the urban watershed have double-digit unemployment rates, as shown in Figure 2.27. Note that large sections of the urban watershed that appear to have lower unemployment rates primarily overlay public recreational space (John McLaren Park and Candlestick Park).

Disadvantaged Communities

In Yosemite, 70% of the population lives in census tracts that are considered disadvantaged, given unemployment rates and median household incomes. This high proportion of disadvantaged communities – compared to 30% in San Francisco – is consistent with the high unemployment rates and low incomes in the Yosemite. As shown in Figure 2.28, most of the Yosemite urban watershed, aside from the park areas (John McLaren Park and Candlestick Park), is considered disadvantaged.

Environmental Justice Areas of Concern

In Yosemite, 57% of the population lives in zip codes that are considered environmental justice areas of concern, given the cumulative negative environmental impacts that these areas experience. These areas are concentrated in the Bayview neighborhood. Since the percentage of the San Francisco population living in environmental justice areas of concern is 8%, the Yosemite urban watershed, at 57%, represents a relatively high proportion of these areas of concern. Figure 2.29 maps environmental justice areas of concern.

Quantity and Distribution of Open Space

Yosemite contains 310 acres of open space, which allows for a high open space ratio of 9.8 acres of open space per thousand residents. This high ratio is a function of the low density of residents and the location of Candlestick Park and John McLaren Park within the small urban watershed area. At 9.8 acres per thousand residents, Yosemite exceeds the San Francisco ratio of 7.2 acres per thousand residents.

Despite a high quantity per thousand residents, parks and open spaces are not well distributed throughout the urban watershed, but rather concentrated in the two large swaths at Candlestick Park and John McLaren Park. Given the small number of large parks, accessibility is low, with 26% of residents living farther than a quarter mile from open space, compared to 13% in San Francisco overall. In particular, an area west of San Bruno Avenue of moderate density lies outside the quarter mile radius, as shown in Figure 2.30.

Street Safety

Approximately 2,800 street-safety related crimes are reported annually in the Yosemite urban watershed. Within the urban watershed, reports of crime occur in dispersed locations in the Bayview neighborhood, as shown in Figure 2.31.

Bike Network

The Yosemite urban watershed has 7 miles of bicycle paths, routes, and lanes, accounting for only 3% of all San Francisco bicycle infrastructure, as shown in Figure 2.32. The majority of bicycle infrastructure in the urban watershed consists of bike routes, with only 15% being bike lanes. According to the SFMTA Bike Route Network database, no new bicycle infrastructure is planned for the Yosemite urban watershed.

Bike and Pedestrian Safety

Yosemite has few intersections with frequently recorded bike accidents – there are fewer than 20 problem intersections, with a single reported bike accident at each between 2005 and 2010, as shown in Figure 2.33. One high pedestrian injury corridor exists at San Bruno Avenue.

2.6.8 Sunnydale Urban Watershed

Population

The Sunnydale urban watershed, with a population of approximately 20,500, represents only 3% of San Francisco's population. Within the urban watershed, 24%

of the population is under 18 years of age, compared to 13% in San Francisco overall.

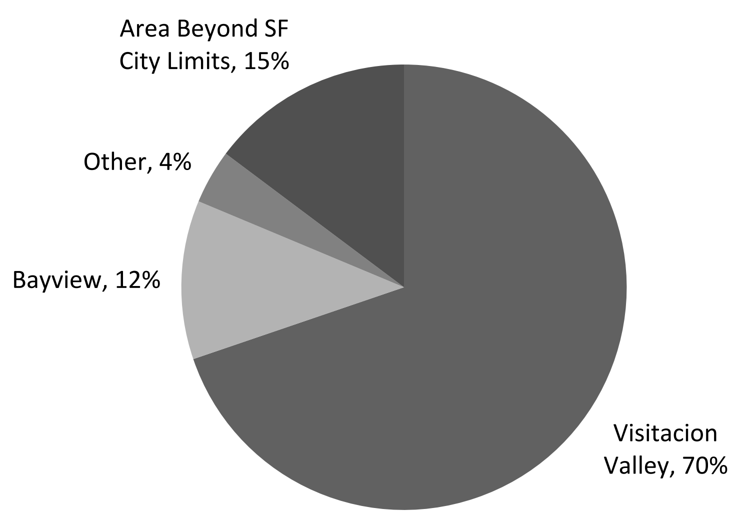
Housing

Sunnydale has only 6,100 households, with a relatively equal split between renters and homeowners (45% and 55% respectively). Compared to San Francisco, where 62% of households rent and 38% own, the homeownership rate is relatively high. In terms of housing stock, the majority of the 6,500 housing units are single-family homes, with only 24% being multi-family units, compared to San Francisco where 67% of units are multi-family.

Neighborhood Areas

The Sunnydale urban watershed covers 898 acres, or, 3% of the area of San Francisco, and intersects four of San Francisco's 36 neighborhoods. The Visitacion Valley and Bayview neighborhoods make up the bulk of the Sunnydale urban watershed, as shown in Figure 2.37. Note that although 15% of the Sunnydale urban watershed extends south beyond the San Francisco city limits, socio-demographic data is only relevant to the area within the city.

Figure 2.37
Sunnydale Urban Watershed Neighborhoods



Race and Ethnicity

Across the entire Sunnydale urban watershed, 93% of the population is a minority, compared with 58% in San Francisco overall. The entirety of the Sunnydale urban watershed contains minority concentrations.

Income

Sunnydale contains predominantly low-income households, although a small area between Bayshore Boulevard and Highway 101 contains households with over 120% of AMI.

Unemployment

The Sunnydale urban watershed has a relatively high unemployment rate of 10.8%, compared to the San Francisco unemployment rate of 6.5%. Consistent with the income pattern, the Sunnydale urban watershed has double-digit unemployment throughout, except in a small area between Bayshore Boulevard and Highway 101, where the unemployment rate falls between 5% and 7.5%. Figure 2.27 shows the distribution of the unemployment rate in the urban watershed.

Disadvantaged Communities

In the Sunnydale urban watershed, 71% of the population lives in census tracts that are considered disadvantaged, given unemployment rates and median household incomes. This high proportion of disadvantaged communities – compared to 30% in San Francisco – is consistent with the pervasive high unemployment rates and low incomes in Sunnydale, especially in the Visitacion Valley neighborhood. Figure 2.28 shows the distribution of disadvantaged communities in the Sunnydale urban watershed.

Environmental Justice Areas of Concern

In the Sunnydale urban watershed, 3% of the population lives in zip codes that are considered environmental justice areas of concern, given the cumulative negative environmental impacts that these areas experience. These areas are concentrated in the Bayview neighborhood. Since the percentage of the San Francisco population living in environmental justice areas of concern is 8%, the Sunnydale urban watershed, at 3%, represents a relatively low proportion of these areas of concern. Figure 2.29 maps environmental justice areas of concern.

Quantity and Distribution of Open Space

The Sunnydale urban watershed contains 270 acres of open space, which allows for a high open space ratio of 13.0 acres of open space per thousand residents, compared to the 7.2 acres per thousand residents in San Francisco overall.

In terms of access, only 1% of residents live farther than a quarter mile from open space, as shown in Figure 2.30. In San Francisco overall, 13% of residents live farther than a quarter mile from open space.

Street Safety

Approximately 1,400 street-safety related crimes are reported annually in the Sunnydale urban watershed. Within the urban watershed, reports of crime are concentrated in Visitacion Valley around Brookdale and Blythdale avenues, as shown in Figure 2.31.

Bike Network

The Sunnydale urban watershed has 3 miles of bicycle paths, routes, and lanes, accounting for only 1% of all San Francisco's bicycle infrastructure, as shown in Figure 2.32. Two thirds of bicycle infrastructure in the urban watershed is bike routes, while one third is bike lanes. According to the SFMTA Bike Route Network database, no new bicycle infrastructure is planned for the Sunnydale urban watershed.

Bike and Pedestrian Safety

The Sunnydale urban watershed has only three intersections, with a single bike accident reported between 2005 and 2010 at each. One high pedestrian injury corridor exists at Geneva Avenue, as shown in Figure 2.33.

2.7 Stormwater and Wastewater Regulatory Framework

This section describes the state and federal regulatory drivers that affect the SFPUC WWE's operation of the combined and separate sewer systems and their discharges. This regulatory context will inform projects and programs that affect modeled CSDs and compliance with future regulations.

2.7.1 Background

The primary regulatory driver for San Francisco's stormwater and sanitary sewer infrastructure is the protection of water quality as mandated by the federal Clean Water Act[31] and the state's Porter-Cologne Water Quality Control Act (Porter-Cologne).[32] The Clean Water Act and Porter-Cologne protect state and federal waters by establishing water quality standards that consist of designated beneficial uses (BUs), numeric or narrative criteria to protect those uses, and requirements to prevent degradation of existing conditions.[33] To ensure attainment of water quality standards, all point source discharges – like those from San Francisco's separate and combined systems – are prohibited unless authorized by a NPDES permit.

2.7.2 Current Discharge Regulations

All discharges of stormwater and wastewater from the Bayside Drainage Basin are regulated by permits issued by the State Water Resources Control Board (SWRCB) and the San Francisco Bay Regional Water Quality Control Board (RWQCB).

- NPDES Permit No. CA0037664, Order No. R2-2008-0007, (Bayside Permit) is issued by the RWQCB. It authorizes discharges from SEP through the deep-water Southeast Bay Outfall (SBO) of secondary treated wastewater during dry weather and a mix of primary and secondary treated wastewater during wet weather. In wet weather, the permit also allows discharges of secondary treated flows through a shallow water outfall to Islais Creek located at Quint Street; primary treated flows through four deep water outfalls from the NPF at Piers at 33 and 35, and combined sewer discharges from the 29 CSD outfalls. A new SEP permit will be issued in August, 2013.
- NPDES Permit No. CAS000004, Order No. 2013-0001-DWQ, (Municipal Separate Storm Sewer, or MS4, Permit) is issued by the SWRCB. It authorizes discharges of stormwater and some categories of non-stormwater that are not "significant contributors of pollutants."[34] The MS4 Permit covers only those

[31] 33 U.S.C. § 1251 *et seq.*
[32] Cal. Water Code § 13000 *et seq.*
[33] 40 C.F.R. § 131.6.
[34] MS4 Permit at sec. D.2.c.6.

portions of the City where stormwater flows are conveyed by SFPUC infrastructure separately from wastewater, which have been deemed by the SFPUC to be separate storm sewer areas. This represents a relatively small area, mostly located near Lake Merced, Mission Bay South, Candlestick Park, and Hunters Point.

- Order No. 2006-0003 is issued by the SWRCB and regulates separate sanitary sewer systems by requiring them to develop and implement sewer system management plans and to report all sanitary sewer overflows (SSOs) to an online database managed by the State. The requirements of this order apply only to those portions of San Francisco served by separate sanitary (and storm) sewers.

Dry Weather Discharges

All dry weather discharges are prohibited with two exceptions. First, the MS4 Permit authorizes specific discharges of specific types of non-stormwater provided that those discharges are not "significant contributors of pollutants." The categories of authorized non-stormwater discharges most relevant to the Urban Watershed Assessment are flows from diverted creeks, riparian habitats and wetlands, springs, uncontaminated ground water, foundation drains, footing drains, and crawl space pumps.[35] If any of these discharges are found to be significantly contributing pollutants, the City must take action to control the discharges or reduce the pollutants contained therein.

Second, the Bayside Permit authorizes dry weather discharges from the deep-water SBO, which discharges secondary treated and disinfected wastewater effluent from SEP to San Francisco Bay. These discharges must meet stringent numeric effluent limitations for biochemical oxygen demand (BOD), total suspended solids (TSS), oil and grease, pH, chlorine, fecal coliform, enterococcus, copper, lead, mercury, silver, zinc, cyanide, dioxin, PCBs, tetrachloroethylene, bis(2-ethylhexyl)phthalate, ammonia, and tributyltin. The permit also limits the average annual dry weather flow to the SEP design flow of 85.4 MGD. Actual flows are in the range of 40 to 80 MGD.

Wet Weather Discharges

Regulation of discharges that include stormwater (wet weather discharges) is substantially different than regulation during dry weather because of the challenges inherent in controlling flows during storms of varying sizes and intensities. In the MS4 areas, the City must implement best management practices in six program areas in order to reduce pollutants in stormwater runoff to the "Maximum Extent Practicable": (1) public education, (2) public participation, (3) illicit discharge detection and elimination, (4) construction site stormwater runoff control, (5) post construction stormwater management, and (6) pollution prevention for municipal operations.[36]

In the combined system, wet weather regulation is focused on maximizing the volume of flows to SEP for treatment, consistent with the federal Combined Sewer Overflow

[35] MS4 Permit at sec. D.2.c.6.
[36] 40 C.F.R. § 122.34(b).

Control Policy. The Bayside Permit defines a "wet weather day" as one in which instantaneous flow to SEP exceeds 110 MGD, the levels of flow in the North Shore storage/transport structure exceeds 100 inches, or the influent concentration of TSS or BOD is less than 100 milligrams per liter (mg/L). Only on these days may the SFPUC discharge from Quint Street, the NPF, or the CSD structures. Discharges from Quint Street and the NPF must comply with fecal indicator bacteria and chlorine effluent limitations.

SFPUC's combined system was designed such that over the long term, the average annual number of storm events that result in a CSD would vary based on the location of the CSD. The design criteria shown in Table 2.10 were established by RWQCB Order No. 79-67, which weighed the pollutant removal, water quality benefits, and costs of different levels of discharge control. After consideration of various factors – including the beneficial use of the receiving waters, toxicity, BOD removal, shoreline bacteria impacts, composition of CSDs, and cost – the RWQCB determined that achieving the specified design criteria would protect beneficial uses provided that the remaining discharges also received settleable and floatable solids removal by T/S structures. As specifically recognized in the Bayside Permit the design criteria are not used to determine compliance or non-compliance; rather, to maintain compliance the SFPUC must "optimize the operation of its system to minimize [CSDs] and maximize pollutant removal."[37]

Table 2.10
Bayside Drainage CSD Basin Design Criteria

Location	Urban Watershed(s)	Outfall No.	Design Criteria
North Shore	North Shore	009 to 017	4
Central	Channel and Islais Creek	018 to 035	10
Southeast	Yosemite and Sunnydale	037 to 043	1

2.8 Planned Projects

This section describes planned projects in the Bayside Drainage Basin, such as SFPUC projects, other city department's capital projects, and large redevelopments. Knowledge of planned capital projects improves overall understanding of urban watershed dynamics and helps to identify possible synergy opportunities. Furthermore, knowledge of area and redevelopment plans helps understand social, environmental, and economic needs in the urban watershed. The following criteria were used to identify projects for possible synergy opportunities with the Urban Watershed Assessment:

- Scale:

[37] Bayside Permit at 37-38.

   - Projects large enough to be listed in area, neighborhood, community, district, or redevelopment plans; SFPUC Programs, or bond measure project summaries
   - Streetscape projects that have funding and are at least 2 linear blocks in length
- Timeframe:
   - Projects either planned or proposed to be completed in 2014 or later
   - Active ongoing projects that will not be completed until 2014 or later were also included
- Project Driver:
   - SFPUC infrastructure projects
   - Projects supported by bond measure funding
   - Area, neighborhood, or community plan proposed/planned projects
   - Redevelopment or other district-scale projects that are planned or in progress
   - Streetscape projects
   - Currently proposed Green Connections network of streets

2.8.1 SFPUC Projects

Projects being planned by the SFPUC that are not part of SSIP, but may impact decisions and recommendations from the Urban Watershed Assessments, include projects being implemented by the Wastewater CIP, Renewal & Replacement Program, and the Local Water Supply Program. Relevant projects from these programs are described in the following subsections.

Wastewater Capital Improvement Programs

The Wastewater CIP (WWE CIP) addresses immediate wastewater needs in the areas of flood control, odor control, and aging facilities and precedes the SSIP's long-term planning efforts. The current WWE CIP (previously called "the WWE 5-year CIP" or "WWE Interim CIP") has an anticipated completion of 2014. Table 2.11 summarizes the WWE CIP collection system projects that are located in the Bayside Drainage Basin and are in the planning or design phases.

Table 2.11
Interim WWE-CIP Collection System Projects within the Bayside Drainage Basin

Project Name	Urban Watershed	Expected Completion
Downtown District Aging Sewer Replacement/Rehabilitation	Channel	March 2014
Cesar Chavez Sewer Improvements - Phase 2	Islais Creek	March 2014

Project Name	Urban Watershed	Expected Completion
Powell and Mason Sewer Improvements	North Shore	February 2014
North Shore Force Main - Phase 2	North Shore	June 2014
Sunnydale Auxiliary Sewer - Phase 2	Sunnydale	May 2014

Source: SFPUC 2012d.

- The Downtown District Aging Sewer Replacement/Rehabilitation project is intended to rehabilitate existing brick sewers throughout San Francisco's Downtown District.
- Cesar Chavez Sewer Improvements - Phase 2 is being implemented to increase sewer capacity of the Cesar Chavez system east of Highway 101. Phase 2 is currently in the planning phase, while Phase 1 is currently under construction with an expected completion date of Spring 2013. Phase 1 of the improvements increases capacity of the Cesar Chavez system between Valencia Street and Highway 101.
- The Powell and Mason Sewer project provides hydraulic and structural improvements by increasing pipe sizes and replacing structurally inadequate sewers on Mason Street (between Columbus Avenue and Jefferson Street), on Powell Street (between Francisco and North Point Streets), and on Bay Street (between Powell and Mason Streets). The project is currently in the design phase, and construction is scheduled to begin in the spring of 2013.
- The North Shore Force Main Phase 2 project consists of providing approximately 3,500 linear-feet of redundant force main to the existing North Shore Force Main on Drumm Street, Spear Street and Howard Street. The North Shore Force Main conveys all of the dry weather flows and some wet weather flows from the North Shore urban watershed to the SEP via the Channel Transport/Storage Box and Channel Pump Station. On multiple occasions during the past five years, emergency repairs have been needed to fix breaks along this critical force main. The project provides redundancy for the section of the force main that is most susceptible to structural failure.
- The Sunnydale Auxiliary Sewer - Phase 2 project consists of 2,780 feet of new sewers intended to upgrade capacity in the Visitacion Valley neighborhood. The sewers scheduled for improvements are located immediately upstream of the Auxiliary Sunnydale Tunnel, which is currently under construction as part of Phase 1.

In addition to the projects of the WWE CIP, one collection system project has moved forward into the planning phase as part of the SSIP. The CBSIP addresses the lack of redundancy to the Channel Force Main, which conveys all flows from the North Shore and Channel urban watersheds to the SEP. The project is expected to include a large diameter tunnel connecting the Channel Drainage System to the SEP via a deep lift station near the plant's headworks. Consolidation or modification of existing satellite pump stations along the alignment will be evaluated as part of the project, as will connector tunnels to improve collection system performance within the Channel urban watershed. The results of the Urban Watershed Assessments are expected to inform the selection of the green and grey infrastructure improvement projects that will be implemented throughout the Channel urban watershed as part of CBSIP.

Wastewater Renewal and Replacement (R&R) Program

San Francisco's collection system is comprised of buried infrastructure assets of varying condition that were constructed at different times and with many different materials. An analysis of the system was undertaken to identify rehabilitation and replacement needs for the sewers based on age and condition. The CSAMP database combines background information (i.e., pipe length, condition, material, type, use, class, date installed, location, public safety) with visual inspection results where applicable to yield a risk score between 4 and 100 for each of 21,160 pipe segments. A risk score of 100 indicates the pipelines with the highest risk and highest priority for replacement. Table 2.12 below summarizes the amount of pipe of various risk scores within the urban watersheds, based on the CSAMP database as of October 30, 2012.

Table 2.12
Miles of Pipe per Risk Score Category
in the Bayside Drainage Basin

Urban Watershed	Risk Score					Total
	4 - 15	16 - 30	31-50	51-75	76-100	
Channel	82	17	21	37	16	174
Islais Creek	107	20	15	11	5	158
North Shore	40	5	8	10	4	68
Sunnydale	7	1	2	1	1	12
Yosemite	22	4	2	2	1	31
Total	258	48	49	62	27	443

The WWE Renewal and Replacement Program (R&R) is an ongoing annual program that seeks to address deficiencies in two wastewater infrastructure categories: R&R Collection System and R&R Treatment Facilities. Although the CSAMP database summarizes the condition of pipe segments, R&R projects are not solely determined based on CSAMP score. A comprehensive asset management approach used to determine pipe replacement priority also takes into account the Department of Public Work's street paving schedule and various other factors. The R&R Treatment Facilities projects are prioritized based upon regulatory compliance, condition assessments, Operation staff recommendations, and WWE Goals. Approximately 10-11 miles of structurally inadequate sewer mains were replaced throughout San Francisco this past fiscal year (FY 11-12) and the sewer replacement rate will increase to approximately 15 miles of main sewer replacement in FY 14-15 to meet WWE Goals (see Figure 2.38) (SFPUC 2012d; CSAMP Database, February 28, 2012).

Water Projects

The Local Water Supply Program is a $281 million dollar, multi-year CIP that was initiated under the Water System Improvement Program (WSIP) and transferred to the Water Enterprise CIP in 2011. The program includes five active projects that provide access to groundwater supplies for the potable system, deliver recycled water supplies for non-potable uses, and address water quality and water level issues. Four of the projects are located in the Westside Drainage Basin. The San Francisco Eastside Recycled Water project is the only project in the Bayside Drainage Basin and is in early planning stages with a tentative forecast of completion in 2017. The project would include a recycled water treatment facility (or facilities) and distribution system to produce and distribute tertiary recycled water to proposed non-potable water customers on the Bay side of the City (SFPUC 2012e).

As part of the Earthquake Safety and Emergency Response Bond that was passed by voters in June 2010, the SFPUC will be seismically upgrading the City's Emergency Firefighting Water System (also known as the Auxiliary Water Supply System or AWSS). The system delivers water at high pressure and includes two pump stations, two storage tanks, one reservoir, and approximately 135 miles of pipes. Additionally, the system includes 52 suction connections along the northeastern waterfront, which allow fire engines to pump water from San Francisco Bay, and two fireboats that supply seawater by pumping into any of the five manifolds connected to pipes. The system also includes approximately 200 cisterns, 1,600 hydrants and 3,900 valves.

Funding under the current bond measure to upgrade the Emergency Firefighting Water System is approximately $102.4 million. Of this, approximately $34.4 million will go toward upgrades to a reservoir, two tanks and two pump stations, while $36 million is dedicated to improvements to cisterns and $32 million to the system's pipelines and tunnels.

The installation of 16 new cisterns for fire protection is anticipated to begin by Summer 2013 in two Bayside neighborhoods - Bayview and Excelsior - and seven Westside neighborhoods - Merced Manor, Outer Sunset, Portola, St. Francis Wood, Richmond and Westwood Highlands. Installation of all 16 cisterns will not occur simultaneously, and it is anticipated that construction will last approximately four months per cistern location. The entire program is anticipated to be completed in 2018 (SFPUC 2012f).

The SFPUC Water Enterprise also maintains a water main repair and replacement program analogous to the Wastewater R&R program. The water and wastewater programs have been coordinating with each other as well as outside utilities via the Committee for Utility Liaison on Construction and Other Projects (CULCOP) to develop a method by which joint projects can be planned to prioritize highest risk pipes.

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

Figure 2.38: Collection System Asset Management Program

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

Early Implementation Green Infrastructure Projects

As part of the SSIP, the SFPUC is planning to implement one green infrastructure project in each of the city's eight urban watersheds. The projects are intended to be planned, designed, and constructed by the fall of 2015. The projects will incorporate a variety of green infrastructure technologies, thereby providing an opportunity to gather information regarding all aspects of green infrastructure implementation in San Francisco, from public outreach and environmental permitting requirements. In the spirit of the city's *Better Streets Plan* and as part of the agency's commitment to developing projects with multiple community benefits, the SFPUC has also developed a process to ensure that these green infrastructure projects will be coordinated with other city efforts and will maximize interagency project synergies where possible. As of Spring 2013, each preliminary project concept has been presented to the CCSF Interagency Streets Capital Group and has gone through a database and in-person meeting analysis (where applicable) to determine whether synergies or conflicts with other agency projects exist. The current project concepts will undergo a more rigorous site screening process prior to final project selection; however, the preliminarily identified projects are shown in Figure 2.39.

2.8.2 Area, Neighborhood, Community and Redevelopment Plans

Area, neighborhood, community, and redevelopment plans[38] within the Bayside Drainage Basin describe numerous proposed and planned projects that may have synergy opportunities with the SSIP. Although some of these plans have not yet been adopted and many of these projects do not yet have specific locations or implementation schedules, the plans provide an indication of which areas within the urban watersheds are likely to have project synergy opportunities in the near future. In addition, the plans provide information on the social, environmental, and economic concerns of local stakeholders. This data is valuable for identifying opportunities to implement SSIP projects that maximize Triple Bottom Line benefits. The SSIP SharePoint site includes a detailed review of the plans and summarizes the plan information relevant to identifying urban watershed needs and Triple Bottom Line opportunities. The area, neighborhood, community, and redevelopment plans located in the Bayside Drainage Basin are shown in Figure 2.40 and listed in Table 2.13.

[38] The Office of Community Investment and Infrastructure is the successor agency to the former San Francisco Redevelopment Agency.

Figure 2.39: Early Implementation Projects

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

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

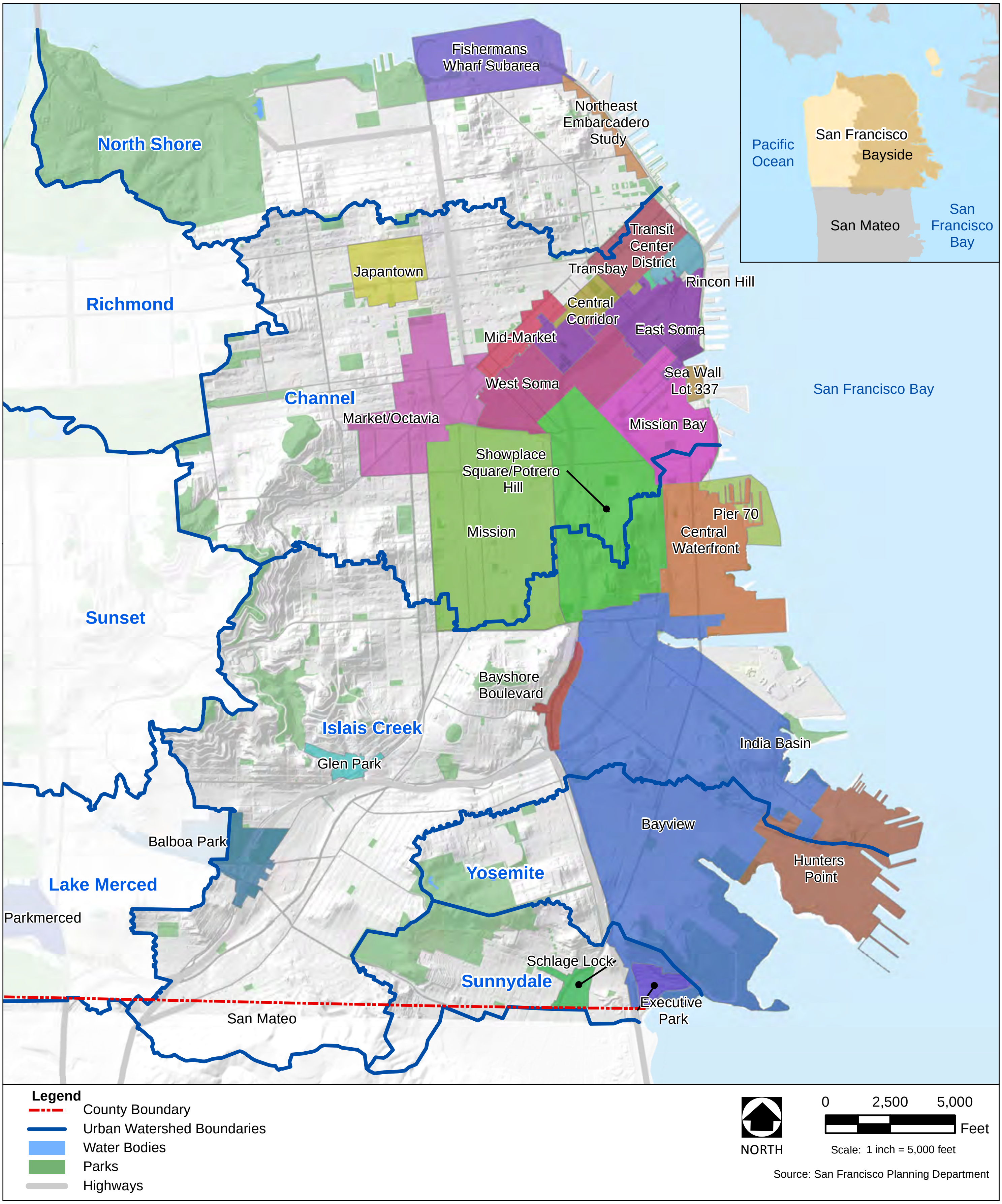


Figure 2.40: Area Plans and District-Scale Projects

Table 2.13
Area, Neighborhood, Community, and Redevelopment Plans
in the Bayside Drainage Basin

Plan Name	Urban Watershed(s)	Plan Status
Civic Center Area Plan	Channel	Adopted and incorporated into the *San Francisco General Plan* (from 1989)
Downtown Area Plan	Channel, North Shore	Adopted and incorporated into the *San Francisco General Plan* (from 1989)
Van Ness Area Plan	Channel, North Shore	Adopted and incorporated into the *San Francisco General Plan* (from 1995)
East SoMa Area Plan	Channel	Adopted and incorporated into the *San Francisco General Plan*
4th and King Railyard Study	Channel	Not yet adopted, plan in development
Market & Octavia Area Plan	Channel	Adopted and incorporated into the *San Francisco General Plan*
Mission Area Plan	Channel , Islais Creek	Adopted and incorporated into the *San Francisco General Plan*
Rincon Hill Area Plan	Channel	Adopted and incorporated into the *San Francisco General Plan*
Showplace/Potrero Area Plan	Channel , Islais Creek	Adopted and incorporated into the *San Francisco General Plan*
Japantown Better Neighborhoods Plan	Channel	Not yet adopted
Transit Center District Plan	Channel , North Shore	Not yet adopted; plan approved by the Planning Commission May 10, 2012
West SoMa Community Plan	Channel	Not yet adopted, currently undergoing environmental impact report (EIR) analysis
Better Market Street Existing Conditions & Best Practices	Channel , North Shore	Not yet adopted, plan in development
Central Corridor Public Realm Assessment	Channel	Not yet adopted, plan in development
Yerba Buena Street Life Plan	Channel	Plan completed in August 2011
Upper Market Community Plan	Channel	Not adopted; however, there is overlap with the adopted Market & Octavia Plan
Balboa Park Station Area Plan	Islais Creek, Lake Merced	Adopted and incorporated into the *San Francisco General Plan*
Bayview Hunters Point Area Plan	Islais Creek, Yosemite, Sunnydale	Adopted and incorporated into the *San Francisco General Plan*

Plan Name	Urban Watershed(s)	Plan Status
Central Waterfront Area Plan	Islais Creek	Adopted and incorporated into the *San Francisco General Plan*
Hunters Point Shipyard Area Plan	Islais Creek, Yosemite	Adopted and incorporated into the *San Francisco General Plan*
Glen Park Community Plan	Islais Creek	Recently adopted
Chinatown Area Plan	North Shore	Adopted and incorporated into the *San Francisco General Plan* (from 1995)
Northeastern Waterfront Area Plan	North Shore	Adopted and incorporated into the *San Francisco General Plan* (from 1998)
Fisherman's Wharf Public Realm Plan	North Shore	Construction on Jefferson Street between Hyde and Jones (Phase 1) is scheduled to begin in October 2012
Northeast Embarcadero Study	North Shore	Not yet adopted; the Planning Commission passed a Resolution supporting the study in July 2010
Candlestick Point Subarea Plan	Sunnydale, Yosemite	Adopted and incorporated into the *San Francisco General Plan*
Executive Park Subarea Plan	Sunnydale	Adopted and incorporated into the *San Francisco General Plan*

North Shore Urban Watershed

The principal redevelopment project moving forward in the North Shore urban watershed is the Central Subway Project. The project extends from the Caltrain station at 4th and King Streets in the Channel urban watershed, up 4th Street through Chinatown. The project consists of seven construction contracts: two utility relocations (nearly complete), tunneling (in construction), three underground station constructions (Chinatown is done and two are designed – all are located below the water table), and the Systems Contract (designed; construction in 2 to 3 years) which includes surface track on 4th Street and street level work around it affecting the entire corridor.

Channel Urban Watershed

Redevelopment plans that are moving forward within Channel urban watershed include: Mission Bay North and South (also located in the Islais Creek urban watershed), Rincon Point - South Beach, Transbay, and South of Market (Varat pers. com., 2012).

- The Mission Bay North and South Redevelopment Project covers 303 acres of land between the San Francisco Bay and I-280. It includes mixed-use, transit-oriented development with: 6,000 housing units, 4.4 million ft^2 of office/life science/biotechnology commercial space, a UCSF research campus containing 2.65 million ft^2 of building space on 43 acres of land, a UCSF hospital complex, 500,000 ft^2 of city and neighborhood-serving retail space, a

500-room hotel, A total of 41 acres of new public open space (including parks along Mission Creek and along the Bay, plus 8 acres of open space within the UCSF campus), a 500-student public school, a public library, fire and police stations, other community facilities, and utilities. This project is almost built out at this point.

- The Rincon Point - South Beach Redevelopment Project is a 115-acre project composed of two non-contiguous geographic areas along San Francisco's northeastern waterfront. Implementation of the project began in 1981 and project build out will include: 2,800 new mixed-income housing units, historical rehabilitation and commercial reuse of five buildings, two waterfront parks (about 2 acres between Howard and Harrison Streets and about 5 acres between Pier 40 and China Basin), development of a 700 berth marina, the use of Pier 40 for marina-related commercial development and public access, development of a corporate headquarters office building on Steuart Street between Howard and Folsom Streets, development of a 41,500 seat ballpark at China Basin for ballpark and complementary uses, reconstruction of the Embarcadero roadway into a boulevard including the realignment in two places to allow for the development of the waterfront parks, and the reconstruction of certain streets, including street surfacing, sidewalks, landscaping and utilities servicing properties within the project area. To date, 2,814 residential units and over 1.2 million ft^2 of commercial space have been constructed, and the 700-berth South Beach Harbor is fully occupied; completed publicly oriented facilities include South Beach Park at Pier 40, AT&T Park and Rincon Park. This project is almost built out at this point.
- The Transbay Redevelopment Project is approximately 40 acres and is roughly bounded by Mission Street in the north, Main Street in the east, Folsom Street in the south and Second Street in the west. The proposed project includes three major components, as summarized in Table 2.14: (1) A new Transbay Terminal at First and Mission Streets, (2) an underground extension of Caltrain from Fourth and Townsend Streets to the basement of the proposed new Transbay Terminal, (3) transit-oriented development. The concept plan includes high-density, transit-oriented residential development along Folsom Street and between and Beale Streets, as well as office and hotel space surrounding the new terminal. The concept plan also incorporates new public improvements, including a major new public park, new pedestrian-oriented alleyways and widened sidewalks. Portions of this project are moving forward, but the future of some portions of the redevelopment project (e.g., Caltrain extension) are still to be determined.

Table 2.14
Transbay Terminal Project Components

Project Name	Urban Watershed	Project Description	Project Timeline
Bus Storage Facility	Channel	Creation of off-peak bus storage facilities, as a part of the Transbay Transit Center project.	Completion scheduled in 2013

Project Name	Urban Watershed	Project Description	Project Timeline
Transbay Transit Center	Channel	The first phase will create a new five-story Transit Center with a 5.4-acre rooftop public park on the site of the former Transbay Terminal.	Completion scheduled in 2017
Downtown Rail Extension (DTX)	Channel	The DTX project plans to extend Caltrain to the new Transit Center, and would involve tunneling, cut and cover construction affecting the entire public right of way (along Townsend to Clarence Place and from Clementina to the Transit Center), and replacement of brick sewers perpendicular to 4th and 5th. Coordination with the Central Subway project will occur where the tracks cross.	The timeline is dependent on funding, and heavy construction would not begin before 2015

- The South of Market Redevelopment Project was originally adopted to repair damage caused by the 1989 Loma Prieta Earthquake. The project area is approximately 70 acres and is roughly bounded by Stevenson, Mission and Natoma streets in the north, Fifth Street in the east, Harrison Street in the south and Seventh Street in the west. The project's focus is the Sixth Street corridor, a mixed-use community located between Market and Harrison Streets. The remainder of the Project Area consists mainly of a combination of older residential and commercial buildings, as well as the new Bessie Carmichael School and new Victoria Manalo Draves Park. The redevelopment program includes affordable housing, including facilitating the development of new affordable housing and rehabilitating existing housing; it also includes planning, economic development, community services, public infrastructure, and community outreach. This project is not under contractual obligation and future implementation is still to be determined.

<u>Islais Creek Urban Watershed</u>

Redevelopment plans within the Islais Creek urban watershed include: Mission Bay North and South (also located in the Channel urban watershed), Bayview Industrial Triangle, Hunters Point Shipyard (also located in the Yosemite urban watershed), Bayview Hunters Point Area B Project (also located in the Yosemite urban watershed), and India Basin/Hunters Point Shoreline.

- The Bayview Industrial Triangle Project includes a total of 20.3 acres. Plan objectives include: preservation and expansion of existing industries by means of voluntary rehabilitation, improvement of the Third Street frontage, acquisition of vacant and under-developed land and removal of structurally substandard buildings not feasible for rehabilitation to provide space for new industrial and commercial development, relocation and rehabilitation of residential structures from the industrial area, provision of off-street parking. This project is almost built out at this point.

- The Hunters Point Shipyard Project encompasses a 500-acre site in both Islais Creek and Yosemite urban watersheds. Phase 1 would include 1,600 housing units, 26 acres of open space, 10,000 ft^2 of commercial space, and would set aside land for the development of community facilities. Phase 2 would occur both at the Shipyard as well as Candlestick Point and would include 10,500 housing units, over 300 acres of parks and open space including a complete renovation of the Candlestick Point State Recreation area, approximately 125,000 $ft^2$of neighborhood-serving retail, approximately 3 million ft^2 of "clean" technology research and development space, a clean tech business incubator and the headquarters for the UN Global Compact Sustainability Center located in Building 813 on the Shipyard, permanent new and renovated space for the existing Shipyard artists, rebuilding the Alice Griffith public housing development, approximately 675,000 ft^2 of regional and neighborhood-serving retail on CP and a 150,000 ft^2 (220 room) hotel on CP.
- The Bayview Hunters Point Area B Project is located in both the Islais Creek and Yosemite urban watersheds and encompasses 1,361 acres. It includes portions of the South Basin, Bret Harte/Double Rock and Town Center areas in Bayview Hunters Point and the Third Street corridor runs through the center. Candlestick Stadium and the Candlestick State Recreation Area are located in the southern portion of Project Area B. The redevelopment plan includes creating new affordable and mixed income housing, furthering economic development, creating jobs, addressing environmental problems, providing open space, fostering cultural development, and improving the physical environment and transportation systems. This redevelopment plan is not under contractual obligation and its future implementation is still to be determined.
- The India Basin/Hunters Point Shoreline area is 76 acres. The goal of the planning process for this area is to shape land use regulations, design guidelines and a community benefits program for the shoreline area that will inform an amendment to the *Bayview Hunters Point Redevelopment Plan*. The plan includes new mixed-use development along Innes Avenue, water-oriented and recreational activities, better integration of the Housing Authority development on Hunters Point Hill, and improved waterfront access. An NOP of an EIR for this program was issued in 2010.

<u>Sunnydale Urban Watershed</u>

The *Visitacion Valley Redevelopment Plan* (draft December 2008) is located within Sunnydale urban watershed.

- The Visitacion Valley project area is 46-acres comprising approximately 124 parcels. The Project Area includes the former Schlage Lock industrial site and the Visitacion Valley neighborhood's commercial corridor of Leland Avenue. The project involves the demolition of the majority of the existing vacant buildings on the former Schlage Lock site, environmental remediation of the site, and the construction of a mixed-use residential, retail and office development. The project involves up to 1,250 new housing units and up to 90,000 ft^2 of retail, including a grocery store. This project would create new pedestrian scaled public streets, three new parks, a community center at the Old Office Building, and new infrastructure improvements. Although the City Board of Supervisors adopted the redevelopment plan in 2009 and made associated amendments to the *San Francisco General Plan*, this redevelopment plan is not under contractual obligation and its future implementation is still to be determined. The *Final Draft Visitacion Valley Redevelopment Area Zone 1 (Schlage Lock Plan Area) Open Space and Streetscape Master Plan* was completed in November 2010.

<u>Yosemite Urban Watershed</u>

Redevelopment plans within Yosemite urban watershed include: Hunters Point Shipyard Project and Bayview Hunters Point Area B Project which are described previously for the Islais Creek urban watershed.

Eco-Districts

In 2012, the Planning Department began introducing the eco-district concept to the City's most rapidly growing neighborhoods rich with transit, employment, and housing options. The Planning Department defines eco-districts as neighborhoods that scale public-private partnerships in ways that strengthen the economy while creating a stronger sense of place. Eco-districts are inherently resilient and efficient because they are self-sustaining and independent from larger regional systems. A primary goal of the Planning Department's program is to facilitate the implementation of sustainable infrastructure systems by coordinating private development and public improvements through community engagement.

With investment from the City, private partners, and state and federal agencies, the Planning Department is currently examining the policies and infrastructure requirements of building eco-districts into our urban fabric. To date, almost $1 million in funding and resources have been dedicated to supporting eco-district work. For the past year, the USEPA Sustainable Growth Implementation Assistance program has been analyzing scenarios for energy systems in eco-districts. The City was also just awarded funding through the California Energy Commission's Public Interest Energy Research Program to continue researching eco-district energy systems.

As members of the eco-district interagency team, SFPUC staff has been actively engaged in the process. SFPUC staff has reviewed and commented on several eco-district deliverables, including the Central Corridor Eco-District Program Framework. Working with AECOM, SFPUC staff examined district-scale water management systems from all over the world to understand project drivers, scale, reuse alternatives implemented, and most importantly, information on how the local public utility interacts or interfaces with the district-scale effort.

SFPUC staff is also analyzing the regulations around pooling and/or sharing non-potable water resources across property lines and the public right of way. SFPUC staff will continue to evaluate the challenges, drivers and viability of district-scale water reuse within the City to identify policies and programs that best meet SFPUC's goals.

2.8.3 Streetscape Projects

Utility Excavation and Paving 5 Year Plan

All planned projects in San Francisco that will occur within the street right-of-way and that have funding are contained in the city's Utility Excavation and Paving 5 Year Plan database. The Planning Projects Module of the database includes information for similar projects that are planned but have not yet received funding. Three criteria were used to identify projects within the database for possible synergy opportunities with the Urban Watershed Assessment:

1. The length of the project is at least two linear blocks.
2. The project end date is 2014 or later (i.e., project timeframe lines up with possible implementation of projects as part of the SSIP).
3. The following private utilities were excluded from the search: Comcast, Newstand, PacBell, and PG&E.

Many of the paving projects listed in the Utility Excavation and Paving database involve typical repaving (i.e., grind and pave) from curb to curb. Some paving projects may also involve work in the sidewalks, ADA upgrades (ramps), and localized base repairs. Some of these types of projects were not viewed as the strongest potential synergies because the proposed work is not as extensive as would be required for SSIP projects. An example of these projects includes the sidewalk ramp ADA retrofits that are occurring throughout the City. These were excluded because the limits of work for ramp retrofit are relatively small; however they are represented in the database as occurring at a majority of intersections.

Streetscape projects that may provide project synergy opportunities are described in Table 2.15 and depicted in Figure 2.41.

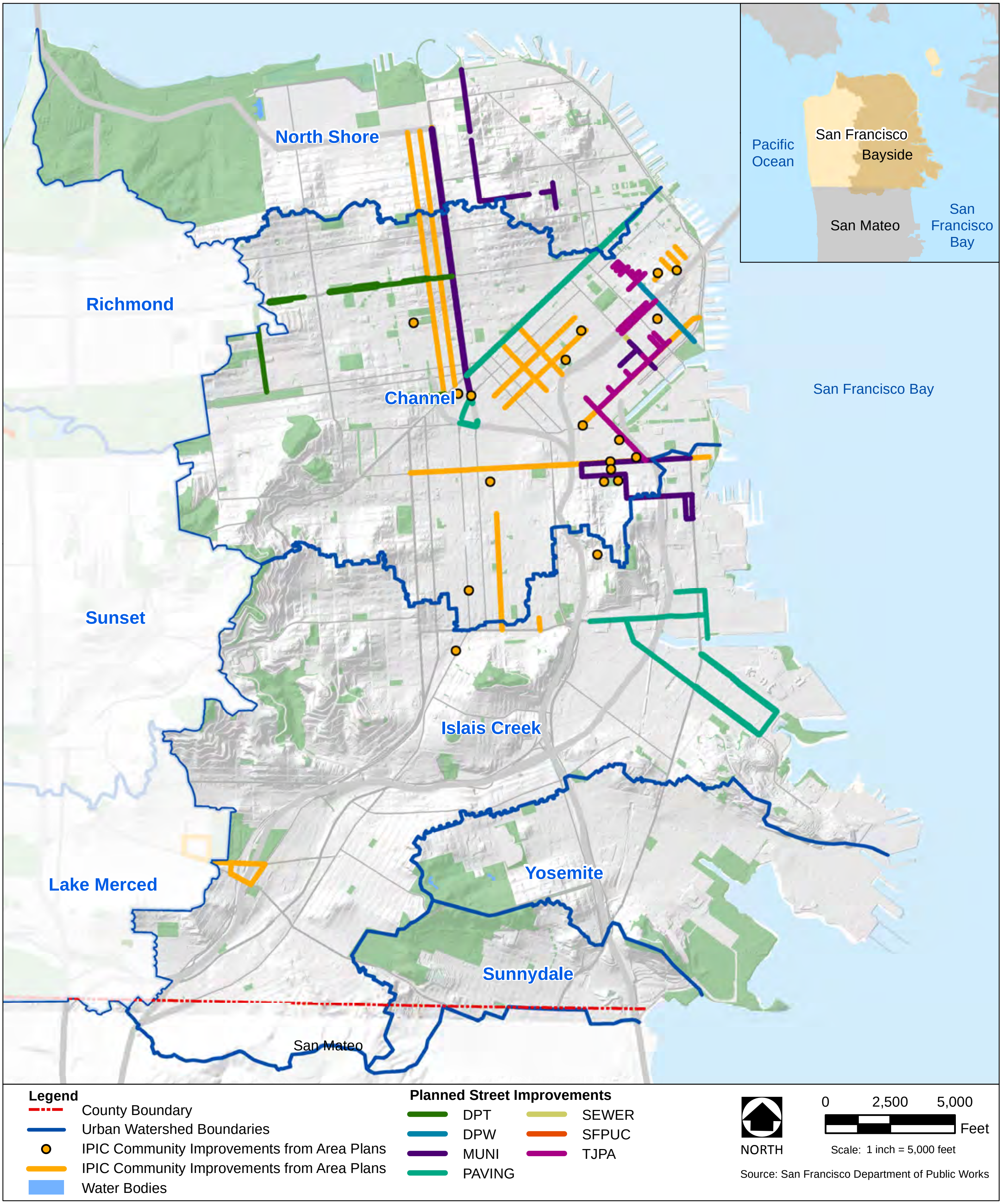


Figure 2.41: Streetscape Projects with Potential Synergy Opportunities

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

Table 2.15
Bayside Drainage Basin Streetscape Projects with Potential Synergy Opportunities

Project Name	Urban Watershed(s)	Project Description	Project Timeline
Haight Street Transit and Pedestrian Improvements	Channel	Convert the lower portion of Haight Street (Octavia to Market westbound) into a two way street. May involve digging/repaving (unknown at this time).	Estimated to begin 7/1/2013 and be completed by 12/1/2014
Van Ness BRT/ Repaving (aka New State Route and SFGO VAN NESS FIBER)	Channel, North Shore	Three alternatives for street improvements (potentially from Mission to Lombard Streets) are being considered. All poles in the sidewalk will be replaced, some sidewalks widened with bulbouts, and curb ramps added, but the majority of work is in the street. Also includes utility replacements/upgrades and a landscaping element.	Estimated to begin 12/18/2015 and be completed by 12/21/2017
Masonic Streetscape	Channel, Richmond	The "Boulevard" option is being progressed and would include median and street trees, sidewalk landscaping, and pervious paving at bus bulbouts between Fell and Geary. The project is currently undergoing environmental review, with construction as soon as 2013.	Estimated to begin 6/1/2013 and be completed by 12/1/2014
SFGO GEARY FIBER	Channel	This is a distant plan project which would upgrade traffic signal infrastructure. Construction is primarily within the sidewalk area, with work in the street no deeper than 24 inches below the surface.	Estimated to begin 2/1/2014 and be completed by 2/1/2015

Project Name	Urban Watershed(s)	Project Description	Project Timeline
Great Streets - 2nd Street	Channel	Scope includes new street trees along 2nd Street between King and Market Streets, a bulbout and pedestrian refuge space at South Park Avenue, and expansion of an existing pedestrian refuge at Harrison Street. The project also includes roadway resurfacing, curb and ramp reconstruction, and upgrades to the traffic signal system.	Estimated to begin 7/1/2014 and be completed by 8/30/2015
Underground Feeder Project	Channel, Islais Creek	The project would involve street excavation and would probably also include some streetscape work. The project extends from 16th Street at Kansas to 3rd Street at 20th.	Estimated to begin 7/1/2015 and be completed by 6/30/2016
16th Street Pole Extension Project (Kansas to Connecticut)	Channel, Islais Creek	Project is under development, with potential for full street reconstruction and reconfiguration. Upgrades include widened sidewalks (at least 6 feet wider), landscaping (generally limited to street trees), and utility work within the street and overhead. Note that the corridor is targeted in the Eastern Neighborhoods Transportation Implementation Planning Study (EN TRIPS).	Estimated to begin 7/1/2013 and be completed by 1/1/2018
Better Market Street Project (1603J)	Channel, North Shore	This project, between Octavia Boulevard and The Embarcadero, is in the planning phase; it could include complete utility relocation and facility rehabilitation or a simple 'retrofit' with only minor targeted changes. One goal is to revitalize Market Street into a destination, and the project could include new open space, living alleys, permeable pavers, subsurface water storage, and green landscaping.	Construction is tentatively scheduled to begin in 2014/15

Project Name	Urban Watershed(s)	Project Description	Project Timeline
BTIP Phase Segments A & G	Islais Creek	Roadway improvements for segments A & G (Cesar Chavez, etc), currently in the planning/environmental stage, include improving intersections, some streetscaping, and new street lights. Project work would mostly be from curb to curb, though work may include some sidewalk widening, narrowing, or bulbing.	Phase A: Estimated to begin 7/1/2013 and be completed by 7/1/2015 Phase G: Estimated to begin 3/1/2015 and be completed by 2/28/2018
Hyde Street Cable Car Infrastructure Improvement	North Shore	The project will include utility upgrades, installation of catch basins and drainage pipes, and rail improvements. There will be excavation between tracks and along streets. Construction will occur on Hyde Street from Washington Street to Victorian Park and on Washington between Mason and Hyde Streets.	Estimated to begin 9/1/2013 and be completed by 12/31/2014
Central Subway 4th Street Surface Track (1424J-7)	Channel	This portion of the Central Subway project, building surface track on 4th between Bryant and King, has not been finalized. A portion of the sewer pipe may be replaced during this process.	Estimated to begin 2/1/2013 and be completed by 6/1/2017

Source: SFDPW Utility Excavation and Paving 5 Year Plan project database.

Streetscape Projects Proposed in Area Plans

The Planning Department's Plan Implementation Group helps to turn the visions from the City's recently-adopted area plans into built projects. The Interagency Plan Implementation Committee (IPIC) is chaired by the Planning Department and includes representatives from the Municipal Transportation Agency (MTA), SFDPW, San Francisco Recreation and Parks Department (SFRPD), San Francisco County Transportation Authority (SFCTA), the Library, the Department of Children, Youth and their Families (DCYFS), and Capital Planning Committee, among other agencies. Area plan policies are often accompanied by implementing planning code and zoning map legislation and a "Community Improvements Program," which identifies transportation, open space, recreational, and public realm amenities planned for the area over a 20-year period. The IPIC is tasked with ensuring the implementation of the Community Improvements Programs.

The most recent IPIC Annual Report (January 19, 2012) summarizes progress that has been made towards implementation of community improvements in several adopted area plans (San Francisco Planning Department 2012; Varat pers. com., 2012). All projects scheduled for completion prior to January 1, 2014 have been omitted from this summary. In addition, projects that do not apparently include construction (e.g., a circulation study that would result in traffic improvements through a shift of trips to transit) have also been excluded. Some of the projects listed below may overlap with those included in the Utility Excavation and Paving 5 Year Plan.

<u>North Shore Urban Watershed</u>

The Chinatown Broadway Street Design project will develop a community-based vision to improve pedestrian conditions along Broadway from Columbus Avenue to the Broadway Tunnel. Broadway is currently a major four-lane arterial road. This project envisions transforming this street from an auto-centric corridor to a more vibrant multi-modal street that can be enjoyed by all users.

- *Rincon Hill Area Plan*

  A number of the streetscape improvements: Lansing Street, Main and Beale (Folsom to Harrison), Fremont Street (east side, Folsom to Harrison), Fremont Street (west side, Folsom to Harrison) proposed by the Rincon Hill plan have a clear relationship to specific entitled development projects and therefore could be implemented through in-kind agreements with project sponsors, subject to approval by the Planning Commission.

- *Market and Octavia Area Plan*

  A number of infrastructure projects have been completed in preparation for the area's 6,000 new residents, including the signature Octavia Boulevard project. Ongoing infrastructure projects include:

- The Haight and Market Streets transit and pedestrian project (which includes the Haight Street Transit and Pedestrian Improvements Project listed in Table 2.15) was identified by the *Market and Octavia Plan* and the Transit Effectiveness Project (TEP), as a key transit improvement. The project will return the Haight Street buses to Haight Street between Octavia and Market streets, add pedestrian signals and pedestrian bulb-outs, and enhance the crosswalks at the Market and Haight intersection. The project is currently undergoing environmental review and advanced engineering. Construction is anticipated to start in 2014. This project is funded mostly through an MTA and Planning secured a TLC grant, Prop K funds, and impact fee funds.
- Van Ness Bus Rapid Transit (BRT) Project. The project includes a package of treatments that provide rapid, reliable transit, including dedicated bus lanes, high-quality stations, and related pedestrian amenities. The project's Draft Environmental Impact Statement (EIS)/EIR has been completed and project completion could be as early as 2016. Impact fee funds are forecasted to complete streetscape and pedestrian amenities along the Franklin and Gough Streets corridor, and greening at the Mission and Van Ness intersection.
- The Market and Octavia Community Opportunities Program will be modeled after the SFRPD’s existing Community Opportunities program, encouraging community members to propose improvements to parks in their area.
- The Market and Octavia Street Tree Planting Program will fund community maintained street trees in the plan area, similar to the existing programs managed by Friends of the Urban Forest.
- The Market and Octavia Living Alleyway Program will fund a matching program for living alleyways in the plan area.

▪ *Eastern Neighborhoods Area Plan*: East SoMa, Showplace Square/Potrero and Mission

The *Eastern Neighborhoods Area Plans*, adopted in early 2009, enable an additional 10,000 units of housing and 10,000 new jobs. No development projects have been completed since plan adoption, however a number have been entitled by the Planning Department. Roughly 60 development projects are in the approval pipeline. Priority projects have been identified as:

- Townsend Street pedestrian improvements, (assumed Embarcadero to Division from *Showplace Square/Potrero Area Plan* map)
- 16th Street Pole Extension Project/Streetscape Improvements, (assumed Illinois to Dolores from *Showplace Square/Potrero Area Plan* map)

- SoMa alley improvements in association with the development project at 900 Folsom Street (exact location unknown)

The Eastern Neighborhoods Transportation Implementation Planning Study (EN TRIPS) seeks to implement the transportation vision established in the *Eastern Neighborhoods Area Plans*. The final EN TRIPS Report (SFMTA 2011) includes a series of detailed designs, funding and implementation strategies focused on the following corridors:

- 16th Street (EN TRIPS priority segment from Mississippi Street to Potrero Avenue)
- Folsom Street (EN TRIPS priority segment from 5th Street to 11th Street)
- Howard Street (EN TRIPS priority segment from 5th Street to 11th Street)
- 7th Street and 8th Street (EN TRIPS priority segment from Market Street to Harrison Street)

The *Mission Streetscape Plan* was adopted in the spring of 2010. The Plan includes an overall design framework to improve pedestrian safety and comfort, increase the amount of usable public space in the neighborhood, and support environmentally-sustainable stormwater management. The project includes 28 specific designs for locations throughout the neighborhood; several of these projects have secured funding (outside of the EN impact fee funds) and are currently undergoing implementation (San Francisco Planning Department 2012):

- Pedestrian amenities and plaza upgrade at the 24th Street Bart Station. Design and engineering are underway.
- Folsom Street (19th to Cesar Chavez) road diet (i.e., lane reduction) is partially funded for implementation. Design and engineering are underway.

<u>Islais Creek Urban Watershed</u>

The *Balboa Park Station Area Plan* was adopted in the spring of 2009. The plan calls for a number of major transportation and public realm infrastructure improvements and 1,780 new housing units. Ongoing planning efforts are underway to identify transportation improvements around the Balboa Park Station.

Cesar Chavez East Community Design Plan is located on Cesar Chavez between Illinois Street and Hampshire Street. The mission of this Plan is to develop a community-based concept design for the Highway 101 interchange and the East Cesar Chavez corridor that promotes safety, comfort and accessibility to all.

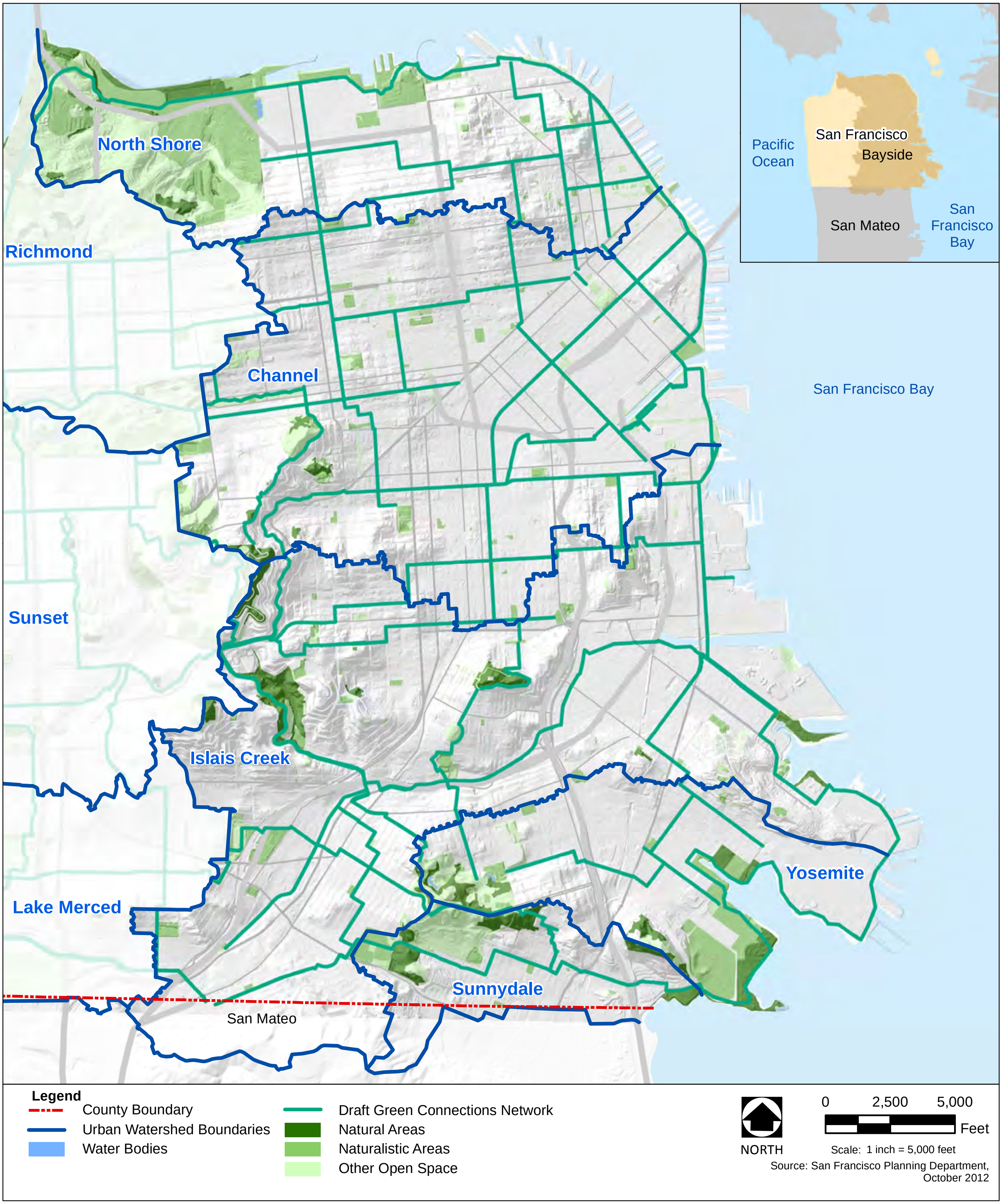
Green Connections

In addition to the streetscape projects described in the preceding table, the San Francisco Planning Department is in the process of developing a "Green

Connections" street network. Green Connections are special streets and paths that connect people and wildlife to parks and open spaces. These streets provide opportunities for greening and landscaping; enhancing wildlife habitat; managing stormwater; and calming traffic. The Planning Department has developed a draft network of streets, shown in Figure 2.42. The Urban Watershed Assessments Opportunities Analysis will evaluate potential synergies between the currently proposed Green Connections network configuration and SSIP challenges. Moreover, the Planning Department has indicated that the Urban Watershed Assessments may recommend modifications to the Green Connections network to better match areas of challenges identified in the Urban Watershed Characterization needs analysis.

2.8.4 Recreation and Parks

Ongoing park maintenance programs may have synergy opportunities with stormwater management. Capital projects within the 2008 Clean and Safe Neighborhood Parks Bond will all be completed by 2014 with the exception of the Mission Dolores Park Renovation, which has an estimated completion date in early 2014. The 2012 Clean and Safe Neighborhood Parks Bond (approved by the voters on November 6, 2012) includes 15 neighborhood capital projects, three citywide park projects, six waterfront park projects, as well as funding for citywide (unnamed) community driven parks improvements, playground repairs, forestry, trails, and water conservation (summarized in Table 2.16) (SFRPD and Port 2012).



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

Figure 2.42: Draft Green Connections Network

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

Table 2.16
Park Projects with
Potential Synergy Opportunities

Project Name	Urban Watershed(s)	Project Description	Expected Completion
Neighborhood Parks			
Mission Dolores Park Renovation	Channel	Replace playground, rehabilitate various park elements (design pending final approval)	2014
Garfield Square	Channel	Renovate the pool, reconfigure park facilities, and improve park access	2017
Hyde & Turk Mini Park	Channel	Renovate children's play area, landscaping and related amenities, and improve park access	2018
Margaret S. Hayward Playground	Channel	Replace park play structures, replace sports courts, upgrade playfields, and improve access	2018
Potrero Hill Recreation Center	Islais Creek; Channel	Replace and renovate natural turf playfields and dog play area	2018
South Park	Channel	Renovate children's play area, landscaping and related amenities, and improve park access	2018
Balboa Park	Islais Creek	Renovate pool, pool building and related amenities and improve park access	2016
George Christopher Playground	Islais Creek	Replace children's play area, restrooms, and improve park access	2018
Glen Canyon Park	Islais Creek	Renovate existing recreation center and related amenities	2016
Joe DiMaggio Playground	North Shore	Reorganize and renovate children's play area, courts, access, and related amenities	2016
Moscone Recreation Center	North Shore	Replace children’s play area on the east side	2017
Willie "Woo Woo" Wong Playground	North Shore	Renovate site facilities, restore sports courts, replace playground, and improve park access	2018

Project Name	Urban Watershed(s)	Project Description	Expected Completion
Gilman Playground	Yosemite	Replace children's play area, restrooms, and improve park access	2016
Citywide Serving Parks			
John McLaren Park	Islais Creek; Sunnydale; Yosemite	Fund improvements to park	Unknown
Waterfront Parks			
Agua Vista Park	Islais Creek	Renovated and connected shoreline access with walking, biking, and view areas	2015
Pier 70 Open Space Sites	Islais Creek	Shoreline restoration, environmental remediation, landscaping, new public access	2015
Warm Water Cove Park	Islais Creek	Renovate and expand park, with improvements to park access and amenities	2015
Islais Creek Improvements	Islais Creek	Construct new public access with walkway and scenic lookouts	2015
Pier 43 Plaza	North Shore	New public plaza adjacent to Pier 43 Trail Promenade	2016
Northeast Wharf Plaza & Pier 27/29	North Shore	Construct new 2.7 acre park with large lawn and view areas	2015

Source: SFRPD and Port 2012.

In addition to the projects listed in the previous table, area plans have recommended park projects at the following locations:

North Shore

- Ongoing Open Space Project: Guy Place Park, located on Guy Place adjacent to First Street. As revenue becomes available, it will be used to develop the park.
- Ongoing Open Space Project: The 333 Harrison Street development coordinated with the City to create a public park on one third of their lot, as called for in the *Rincon Hill Area Plan*. The City will continue to work with the project sponsor towards the development and implementation of this park.

Channel

- A renovation of Hayward Park is proposed in coordination with the next Park and Open Space Bond. The exact scope of improvements is unknown.
- Brady Park (proposed for construction by the *Market and Octavia Plan*) is planned to be built in coordination with redevelopment of the surrounding lots
- Victoria Manalo Drave Park Pedestrian Improvements
- 17th Street between Folsom Street/Shotwell Park
- *Showplace Square Open Space Plan* and open space (located in various places, including somewhere between 15th Street, Channel Street, 7th Street, Brannan Street, and Highway 101/I-80). Potential open space sites include:
    - Widening of Jackson Playground on Arkansas and/or Carolina Streets
    - Wisconsin Street right-of-way (located in Islais Creek urban watershed)
    - Hooper Street right-of-way
    - Daggett Street right-of-way
    - Norcal Triangle Site
    - Townsend Circle right-of-way
    - Wolfe's Café Site (8th Street right-of-way), intersection of 16th, Wisconsin, and Irwin Streets
- New park at Daggett triangle, between 7th, 16th, and Hubbell Streets

2.8.5 Schools

Proposition A (2011) authorized up to $531 million in bonds to fund seismic upgrades and repairs to 53 school buildings. The San Francisco Unified School District (SFUSD) anticipates initial design work for 2011 Proposition A projects started in March 2012 and completion of all projects within six years. Education Outside (formerly the Green Schoolyard Alliance) promotes and supports green schoolyards and is funded by money from the Proposition A bond measure. All elementary schools and 10 middle and high schools in SFUSD have received or will receive $100,000-$150,000 to green their schoolyards. The green schoolyard projects will generally feature improvements such as pavement removal, site grading, irrigation and plumbing systems, installation of equipment, and installation of hardscape and landscaping.

The SFUSD website includes a list of current RFPs, RFQs, and invitations for Bids. Projects are as shown in Table 2.17.

Table 2.17
Bayside Drainage Basin School Projects with Potential Synergy Opportunities

School	Urban Watershed	Project
Chinese Immersion School	Channel	Green Schoolyard Project
Grattan Elementary School	Channel	Green Schoolyard Project
John Muir Elementary School	Channel	Green Schoolyard Project
Dr. William Cobb Elementary School	Channel	Green Schoolyard Project
Willie L. Brown, Jr. Middle School	Islais Creek	Replace the existing school with a new school, on the same site
Guadalupe Elementary School	Islais Creek	Green Schoolyard Project
Glen Park Elementary School	Islais Creek	Green Schoolyard Project
Cleveland Elementary School	Islais Creek	Green Schoolyard Project
Sunnyside Elementary School	Islais Creek	Sitework for placement of new relocatable classroom buildings
Fairmont Elementary School	Islais Creek	Green Schoolyard Project
Spring Valley Elementary School	North Shore	Green Schoolyard Project
Chinese Education Center	North Shore	Green Schoolyard Project
Marina Middle School	North Shore	Resurfacing deteriorating pavement surfaces
Claire Lilienthal Elementary School	North Shore	Green Schoolyard Project
George Washington Carver Elementary	Yosemite	Green Schoolyard Project

Sources: SFPSD 2013; Educate Outside 2012.

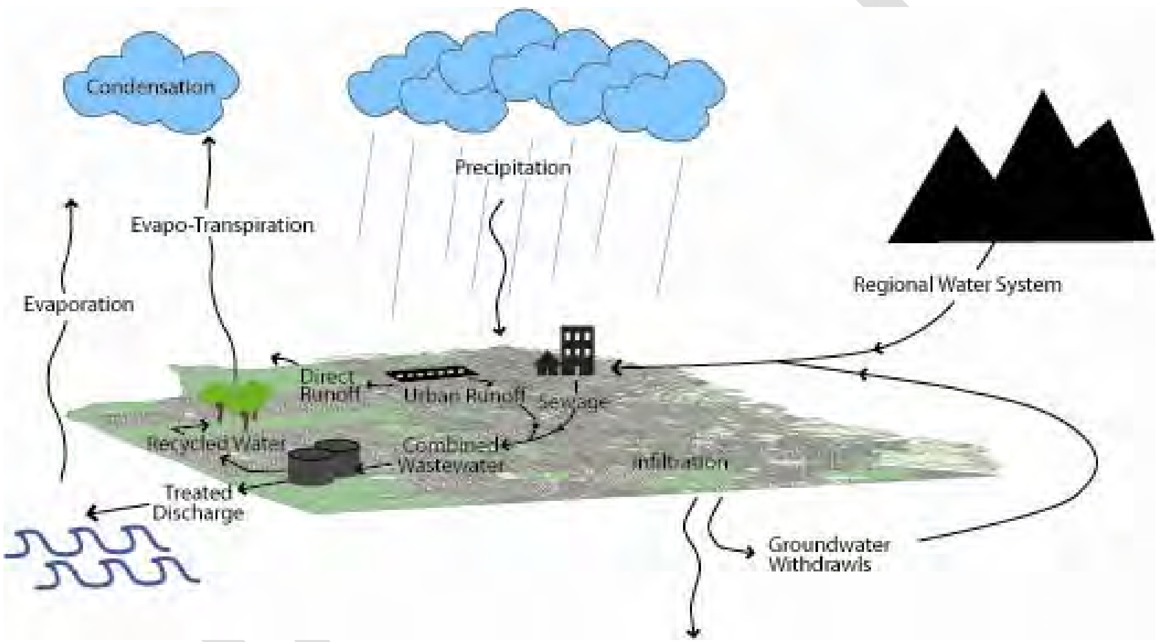
2.9 Urban Water Balance

This section describes and quantifies the water balance in the Bayside Drainage Basin. The spatial and temporal identification of sources, demands, and excess water will ultimately inform the identification of projects and project types that meet system needs, particularly those that influence the hydrologic cycle and the water balance in San Francisco, such as green infrastructure and water reuse. Data from the *2010 Urban Water Management Plan*, as well as SFPUC groundwater and recycled water reports (SFPUC 2010b, 2011f, 2011d, and 2012b), were analyzed with the City and County of San Francisco Hydrologic and Hydraulic Model (CCSF H&H Model) and a Storm Water Management (SWMM) Model.

2.9.1 Introduction

The urban hydrologic system in San Francisco is a network of natural hydrologic cycle components, supplied sources, municipal water demands, wastewater production, and treated effluent discharges, as shown in Figure 2.43. These components are quantified and included in the San Francisco urban water balance to help define existing conditions as part of the Urban Watershed Characterization subtask. The purpose of compiling the water balance is to quantify the flow of water, both naturally occurring and imported, through the City as a means to help inform the Opportunities phase of the Urban Watershed Assessment. Specifically, identifying where sources, demands, and excess water occur spatially and temporally across the city will help the Urban Watershed Assessment Team match areas of need with areas of opportunity. This will enable the team to identify appropriate locations to employ four basic management strategies: 1) runoff reduction, 2) increased conveyance, 3) increased storage, 4) increased pumping and treatment. The water balance addresses only CSS service areas, and not MS4 service areas since those pipe systems drain directly to the ocean or Bay.

Figure 2.43
Conceptual Diagram of San Francisco's Urban Hydrologic System



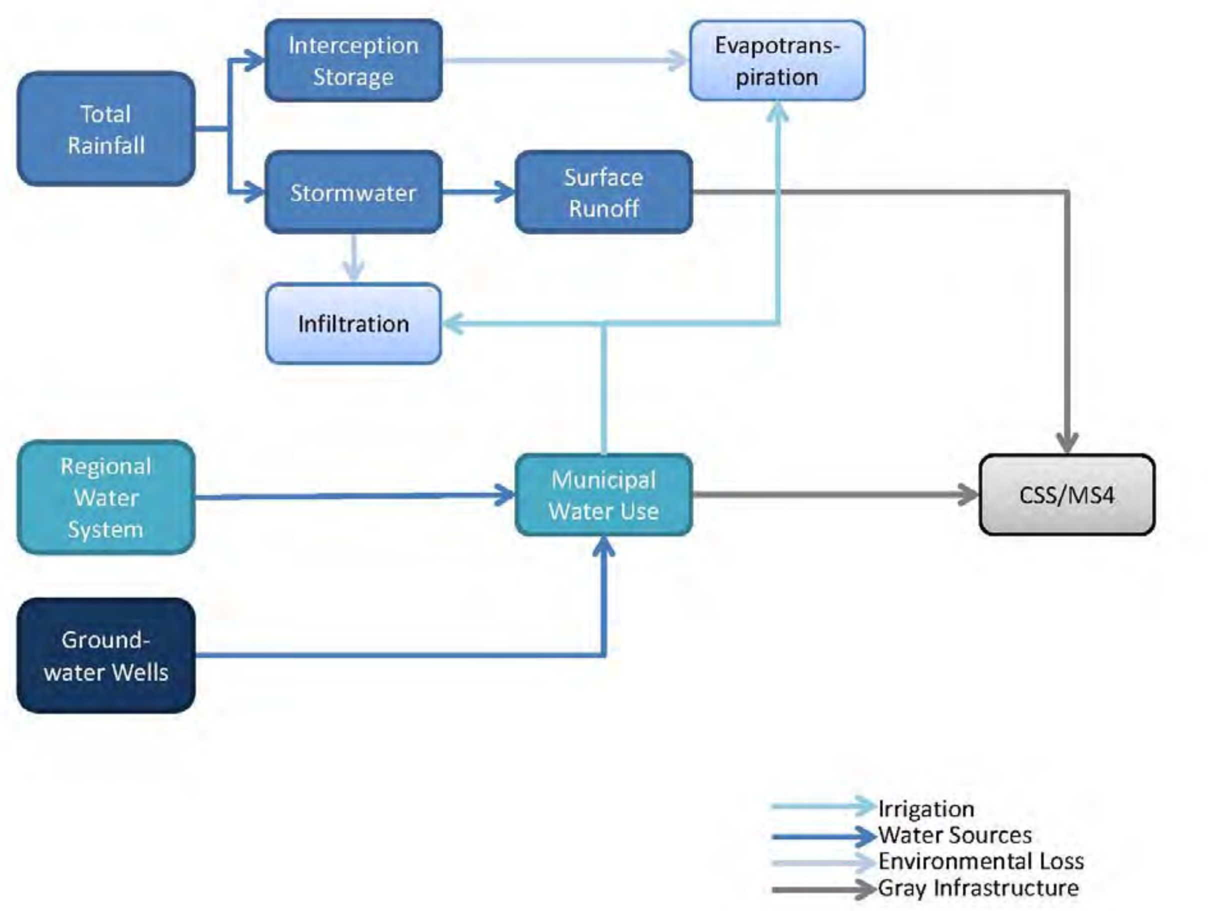
2.9.2 Methodology

A water balance is essentially a mass balance wherein the sum of all sources should be equal to the sum of all sinks, assuming there are no significant changes to the total storage volume in the system over the course of an average year. Annual volume in million gallons per year (MG/yr) was selected as the standard unit of measure. However, there is significant seasonal variation due to the prevailing Mediterranean climate in the Bay Area. Hence, data were analyzed on a monthly basis to track those seasonal variations.

The process of constructing the water balance involved identifying all significant contributing hydrologic components, then compiling the best available data to represent each of those components. The water balance tracks each significant source to its fate leaving the city, either as stormwater lost through environmental processes or as effluent discharged by the City's wastewater treatment system.

Analysis of the intermediate steps provides valuable insight into where various stormwater and wastewater management strategies can be most effective. Figure 2.44 shows the predominant flow paths for water traveling through the Bayside Drainage Basin.

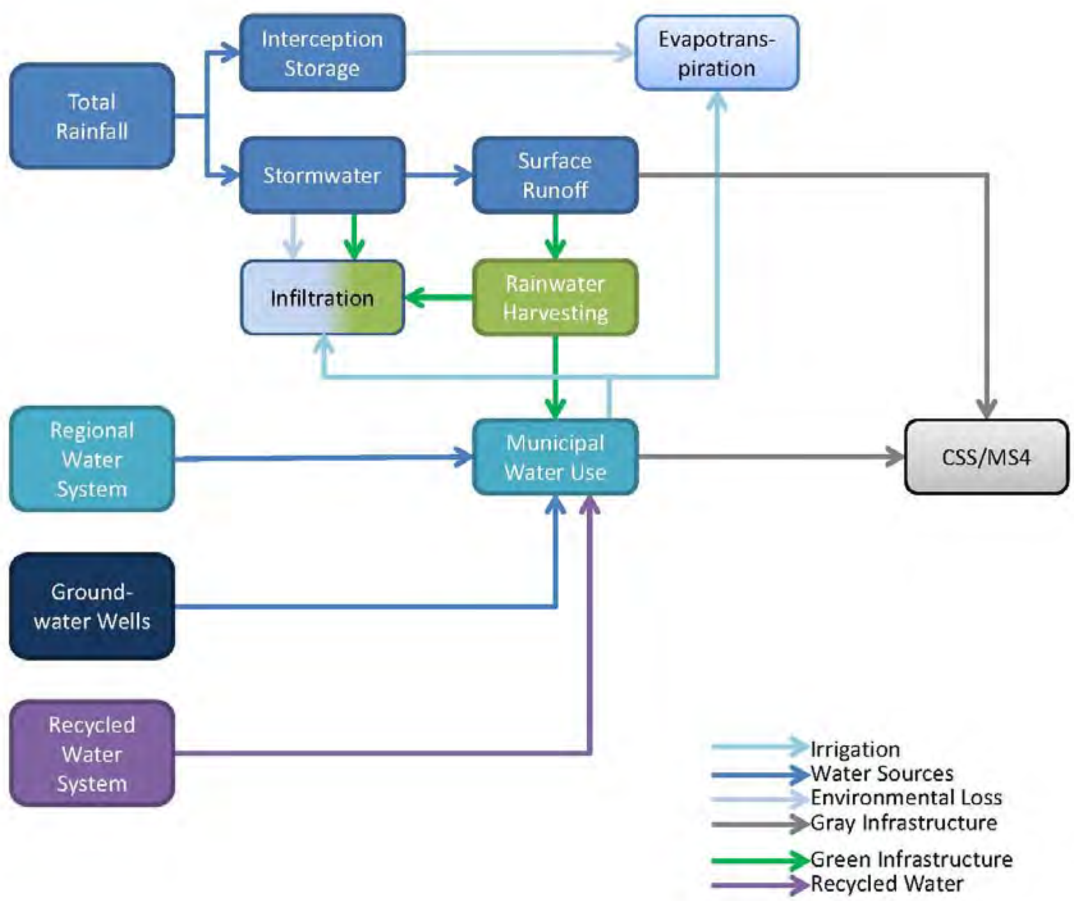
Figure 2.44
Predominant Existing Hydrologic Flow Paths
in the Bayside Drainage Basin



Additional water balances will be developed in the Urban Watershed Assessments Opportunities Analysis. These analyses will represent possible alternative future conditions accounting for implementation of different packages of additional stormwater and wastewater management strategies. Some management strategies are already in their implementation phase, such as stormwater management facilities resulting from the Stormwater Design Guidelines (SDG) requirements. Others are pending implementation, such as the suite of recommended projects that will result from the Urban Watershed Assessment process. Strategies currently implemented at a small scale, such as rainwater harvesting and recycled water, were not deemed significant due to their low annual volumes and are not included under the existing conditions scenario. However, both of those strategies will be included in alternative future water balance scenarios because their implementation is expected to become more widespread over the next 20 years.

Figure 2.45 shows the incorporation of additional flow paths in the city that could result from implementing new stormwater and wastewater management strategies. The diversion of surface runoff from the CSS either back into the natural environment or for nonpotable reuse will be driven both by public sector SSIP projects and by private projects resulting from the SDG requirements.

Figure 2.45
Future Hydrologic Flow Paths in San Francisco



Note:

[1] Includes landscape irrigation which is not shown in this figure for simplification. Irrigation and other losses are factored out of flows to the CSS/MS4 from the Municipal Water Use.

2.9.3 Source Data

A variety of data sources were used to inform the urban water balance, as listed in Table 2.18. Where multiple sources were available for the same component, the primary source was used to quantify that component, and the supplemental sources were used as a quality assurance check.

The *2010 Urban Water Master Plan* was a comprehensive data source for the Regional Water System and other municipal water sources. Additional detail for local groundwater is available from SFPUC annual groundwater monitoring reports (SFPUC, 2010b) and Study of Existing Groundwater Supplies (SFPUC 2011e). Additional detail for recycled water is available from reports on Recycled Water Projects on the Westside (SFPUC 2011d) and the Bayside (SFPUC 2012b).

Many of the data sets used in the urban water balance were products of modeling efforts. The SSIP modeling team performed extensive data processing to prepare input for, and validate output from, the CCSF H&H Model. For more information on the CCSF H&H Model including system representation, methods, boundary conditions, and calibration/validation, the reader is referred to the *SSIP Draft Model Documentation: City and County of San Francisco Hydrologic and Hydraulic Simulation* (SSIP-PMC 2012c). For the Water Balance effort, the CCSF H&H Model Version EHY13_116 was used. Model input data that were used in the urban water balance include the “Typical Year” rainfall data set developed by the SFPUC as part of the *2010 Wastewater Master Plan*. Also, dry-weather flows, a combination of municipal sewage and base flow (i.e., groundwater that infiltrates into the sewer network), were estimated from SFPUC water use records and flows measured at the treatment plants. Output produced by

Table 2.18
Data Sources Used to Compile the San Francisco Urban Water Balance

DATA LAYER		PRIMARY SOURCE[1]	SUPPLEMENTAL SOURCES[2]	COMMENTS
Hydrologic Components	Total Rainfall	SFDPW Typical Year data set	SFPUC rain gauge data	Produced for 2010 UWMP.
	Evapotranspiration	SWMM output	CCSF H&H Model output	
	Runoff to CSS / MS4	SWMM output	CCSF H&H Model output, GIS spatial data	MS4 areas were not modeled.
	Infiltration	SWMM output	CCSF H&H Model output	
Supplied Sources	Regional Water System	UWMP (SFPUC 2011b)	TM CS-971.B (2012)	
	Groundwater Wells	UWMP (SFPUC 2011b)	SFPUC GW reports	Westside only.
	Recycled Water	Eastside Report (2012)	UWMP (SFPUC 2011b)	Minor use in Westside only.
Municipal Water Use		CCSF H&H Model input	UWMP (SFPUC 2011b), TM CS-971.B, SFPUC billing records for 2010-11	Billing data processed by modeling team.
Sanitary Flow		CCSF H&H Model input	UWMP (SFPUC 2011b), TM CS-971.B	

DATA LAYER		PRIMARY SOURCE[1]	SUPPLEMENTAL SOURCES[2]	COMMENTS
Treated Effluent	Southeast Water Pollution Control Plant	CCSF H&H Model output	DCS data	
	North Point Wet Weather Facility	CCSF H&H Model output	DCS data	
	CSDs	CCSF H&H Model output	DCS/Telog data	Low confidence in measured CSD volumes.

Notes:
[1] Used to quantify the subject data component
[2] Used as a quality assurance check against the primary data source

the CCSF H&H Model was used to help quantify the various hydrologic fates of rainfall and dry-weather flow. Measurements of treated effluent discharges from the three wastewater treatment plants and CSDs, which were recorded by the City's DCS, were used to validate model output. It should be noted that the City has a high level of confidence in the effluent measurements from the treatment plants, but a lower level of confidence in measured CSD volumes; the reason is that all Bayside CSD monitoring is level only (volume estimated using weir equation or rating curve).

Additionally, a Storm Water Management Model (SWMM) model was constructed to analyze surface hydrology only. This sister model to CCSF H&H Model was created because it runs relatively quickly. Both models were constructed based on the same subcatchment delineation so their hydrologic output should be virtually identical, but differences between the hydrologic methods employed by the two models have led to differing results. The task of fine tuning the CCSF H&H model such that hydrologic results match those of SWMM (used for the Water Balance) is presently ongoing.

2.9.4 Hydrologic Components

Rainfall is the lone natural driver to the hydrologic system in San Francisco. All other source waters are introduced via human activity (e.g., imported water, groundwater withdrawals, and recycled water). The City and County of San Francisco has historical rain data from three primary sources; two long-term National Weather Service rain gages, San Francisco Hydraulic-Hydrologic Data Acquisition rain gages, and the SFPUC rain gage network.

A data set representing the typical rainfall year in San Francisco was developed for modeling and analysis purposes, as documented in the *Statistics for Typical One Year Period* technical memorandum (AECOM 2006). That data set was created by selecting the year of data from the National Weather Service (NWS) gage located at Duboce Park that was deemed most typical of historical rainfall in San Francisco in terms of total storm depths, peak intensities, and distribution. Some adjustments were then made to the largest measured storm events to better match average records over the last 30 years. Table 2.19 briefly describes the hydrologic elements evaluated and how their values were derived.

Table 2.19
Hydrologic Elements Evaluated and Derivation of Values

Total Rainfall	The SFPUC's Typical Year rainfall data set was used to represent rainfall under existing conditions in this average annual urban water balance. This data set was utilized in SWMM and CCSF H&H modeling simulations as the basis for all other hydrologic components.
SFPUC Typical Year Rainfall data set	
Surface Runoff	The portion of stormwater which flows across the land surface (reduced through interception, depression storage, and infiltration) will be intercepted by either the combined or separate sewer system. MS4 areas and those with direct runoff, which route directly into the ocean or Bay, are located outside of the modeled urban watersheds and are not accounted for.
SWMM model simulation output	
Evaporation and Evapotranspiration	Interception is the process by which rainfall is lost to the environment prior to reaching the ground. Rainfall is retained on surface vegetation and is intercepted by buildings and above-ground structures. Depression storage is the rainfall that accumulates in surface depressions on the ground during a storm. These rainfall components evaporate after the storm event. A portion of water seeping into the ground is transpired back to the atmosphere by the root action of vegetation.
SWMM model simulation output	
Infiltration	Infiltration is the process by which rainfall seeps into the ground through pervious surfaces. Stormwater initially infiltrates and saturates soils, after which runoff occurs. This process is enhanced through the use of green infrastructure.
SWMM model simulation output	

Green infrastructure has the potential to significantly alter the pathways and fate of stormwater within the urban hydrologic system. By intercepting and diverting stormwater before it enters the sewer system, total wastewater volumes can be decreased. Properly designed green infrastructure can specifically target CSD and floodwater volume reductions.

Potential future impacts from climate change will affect the hydrologic components of any future scenario water balance, and will be examined following the climate change analysis to be performed as a separate task under the SSIP. Possible future impacts are expected to include more intense storm events, potentially exacerbating flooding and CSD challenges.

2.9.5 Municipal Water Use

The Regional Water System (RWS) currently supplies more than 97% of the City's retail water supplies (SFPUC 2011b). The remainder is supplied through locally produced groundwater and tertiary treated recycled water, which is applied to Harding Park Golf Course on the Westside. The SFPUC plans to maintain the self-imposed supply limitation from the RWS and continue developing local supplies to diversify and supplement its water supply.

Desalination is also being evaluated as a regional project to meet system wide demands. It is not part of the phased WSIP goals for local conservation groundwater and recycled water. Table 2.20 briefly describes the supplied sources and how their values were derived.

Table 2.20
Supplied Sources and Derivation of Values

Regional Water System Deliveries 2011 Customer Billing Data	The RWS is the primary source for the in-City distribution system, storing and delivering water from the Hetch Hetchy System and local Bay Area surface waters. Alternative water sources currently in development and planned for the future would reduce dependance on this system.
Recycled Water System Data reported in UWMP (SFPUC 2011b)	Existing recycled water use in the City is limited. The Harding Park Project imports recycled water from the North San Mateo County Sanitation District to irrigate the golf course, estimated at 0.23 MGD. The Westside Recycled Water Project is in preliminary design phase with environmental review expected to begin this year and the Eastside Recycled Water Project is in conceptual phase. Upon completion both will be operational and delivering around 2 MGD.
Groundwater Wells Data reported in UWMP (SFPUC 2011b)	There is no groundwater use within the Bayside Drainage Basin. Groundwater is pumped from the Westside Groundwater Basin by wells located in Golden Gate Park and the San Francisco Zoo. The proposed SF Groundwater Supply Project would include expanded groundwater pumping for potable municipal water use.

Regarding decentralized water reuse, rainwater harvesting overlaps with stormwater management and has the potential to be implemented on a broad scale; however, the quantity of existing rainwater reuse projects in the City is negligible. Significant quantities of rainwater harvesting projects are projected to be developed over the next 20 years through a combination of the SDG requirements and the SSIP.

Additional rainwater reuse projects may be developed through the Water Enterprise's Non-Potable Water Program. Black water reuse is not expected to be implemented on a broad scale due in part to the estimated cost of regulatory compliance. However, graywater reuse could be implemented at a wider scale due to revisions in the 2013 California Plumbing code that create clear standards and codes and ease regulatory requirements, the development of NSF 350 (National Certification Standard for graywater treatment systems), the development of the San Francisco Non-Potable Ordinance. Similarly, sump water reuse is currently not calculated to be significant due to its limited practice, however further study of base flow sources and reuse incentives may demonstrate that sump water is a significant source of nonpotable water. It should also be noted that while there are not many customers in the City that pump sump water directly to the sewer, the ones that do pump and discharge to the CSS, pump large volumes. The potential impact of these alternative water sources is analyzed in detail within the SFPUC *Potable Offset Investigation Summary* (SFPUC 2012c).

2.9.6 Total Municipal Water Use

To estimate the total amount of water used, customer billing data was analyzed for 2011, and total water use was determined for each subcatchment in the model. There was an appreciable difference between billing/consumption data (averaging 64.4 MGD citywide) and the total flow measured at county line meters (averaging 71.3 MGD citywide). This difference represents meter under-registration, unbilled authorized consumption (including fire hydrant use, main flushing, street cleaning and dust control) and water loss to the system (through all types of leaks, breaks, and overflows).

2.9.7 Sanitary Flow

Average daily sanitary flow was developed and applied as input to the CCSF H&H Model. For each subcatchment, an "equivalent population" estimate was generated including not only residents but also people working in the study area who contribute to daytime sanitary flow.

1. The average daily sewer flow per parcel was calculated by multiplying average daily water consumed in each parcel by a return to sewer system factor. The rate of return to sewer system was assumed as 0.9 based on standard H&H modeling methods for estimating sanitary flows.
2. The CCSF H&H model requires the average daily sewer flow input as two separate parameters: equivalent population and daily sanitary flow per equivalent person. The daily sanitary flow per equivalent person was assumed as 50 gallons per day, and equivalent population was calculated by dividing average daily sewer flow by 50 gallons per day. The 50 gallons per day was selected as being closer to the average per capita water consumption developed by planning documents (SFPUC 2011b, Chapter 4.1.1 Current Retail Demand).
3. The equivalent population for all parcel lots within each subcatchment was aggregated to provide the total for each sub-catchment. This equivalent

population value was adjusted when calibrating the model to dry weather period of flow monitoring data.

4. Diurnal patterns, i.e., hourly factors for a 24-hour weekday and weekend duration were generated using flow monitoring data. The diurnal patterns were assigned to all subcatchments tributary to the flow monitoring location. The hourly factor from the diurnal pattern multiplied with sanitary flow rate of 50 gallons per day and equivalent population in each subcatchment provides the modeled sanitary flow at a given hour of the day.

A baseflow estimate was also determined for the CCSF H&H Model, representing the non-rainfall dependent infiltration of groundwater that enters the sewer system through cracks or defective joints in the pipes and manhole walls or via dewatering pumps from basements or underground parking structures. The magnitude of baseflow depends on the condition of the sewers, the depth of the groundwater table relative to the collection system and the location of historical creeks or water bodies that have since been diverted into the CSS.

Steps for calculating baseflow included:

1. Using flow monitoring data, baseflow for tributary area upstream of the meter was estimated using the empirical method of 0.88 times the minimum daily flow method.
2. The baseflow calculated at a flow meter was distributed proportionately by area amongst parcels upstream of the meter.
3. This was adjusted during model calibrating to dry weather flow-monitoring data.
4. A monthly factor for baseflow was developed using historical pumping records from Griffith Pump Station (GFS) and South-east Plant (SEP) and applied to upstream tributary area with average ground water depth less than 10 feet.

2.9.8 Treated Effluent Discharges

The CCSF H&H Model simulation run produced data describing the discharge volumes from the WWTP outfalls and at each CSD location. Plant outfalls in the Bayside Drainage Basin occur at the NPF and SEP. Approximately 87% of all effluent discharge within the Bayside Drainage Basin occurs as secondary discharge from the SEP. Within the Bayside Drainage Basin there are CSDs classified within three CSD Basins; North Shore, Central Bayside, and Southeast Bayside. The majority of all CSD volume occurs within the Central Bayside CSD Basin.

Although there are measured discharge volume data from the WWTP and CSD outfalls, these measurements were used to calibrate the model rather than being used directly. This is because assumed errors in equipment and data collection have led to low confidence in the measured volumes from CSDs. The primary and secondary discharge measurements from the plants are considered to be more accurate. Thus, these data were used to calibrate the model based in part on discharges at WWTP outfalls, and the CSD model output data was then considered to

Table 2.21
Bayside Urban Water Balance for "Typical Year" Rainfall
(All values in MG units)

HYDROLOGIC COMPONENTS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Total Rainfall	2,364	2,264	806	186	68	0	28	0	0	911	2,491	1,827	10,945
Evapotranspiration	158	191	153	44	30	0	9	0	0	79	267	150	1,081
Infiltration	697	577	330	49	19	0	7	0	0	292	724	561	3,256
Surface Runoff to CSS	**1,509**	**1,496**	**323**	**93**	**19**	**0**	**12**	**0**	**0**	**540**	**1,500**	**1,116**	**6,608**

	MUNICIPAL WATER USE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Sources	Regional Water System	1,597	1,464	1,598	1,547	1,670	1,715	1,793	1,785	1,733	1,767	1,557	1,557	19,782
	Recycled Water System	0	0	0	0	0	0	0	0	0	0	0	0	0
	Groundwater Wells	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Water Use		1,597	1,464	1,598	1,547	1,670	1,715	1,793	1,785	1,733	1,767	1,557	1,557	19,782
Sanitary Flow to CSS		**1,116**	**1,008**	**1,116**	**1,080**	**1,116**	**1,080**	**1,116**	**1,116**	**1,080**	**1,116**	**1,080**	**1,116**	**13,140**
Baseflow to CSS[1]		**635**	**590**	**650**	**546**	**567**	**551**	**564**	**569**	**491**	**617**	**602**	**631**	**7,012**

Note:
[1] As described in Section 2.9.7, the baseflow to CSS estimate represents the non-rainfall dependent infiltration of groundwater that may enter the sewer system through cracks or defective joints in the pipes and manhole walls or through dewatering pumps from basements or underground parking structures.

TREATED EFFLUENT DISCHARGES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
North Point - Primary	294	248	32	10	0	0	0	0	0	86	261	212	1,142
SEP - Primary	367	431	101	22	0	0	0	0	0	127	462	294	1805
SEP - Secondary	2,160	2,200	1,955	1,687	1,702	1,631	1,692	1,685	1,571	1,878	2,317	2,063	22,540
CSDs - North Shore	9.6	21.2	0	0	0	0	0	0	0	10.8	0	0	42
CSDs - Central Bayside	429.2	193.6	0	0	0	0	0	0	0	170.8	143	294.4	1,231
CSDs - Southeast Bayside	0	0	0	0	0	0	0	0	0	0.1	0	0	0
Total Treated Effluent Discharges - Bayside	**3,260**	**3,094**	**2,089**	**1,719**	**1,702**	**1,631**	**1,692**	**1,685**	**1,571**	**2,273**	**3,182**	**2,863**	**26,760**

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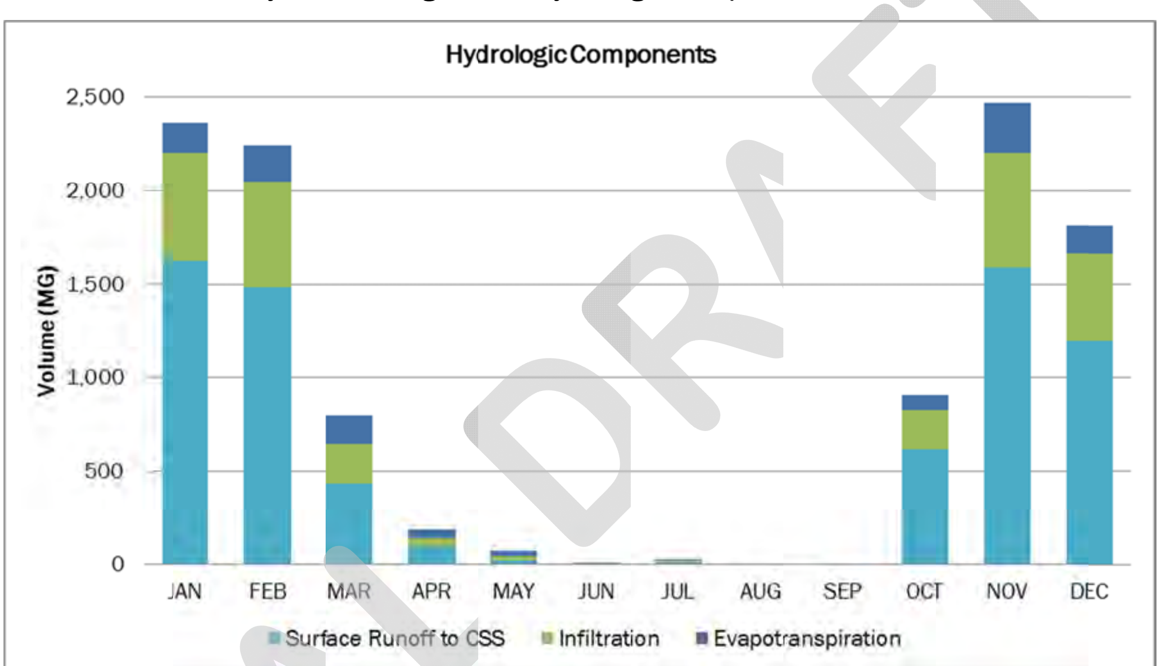
be indirectly calibrated to high-quality data. Where CSD measurements were found to be valid, they were used for model calibration.

2.9.9 Results

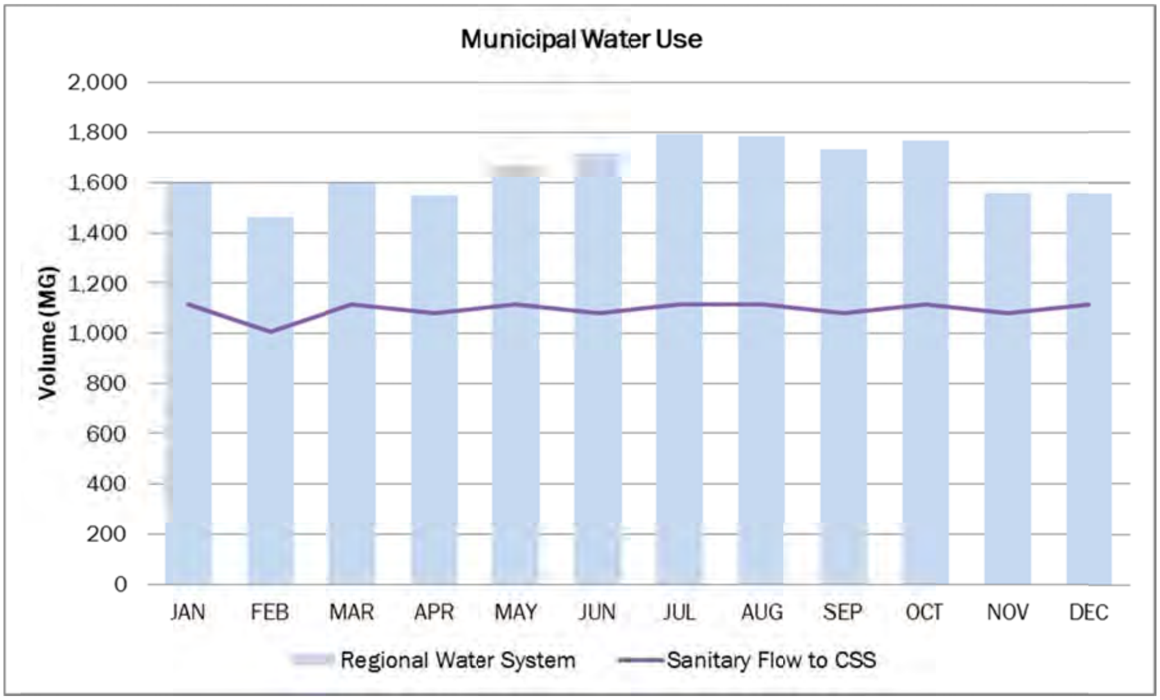
Table 2.21 and Figures 2.46 through 2.50 contain tabular and graphical summaries, respectively, of the monthly water balance calculations for the Bayside Drainage Basin. The quantities are based on the SFPUC Typical Year rainfall data set.

Figure 2.46
Bayside Drainage Basin Hydrologic Components



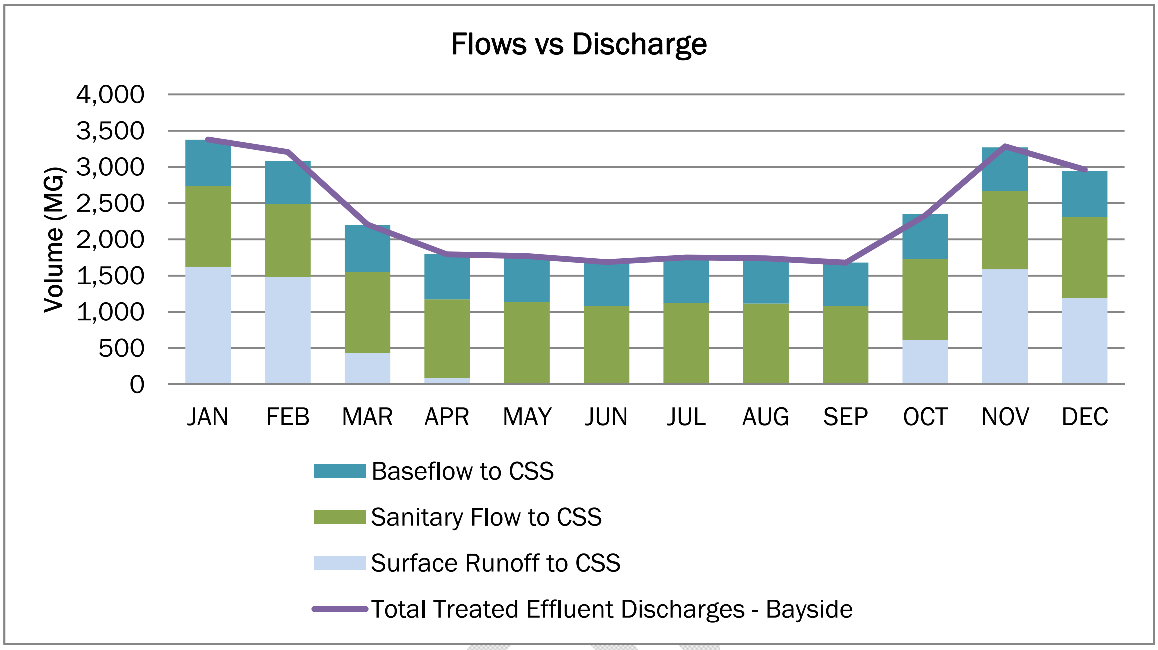
The majority of rainfall that falls on the urban watershed is converted to surface runoff and captured by the sewer system. On an annual basis, approximately 60% of rainfall becomes runoff. Approximately 30% of rainfall is absorbed and infiltrated within pervious areas. The remaining 10% of the rainfall evapotranspires.

Figure 2.47
Bayside Drainage Basin Water Use and Wastewater Production



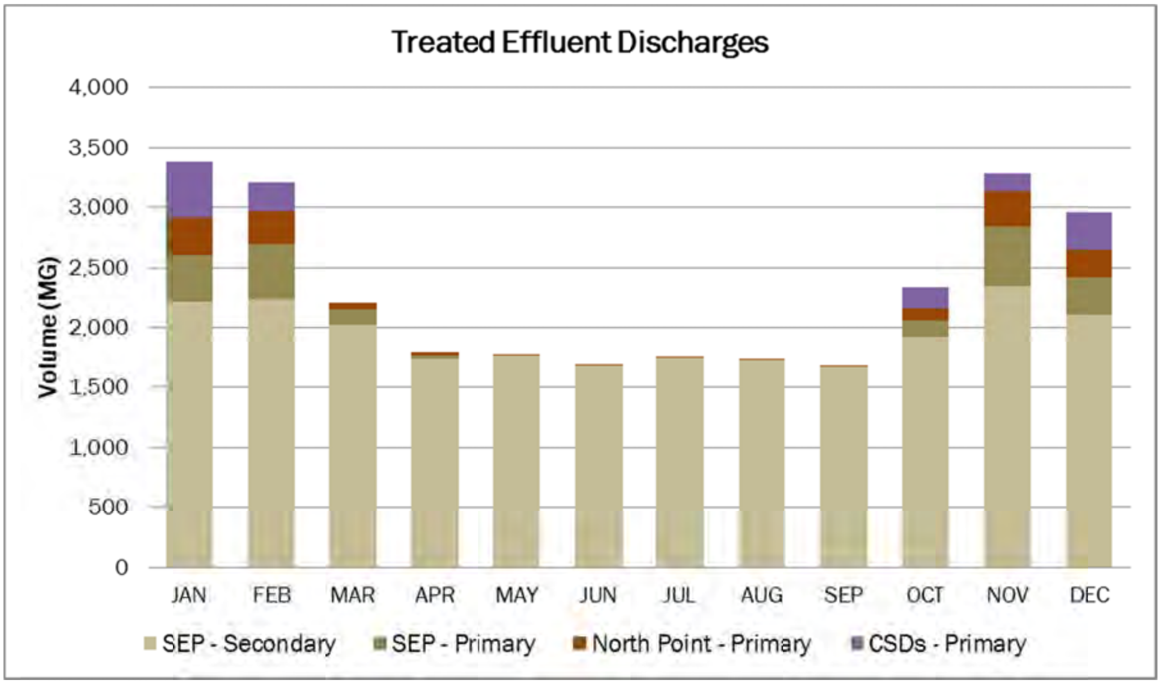
Municipal water use does not exhibit the same monthly variation that the hydrologic components do, as shown in Figure 2.47. The amount of water used within the Bayside Drainage Basin does increase in the summer months as irrigation demands go up, with an overall fluctuation of about 15% between December and July. This additional volume of irrigation water is not entirely returned as wastewater to the sewers, and thus the volume of wastewater produced each day remains constant throughout the year. The volume of municipal water used in a given month, according to the flow measured at the county water line meters, is typically 25 to 35% higher than the wastewater produced from that municipal water. Though not entirely understood, this difference is attributed to environmental losses during the delivery, use, and capture of the water, unmetered use, and errors measuring and tracking metered data.

Figure 2.48
Bayside Drainage Basin Comparison of Contributing Flows and Total Discharge



Per the CCSF H&H Model (Version EHY13_116) results of the typical year total runoff to the CSS varies greatly from the summer to winter months, as shown in Figure 2.48. Monthly combined flows in the winter may be twice the summertime flows, or more in a wet year. Overall, sanitary flow makes up 49% of the total annual flow, stormwater runoff makes up 25%, and base flow the remaining 26%. Because the burden on the system is greatest during storm events and stormwater management allows an amount of control over that excess water, analysis of the urban water balance herein focuses on stormwater management above other contributing flows. There may also be feasible opportunities to divert base flows at certain locations.

Figure 2.49
Bayside Drainage Basin Treated Effluent Discharges



As shown in Figure 2.49, total discharge volumes reach their peak during the winter months, when nearly all of the CSDs and WWTP primary discharges occur. Per the LOS model results of the typical year, CSDs make up less than 5% of the total discharge volume from the Bayside Drainage Basin, and primary discharge from the plants makes up less than 12%. The SEP secondary discharge makes up the bulk of the total volume at more than 83%.

2.9.10 Conclusions

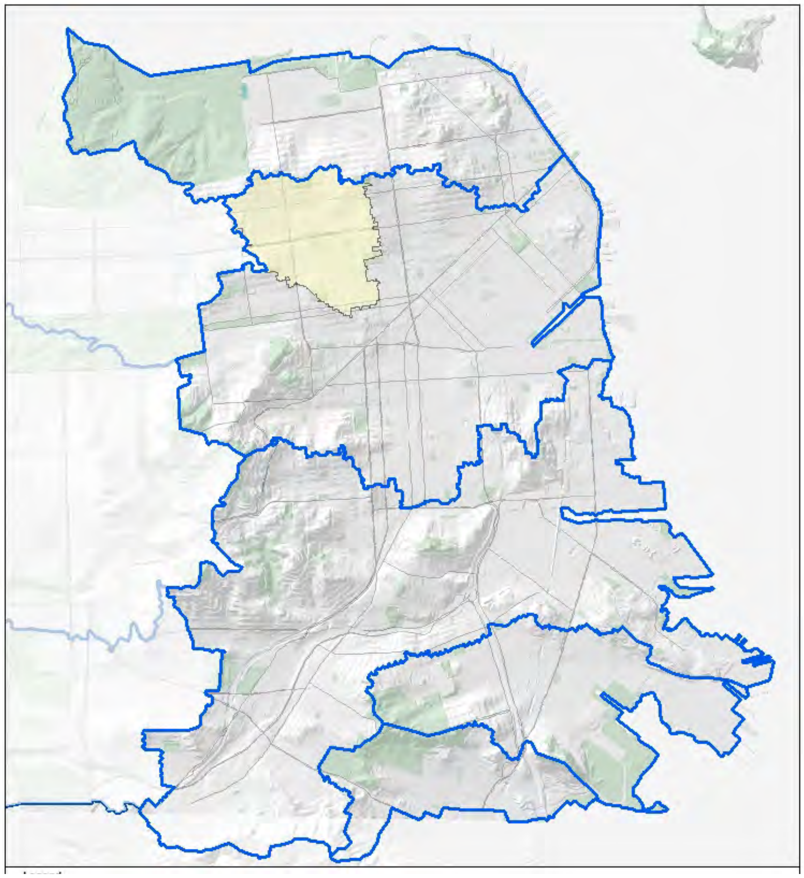
The flows and fates of water identified in the water balance indicate broad patterns when viewing the entire Bayside Drainage Basin. The data is most useful when used to analyze smaller areas; neighborhoods or streets where management strategies can be considered for improving the sewer system. Table 2.22 and Figure 2.50 demonstrate a water balance applied at different scales, with key values summarized per their annual total.

Table 2.22
Urban Water Balance at Different Scales of Application

Catchment Area	Total Rainfall	Evapo-transpiration		Infiltration		Runoff to CSS		Sanitary Flow to CSS	Baseflow to CSS
	Annual Total Volumes (MG)	Annual Total Volumes (MG)	Percent of Total Rainfall (%)	Annual Total Volumes (MG)	Percent of Total Rainfall (%)	Annual Total Volumes (MG)	Percent of Total Rainfall (%)	Annual Total Volumes (MG)	Annual Total Volumes (MG)
Bayside Drainage Basin	10,945	1,081	10%	3,256	30%	6,608	60%	13,140	7,012
Channel Watershed	556	55	10%	110	20%	388	70%	1,277	274
California Street	17	1.8	11%	1.1	6%	14	82%	70.2	5

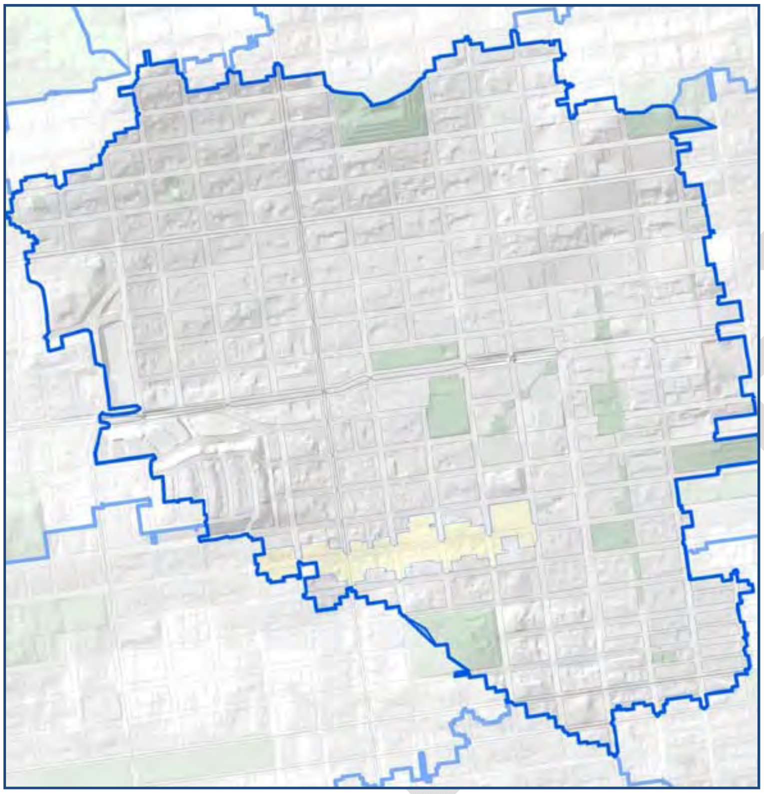
At the Bayside Drainage Basin scale, approximately 60% of rainfall becomes runoff reaching the CSS and 30% of rainfall is infiltrated. At this scale the annual stormwater runoff is about half the volume of the annual wastewater flow.

Figure 2.50
Bayside Drainage Basin – City-Scale Catchment Area



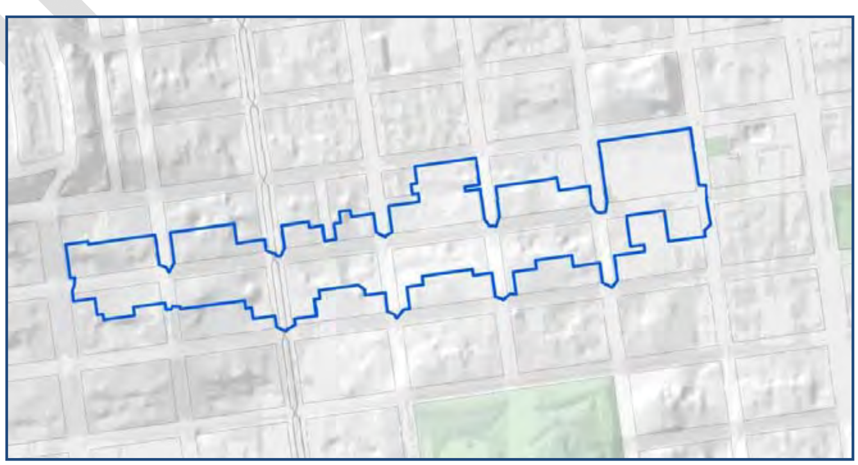
Zooming in further, to a sub-basin within the Channel watershed, the pattern of water flows looks a bit different (see Figure 2.51). Within this neighborhood the proportion of runoff is increased, and infiltration decreased, by 10%. The annual wastewater flows are also much higher proportionally, equal to more than three times the runoff. At different scales, the relative amount of impervious/pervious areas as well as sanitary derived wastewater flows will vary.

Figure 2.51
Minor Urban Watershed 30-B within Channel Urban Watershed – Neighborhood-Scale Catchment-Area



When viewed at a smaller project scale, such as a six-block of California Street, a different set of circumstances is evident, as shown in Figure 2.52. The ratio of runoff is even greater, more than 80% of rainfall, and a very small proportion of stormwater is infiltrated. This scenario represents an ideal opportunity for considering the incorporation of green infrastructure designed to reduce the amount of runoff.

Figure 2.52
Golden Gate Avenue – Project-Scale Catchment Area



Moving into the Opportunities phase of the Urban Watershed Assessment, the water balance data will be a valuable tool for identifying areas with higher proportions of runoff. This tool will be utilized alongside other BMP siting data, such as soils information, slopes, and street characteristics, in order to highlight the locations which are most appropriate for implementation of green infrastructure.

3.0 URBAN WATERSHED CHALLENGES AND NEEDS ANALYSIS

To target location-specific opportunities to meet the WWE Goals and provide ancillary benefits to the City, a detailed inventory of challenges and urban watershed needs has been developed. These challenges and needs have been developed through the collection of anecdotal data, additional modeling and further analysis of model output. The subsequent sections document these data for the Bayside Drainage Basin.

3.1 Existing Wastewater Enterprise Challenges

3.1.1 Location-Specific Challenges

The following challenges were identified through the Watershed Challenges Forum, Operational Workshops and interviews with City staff conducted in early (January through March) 2012. The information is largely anecdotal or observed conditions and not generated from model output, analysis or field measurement. In general, these challenges were used to provide the team a starting point for understanding where existing needs in the collection system. The challenge categories include:

1. Wet Weather Challenges
2. Odor and Solids Challenges
3. Reliability and Redundancy Challenges
4. Operation and Maintenance Challenges

The process identified a number of specific challenges in the collection system that were Bayside Drainage Basin wide and location specific, below is a summary of the challenges:

1. Capacity: Challenges related to capacity are observed in a number of locations.

   For example, in the Islais Creek urban watershed, the Hudson Avenue and Toland Street intersection also often surcharges due to limited downstream pumping or storage.

2. CSDs: There are several CSD locations that have different operational challenges, including:

   a. In the Mission Creek, the baffles may not always operate as designed, resulting in organic and inorganic (i.e. trash) solids flushed into Mission Creek.

   b. In Islais Creek, the low elevation of the Islais Creek area may make it challenging to address CSD issues. CSD outfalls at 3rd Street South and Selby Street may not provide any primary treatment with the baffles, as the sewers from 3rd Street are downstream of the baffle and thus discharge directly into the Bay.

c. In Islais Creek, Mariposa and Tennessee pump stations may reach capacity in small storms and discharge into the Bay causing a CSD event, even when rest of the Bayside CSD outfalls do not activate.
d. If CSDs cannot be avoided, operational strategies may be able to prioritize the preferred locations.

3. Flow release methods: the current design of the flow release control elements introduces operational challenges. The CSD outfalls at Sansome, Howard, and Brannan streets have butterfly valves that are used to alleviate flooding. When opened, the butterfly valves release flow from the entire cross section of the T/S Box, including high concentration sediment portions near the bottom. Adjustable weirs are generally preferred over butterfly valves on account of lower maintenance requirements and greater reliability.
4. Odor issues are pronounced along numerous locations in Financial District, Embarcadero, Mission Creek, Marina, along North Point Main and SoMa. This is largely due to the flat slopes in the area, and around the vented manholes in the Mission Creek district. Odors are also related to sewer cleaning and storage in T/S boxes. The City has installed some elevated vents along Embarcadero. Since their installation and operation, these areas have had fewer public odor complaints and thus, may be extended to other areas of the City.
5. Solids deposition has been observed in several locations including Islais Creek box, North Point Main and Brannan and 6th street area. Solids accumulation in Islais Creek box is impacted by the practice of flow equalization to the plant, whereas solids accumulation in North Point Main is due to inadequate flushing velocity in the sewers. The solids in the sewers around Brannan and 6th street are deposit during dry weather flows and are flushed out during wet weather flows; however, sediment remains in the sewers and requires physical removal of the accumulation.
6. Debris accumulation has been observed in the Sunnydale T/S box; there are no bar screens protecting the Sunnydale Pump Station, so there is an adverse impact on pump operation.
7. There is inadequate redundancy at several pump stations and force main facilities on the north and central Bay side, with a common problem of pump station capacity being challenged during wet weather.

a. In North Shore urban watershed, NPF has two pumps and requires both pumps to stay in compliance. The North Shore Force Main does not have any redundancy for conveying flows from North Shore to Channel box. The city recently finalized a contract for a new force main, North Shore to Channel Force Main (NSCFM) to provide a redundant pipeline; however, this does not resolve the overall North Shore redundancy issue.

b. In North Shore urban watershed, the Palace of Fine Arts pump station currently lacks redundancy. However, a redundant pump station may not be required after the Exploratorium moves out of this area.

c. In Channel and Islais urban watersheds, 20th Street, Mariposa, Tennessee and Shotwell pump stations may need to be upgraded. Also, the Channel Force Main is the only path for pumping channel flows to the SEP; a solution is in the planning phases are part of the CBSIP.

d. In Yosemite urban watershed, there is only one pump at the Hunters Point pump station, whereas this area needs more pumping and the pump station lack redundancy.

e. In Sunnydale urban watershed, the Sunnydale Pump Station force main lacks redundancy.

8. There are concerns related to seismic reliability, specifically at pump stations and T/S boxes. Such concerns need to be addressed in the planning efforts for operations during emergency situations. Some of the major collection system facilities that have concerns with seismic reliability include:

    a. The portion of Channel T/S Box and Sewers at 4th, 5th and 6th streets that is not supported on piles, North Point Main, Hunters Point Tunnel, Candlestick Tunnel are not classified for seismic reliability.

    b. In general, all old and aging brick sewers are not seismically reliable.

9. Aging infrastructure is a concern in several locations on Bayside, including T/S boxes and brick sewers.

10. Easement sewers typically arise primarily as a maintenance issue; they can also have a negative effect on operations. Areas with easement sewers are especially prone to risks such as flooding due to root intrusion and often have access issues since they do not reside in the right of way.

11. Maintenance “hotspots” are locations with observed chronic maintenance issues. They include grease buildup, difficult access to equipment, and other maintenance related challenges. Without adequate maintenance, operational reliability and flexibility can be significantly reduced. The maintenance “hotspots” can be grouped into the following:

    a. Grease buildup: Areas include Beach Street between Polk and Montgomery, Washington Square Park, Brannan Street, Drumm Street between California and Sacramento streets.

    b. Lateral Connections: Lateral connection repair and maintenance accounts for 50% of the maintenance problems. Many are hard to access, for example along Market Street, main and side sewers are under the SFMTA Overhead lines and light rail vehicles which makes the situation that much more challenging to address.

    c. North Point Main, Berry Street Box, Sunnydale T/S box all have challenges issues for solids or grease cleaning, including resource requirements for frequent cleaning, difficult access to the sewers, Hazmat 1 classification requirements for cleaning.

12. Some of the Bayside outfalls experience salt water intrusion problems during high tides, including:
    a. In Channel urban watershed, the Brannan gates along Embarcadero do not fully close due to barnacle growth frequently and leak in closed position. These gates may not be able to protect against salt water entering the sewer system during high tide.
    b. In Islais Creek urban watershed, the operations staff report sea water entering the sewer system at Islais Creek North CSD during high tides. The Islais Creek area in general is low-lying. Raising the weirs in the area may cause further inland flooding and lowering the weirs in the area may allow sea water intrusion.
13. Using the T/S boxes to equalize flow prior to sending to SEP poses additional challenges. When the T/S boxes are used as storage for flow equalization, the storage may not be fully available at the beginning of the storm events. Also, debris that accumulate from this practice can also reduce storage capacity.

3.2 Needs Analysis Relative to Wastewater Enterprise Goals and Levels of Service

WWE Goals and LOS are listed in Table 1.1. This section summarizes Bayside drainage system needs for each Goal and LOS.

The WWE Goal of providing a compliant, reliable, resilient, and flexible system that can respond to catastrophic events will be addressed in two parts:

- Provide a Compliance System (Section 3.2.1)
- Provide a Reliable, Resilient, and Flexible System (Section 3.2.2)

3.2.1 Provide a Compliant System

WWE LOS: Full compliance with state and federal regulatory requirements applicable to the treatment and disposal of sewage and stormwater.

Section 2.7, Stormwater and Wastewater Regulatory Framework, describes the regulatory drivers and permits that dictate wet weather performance requirements in San Francisco. This section builds on that background information by evaluating the current state of wet weather compliance in San Francisco and identifying areas in need of improvements to meet the LOS. In addition, although future regulatory conditions are difficult to predict, this section also describes emerging trends in environmental regulations that may result in future changes to San Francisco's permit requirements. Finally, in light of potential regulatory changes and climate change impacts, this section forecasts the state of long-term wet weather performance in San Francisco and identifies areas in need of improvements to maintain compliance.

Current State of Wet Weather Compliance

The evaluation of Bayside wet weather compliance focused on the current MS4 and Bayside Permit requirements that directly relate to collection system performance during wet weather. These requirements include:

- CSD Performance Criteria
- Efficacy of Combined Sewer Overflow (CSO) Controls
- Maximization of Collection System Storage
- MS4 Post-Construction Stormwater Management

Dry weather and treatment plant regulatory requirements are being addressed by SSIP evaluations conducted outside of the Urban Watershed Assessment.

CSD Performance Criteria

The three CSD basin areas of the Bayside Drainage Basin were constructed in accordance with the following regulatory design criteria: a long-term average of four discharge events per year in North Shore, 10 per year in Central Bayside, and 1 per year in Southeast Bayside. To be considered a discrete CSD event, the discharge from the CSD structure must be separated by six hours in time from any other CSD event within the permitted area. The long-term average of CSD events is calculated from 1998 when the final phase of the transport storage improvements was completed.

While the long term annual average design criteria are not used as the basis for determining whether the city is in compliance with its permits in any particular year, the long term average number of discharges are useful for assessing whether the system is being operated to maximize storage and pollutant removal and, therefore, to provide the most protection to the San Francisco Bay and the Pacific Ocean. Table 3.1 summarizes the last 14 years of reported Bayside CSD performance relative to these criteria.

Table 3.1
Status of Bayside CSD Performance[1]

Year	Rainfall (in)	Number of CSD Events		
		North Shore	Central Bayside	Southeast Bayside
1998-99	17.0	1	13	0
1999-2000	20.9	3	12	1
2000-01	15.8	0	8	0
2001-02	19.3	2	9	2
2002-03	21.1	3	14	4
2003-04	16.9	4	8	2
2004-05	28.2	4	15	1
2005-06	28.9	3	16	2

Year	Rainfall (in)	Number of CSD Events		
		North Shore	Central Bayside	Southeast Bayside
2006-07	15.1	1	5	1
2007-08	17.4	3	7	2
2008-09	15.6	3	4	1
2009-10	22.4	5	11	3
2010-11	26.3	6	21	0
2011-12	15.9	2	8	1
Average	20.8	3	11	1
Design Criteria		4	10	1

Note:
[1] Data is from "Bayside Monthly Discharge Monitoring Reports" submitted each month by SFPUC to the Regional Water Quality Control Board, San Francisco Bay Region, NPDES Division.

SFPUC treats 100% of wet weather flows. On average, 90% of flows are treated at the NPF and SEP and the remaining 10% receive settling and baffling equivalent primary treatment in the T/S structures. However, as noted in Section 3.1, Existing Wastewater Enterprise Challenges, treatment effectiveness at certain CSD outfalls may be compromised by the current design of the structures' baffles or flow control elements. Improved removal of solids and floatables at these locations are needs that should be addressed as part of the SSIP.

As shown in Table 3.1, since 1998, the average number of reported discharges in the three CSD basins is 3 per year in North Shore, 11 per year in the Central Bayside, and 1 per year in Southeast Bayside. Although exceeding the long term average annual criteria does not signify non-compliance in any particular year, a consistently high number of discharges warrants further evaluation. In comparison to historical reported CSDs, Table 3.2 summarizes modeled output (CCSF H&H Model Version EHY13_116) of volume and discharge frequency at each Bayside Drainage Basin CSD outfall. The output is based on a "typical year" rainfall simulation.

Table 3.2
Typical Year Model CSD Performance[1]

Outfall Location	Weir Elevation (ft)[2]	Model Predicted Total Volume (MG)	Model Predicted No. of Discharges	CSD Basin
009 (Baker)	-4.0	8.4	4	North Shore Total Volume: 42 MG Max. Discharge Frequency: 4 Design Criteria: 4
010 (Pierce)	-4.0	10.7	4	
011 (Laguna)	-2.9	0.0	0	
013 (Beach)	-3.51	1.7	3	
015 (Sansome)	-4.0	19.0	3	

Outfall Location	Weir Elevation (ft)[2]	Model Predicted Total Volume (MG)	Model Predicted No. of Discharges	CSD Basin
017 (Jackson)	-3.9	1.8	3	
018 (Howard)	-3.5	69.6	10	Central Bayside Channel Subtotal: 516 MG Mariposa Subtotal: 6 MG Islais Subtotal: 709 MG Total Central Basin: 1231 MG Max. Discharge Frequency: 13 Design Criteria: 10
019 (Brannan)	-3.75	142.4	12	
022 (3rd Street)	-3.5	0.1	1	
023 (4th Street (N))	-3.5	0.2	1	
024 (5th Street)	-3.5	65.2	7	
025 (6th Street)	-3.5	104.5	9	
026 (Division Street)	-3.5	132.9	9	
027 (6th Street (S))	-3.11	0.1	2	
028 (4th Street (S))	-3.5	0.5	4	
029 (Mariposa)	-3.5	4.2	10	
030 (20th Street)	-3.0	1.8	11	
030A (22nd Street)	-2.7	0.0	2	
031 (3rd Street)	-3.0	30.5	11	
031A (Islais North)	-3.0	296.0	11	
032 (Marin Street)	-3.0	36.2	11	
033 (Selby Street)	-3.0	112.5	11	
035 (3rd Street (S))	-3.0	234.2	11	
037 (Evans Street)	+1.3	0.1	1	Southeast Bayside Total Volume: 0.1 MG Max. Discharge Frequency: 1 Design Criteria: 1
038 (Hudson Street)	+7.0	0.0	0	
040 (Griffith)	-2.5	0.0	0	
041 (Yosemite)	-2.7	0.0	0	
042 (Fitch)	-2.7	0.0	0	
043 (Sunnydale)	-2.6	0.0	0	
TOTAL		1,272		

Notes:

[1] Results from "typical year" model simulation using CCSF H&H Model Baseline Version: EHY13_Ver116 (June 2013).

[2] Elevation based on City Datum.

The results from the typical year simulation currently show the following CSD event frequencies: four in North Shore, thirteen in Central Bayside, and one in Southeast Bayside. While the maximum frequency in Channel Basin is twelve, one of the events in Islais Basin occurs when there is no CSD event in Channel basin, leading to a maximum frequency count in the Central Bayside to thirteen. Central Bayside is the only basin that is significantly different (more than +/- one CSD event) than the running average of historically reported CSDs. While the model will continue to be updated and refined over time, it has been calibrated and validated against monitoring and DCS information collected within the CSS pipe network, pump stations, T/S boxes, CSD structures, and treatment plants. Therefore, although the model results will never exactly replicate real world performance, the results provide a good approximation of expected CSS performance. In any given rainfall event for which observed data are acquired, there may be some event particular influences that are not represented in the model simulation of the same event. For example, there may have been some intermittent debris in the sewers that influenced CSD activity. Also, there is always a risk that the equipment or the processes engaged to gather observed data were faulty during any particular event. The modeled CSD results support the historical data in indicating that the Central Bayside may have difficulty meeting the long-term average of 10 CSD events.

The latest model results show that the North Shore CSD events are affected by the sediment in North Point Main. Using historical observations of sediment in North Point Main during the typical year simulation brings the maximum frequency in North Shore to four. Typical year simulation without sediment in North Point Main lead to CSD events greater than four. The sediment in North Point Main reduces the flows from Channel to North Shore, thus less flows in the North Shore Transport/Storage boxes and maximum frequency of 4 during typical year simulation. Historical data on sediment depths and evaluating sediment built-up in this area using long term continuous simulations will be studied further.

Taking these factors into consideration, historical and model data suggest that of the three permitted areas in the Bayside Drainage Basin, the Central Bayside is the most in need of improvements to maintain a long-term CSD activation frequency that meets the design criteria set forth in the Bayside Permit.

<u>Efficacy of CSD Controls</u>

The Bayside Permit requires that the SFPUC monitor CSD outfalls to effectively characterize overflow impacts and the efficacy of the CSO controls. In accordance with these requirements, the SFPUC recently submitted the *Overflow Impact and Efficacy of CSO Controls for the Bayside System* (June 2012), which summarizes the results of the last two years of SFPUC's CSD monitoring and characterization efforts. CSD monitoring has been taking place at the following locations: Marina Beach at Pierce Street (Outfall No. 010), Mission Creek at Sixth Street (Outfall No. 025), Central Bay at Mariposa Street (Outfall No. 029), North Islais Creek (Outfall No. 031-A), Yosemite (Outfall 041), and Candlestick Cove at Sunnydale Avenue (Outfall No. 043).

Results of the characterization and monitoring efforts found that in an average year, 90% of stormwater is treated at the NPF and SEP plants, and the remaining 10% is discharged through CSDs. The small percentage of flow discharged as CSDs is first passed through the T/S structures, which allows solids to settle and floating debris to be retained. Water quality monitoring found that these discharges are of similar or better quality to untreated urban stormwater runoff and that only copper and zinc were identified as being present in elevated concentrations as compared to receiving waters.

The report also found that the impacts CSDs have on recreational uses are negligible. Receiving water monitoring demonstrates that almost all instances of high levels of fecal indicator bacteria occurred when there were no CSD events. Similarly, surveys and analyses of actual recreational use show that the primary factors affecting recreation are weather and visibility rather than a CSD event.

With the exception of the few baffle and flow control improvements referenced earlier, no collection system improvements are needed relative to the efficacy of CSO controls.

<u>Maximization of Collection System Storage and Treatment</u>

To maximize flow to the treatment plants, as required by the Bayside Permit, the SFPUC currently operates the plants and major pump stations in accordance with the operating rules identified in the Bayside Permit. These rules are intended to effectively utilize existing collection system storage (including T/S boxes) without causing flooding. Due to topography and existing HGLs, expanding inline storage within the collection system is challenging. As noted in Section 3.1, modifications to specific aspects of collection system operations could potentially improve storage optimization although such improvements are not needed for regulatory compliance purposes. These include:

- North Point Main – Connections to the tunnel section of the North Point Main in the SoMa area could be modified to divert more flow to NPF. This would reduce the peaks to the Channel T/S box, which may improve overall collection system storage. This option should be furthered evaluated to ensure CSD frequency in North Shore is not increased.
- Data Acquisition and Real Time Control (RTC) – Optimal operation during wet weather is, in part, a function of the information that is available to the operators to use to make decisions. Enhanced rainfall forecasting and CSS monitoring (e.g., radar rainfall data, CSS flow and level sensors) tied to RTC elements would provide the operators with more tools to effectively operate the system.
- Griffith and Sunnydale Pump Stations – Modifications to operating rules at Sunnydale and Griffith pump stations may better distribute storage between the Southeast and Central Bayside permitted areas. Potential modifications to the pump station operations are currently being evaluated separately from the Urban Watershed Assessment. Lessons learned from the evaluations should be incorporated into the Opportunities and Alternatives Analysis phases of the Urban Watershed Assessment.
- Obstructions – Solids, grit, and debris often accumulate in sewers, thereby reducing their overall storage and conveyance capacity. The SFPUC is making modifications to their maintenance program to more quickly identify and clean these sewers. Specific sewers with known issues were identified in Section 3.1, Existing Wastewater Enterprise Challenges.

MS4 Post-Construction Stormwater Requirements

In separate sewer areas under SFPUC jurisdiction, new developments and redevelopments disturbing over 5,000 ft2 of ground surface are required to capture and treat 80% of average annual rainfall onsite. In San Francisco, this translates to capturing the runoff volume from all rain events with a total depth less than or equal to 0.75 inches OR to capturing the runoff peak flow from all rainfall intensities less than or equal to 0.2 inches per hour. The SFPUC is currently in compliance with MS4 requirements.

Potential Future Regulatory Changes

Forecasting long-term regulatory changes that may affect compliance is challenging for many reasons. Scientific developments, political priorities, and financial considerations all influence – often in unanticipated ways – the direction and extent of environmental regulation. Anticipating potential issues that may be the focus of future regulatory attention requires staying abreast of factors such as emerging trends in regulation and enforcement, changes in our understanding of ecosystem functions and impacts, alterations in land use, and technological developments. The SFPUC's robust regulatory engagement resources enable the agency to track potential regulatory trends and to participate int the development of new rules and requirements. The possible areas of further regulation described below may affect the prioritization of capital improvement projects identified through the Urban Watershed Assessment process.

Four San Francisco beaches – Baker Beach, Crissy Field, Aquatic Park, and Candlestick Point – are on the state's list of waters not meeting the water quality standards necessary to protect the beneficial use (BU) of primary water contact recreation (REC-1). REC-1 is defined as those uses that involve body contact with water where ingestion of water is reasonably possible including, but not limited to, swimming, wading, surfing, and fishing (San Francisco Bay RWQCB 2011:2-5). The causes of many of the exceedances leading to the listing are currently under investigation and are likely the result of factors other than San Francisco's discharges. For example, exceedances often occur during dry weather when there have been no discharges, and – except for Candlestick Point – CSD outfalls are typically located some distance from the receiving water monitoring location. Aquatic Park Beach, Candlestick Point, and Crissy Field Beach within the Bayside Drainage Basin are all listed on the EPA's 303(d) list for indicator bacteria (SWRCB 2007). Currently, the state has proposed 2019 as the date by which a plan, known as a Total Maximum Daily Load (TMDL), will be completed for bacteria. Unless the CSDs are demonstrated to have a negligible impact on bacteria levels, the TMDL may assign a wasteload allocation to CSDs.. Current information shows CSDs and Bayside Water Quality exceedances are not correlated.

Over the past twenty years land use in the Channel Basin has changed substantially, especially near Mission Creek. Mission Creek, which was once largely industrialized and inaccessible to the public, is now bordered by a ballpark, condominiums, parks, trails, and a kayaking facility. According to a recent recreational use study conducted by the SFPUC, water contact recreational use is still relatively light but does occur.

The study estimated 805 water-based recreational users per year, with kayaking currently accounting for 91% of that use. Similarly, the area near Islais Creek is also shifting away from industrial uses to commercial and residential uses, with plans to facilitate Bay access through creation of a shoreline park along Islais Creek. In the future, these changes may lead to an increase in the frequency of recreational uses to the extent that a re-evaluation of the Mission and Islais Creek discharges could be considered. Currently, no indication exists that current recreational uses are adversely affected by the CSDs.

Future TMDLs or revisions to existing TMDLs, could require reductions in sediment bound pollutants from the City's discharges. Currently, the T/S structures in San Francisco's CSS act to remove some solids prior to discharging, but the performance in terms of solids removal is highly variable depending on the storm event. Whether dditional reductions are necessary depends on the long term development of bay water quality assessments and the adoption of TMDLs that address specific bay quality impairment. Given the current extended regulatory schedule for addressing bay impairment and developing TMDL's, the effect of any such activities on SSIP project development is speculative.

Long-term Wet Weather Compliance

The Urban Watershed Assessment will evaluate long-term performance relative to climate change and potential future regulatory conditions. The basis for regulatory changes will be the issues presented in Section 3.2.1. The basis for tidal and rainfall conditions will be the results of the SSIP climate change analysis.

Summary of Needs to Meet LOS

The Bayside Drainage Basin is currently in compliance with wet weather requirements. However, in light of pending regulatory and climatic changes, several collection system needs have been identified that may need to be addressed as part of the SSIP to maintain long-term compliance. These needs are summarized in Table 3.3.

3.2.2 Provide a Reliable, Resilient, and Flexible System

There are two LOS related to the WWE Goal of providing a reliable, resilient, and flexible system that can respond to catastrophic events. The LOS, summarized below, are collectively referred to herein as the "Reliability and Redundancy LOS."

- Redundancy WWE LOS: Critical functions[49] are built with redundant infrastructure.

  Redundancy, where applicable, will help maintain operation of the system after a catastrophic event or equipment failure. The strategy for providing redundancy focuses on providing redundant force mains, redundant power

[49] Critical functions are defined as force mains, power supply to the WWTPs, and pumps at the existing pump stations, *Collection System Validation Report* (SSIP-PMC 2013b).

supply to the wastewater treatment plants, and redundant pumps at existing pump stations.

- Reliability WWE LOS: Primary treatment with disinfection will be on-line within 72 hours of an earthquake.

  The primary strategy to achieve this LOS is to design new facilities and retrofit critical existing facilities to withstand earthquakes of specified magnitude; magnitude 7.8 on the San Andreas Fault and magnitude 7.1 on the Hayward Fault. Critical facilities primarily include treatment plants and major pump stations.

In addition to seismic improvements at critical facilities, reliability of the system also requires that wastewater assets be renewed and replaced over time to sustain performance. To assess performance reliability needs, the SFPUC is in the process of conducting a systemwide condition assessment of its assets. Information from the condition assessments will be incorporated into the SFPUC's proactive, risk-based asset management program that prioritizes renewal and replacement projects based on the likelihood and consequence of asset failure. Anticipated needs related to performance reliability are included within this section; however, it should be understood that these needs are very preliminary and will be updated based on the results of the pending condition assessments. Moreover, it should be noted that performance reliability needs are by nature perpetual and systemwide, and therefore, projects to address these needs may be implemented by SFPUC initiatives that are outside the timeframe or purview of the SSIP.

The following sections describe the areas of the CSS in need of improvements to meet the Reliability and Redundancy LOS.

Collection System Network

As described in Section 2.8.1, the SFPUC's Renewal and Replacement (R&R) Program is systematically addressing the reliability needs of the approximately 781 miles of smaller diameter pipes city-wide (less than or equal to 36-inch) (BCM JV 2010j). The R&R process is ongoing and distinct from the SSIP capital improvements that will be recommended at the conclusion of the Urban Watershed Assessments. However, the status and schedule of the R&R Program is very relevant to identifying potential project synergies. The potential overlap between R&R and LOS needs will be evaluated as part of the Opportunities Analysis of the Urban Watershed Assessments.

Table 3.3
Bayside Collection System: SSIP Regulatory Needs

Wastewater Enterprise LOS		Bayside Collection System SSIP Improvement Needs by Urban Watershed Relative to LOS				
		North Shore	Channel	Islais Creek	Yosemite	Sunnydale
Provide a Compliant, Reliable, Resilient, and Flexible System that can Respond to Catastrophic Events						
Full compliance with state and federal regulatory requirements applicable to the treatment and disposal of sewage and stormwater	CSD Performance Criteria		Urban watershed improvements to maintain long-term average of 10 or less CSD events per year in the Central CSD Basin (currently in full compliance)	Urban watershed improvements to maintain long-term average of 10 or less CSD events per year in the Central CSD Basin (currently in full compliance)		
	Efficacy of CSO Controls	Continued monitoring of CSD effluent quality	Continued monitoring of CSD effluent quality	Continued monitoring of CSD effluent quality	Continued monitoring of CSD effluent quality	Continued monitoring of CSD effluent quality
	Maximization of Collection System Storage and Treatment	Evaluation of potential modifications to the North Point Main, especially to the drop-outs in the SoMa area to facilitate increased treatment at NPF Enhanced data (e.g., radar rainfall, CSS flow and level sensors) linked to RTC elements	Enhanced data (e.g., radar rainfall, CSS flow and level sensors) linked to RTC elements	Enhanced data (e.g., radar rainfall, CSS flow and level sensors) linked to RTC elements	Re-evaluation of Griffith Pump Station operating plan Enhanced data (e.g., radar rainfall, CSS flow and level sensors) linked to RTC elements	Re-evaluation of Sunnydale Pump Station operating plan Enhanced data (e.g., radar rainfall, CSS flow and level sensors) linked to RTC elements
	MS4 Post-Construction Stormwater Requirements		Allocation of additional staff resources to address potential increases in regulatory oversight and O&M needs (primarily at Mission Bay)	Allocation of additional staff resources to address potential increases in regulatory oversight and O&M needs (primarily at Hunters Point)	Allocation of additional staff resources to address potential increases in regulatory oversight and O&M needs (primarily at Hunters Point)	

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There are approximately 200 miles of major linear assets in San Francisco that serve as the primary collection and conveyance structures for the CSS. The SSIP is responsible for evaluating the conditions of these assets, which include the following:

- T/S boxes
- Tunnels
- Brick sewers
- Other gravity sewers, greater than 36-inch
- Force mains

The collection system condition assessments will be conducted over the next several years as part of the SSIP; the results of which will be instrumental in informing the recommended reliability and redundancy improvements to include as part of the SSIP. Although this information is not yet fully available, for the purposes of developing program budgets and schedules, the SSIP condition assessment team is currently using best available information to project assets that are likely to need structural improvements. Using the information collected by the SSIP condition assessment team, additional past studies, and information received during the Challenges interviews, this section identifies the collection system linear assets that are likely to need reliability or redundancy improvements (see Figure 3.1 on the following page). Condition assessment is differentiated from the CSAMP program described previously by the size and function of the asset. CSAMP evaluates the need to repair and/or replace collection system assets 36 inches or less, whereas the condition assessment will consider all non-line assets and pipes greater than 36" and larger, including pump stations, force mains, and other major infrastructure. The list of recommended improvements will continue to be updated as the results of the condition assessment and subsequent structural analyses are made available.

<u>T/S Boxes</u>

San Francisco has a total of 17 miles of T/S structures. The width and depth of these structures ranges from 9 feet to 24 feet wide, and from 13 feet to 52 feet deep. The Bayside Drainage Basin T/S facilities include the North Shore facilities (Marina T/S, North Point Tunnel, and Jackson T/S), Channel T/S, Islais Creek T/S, Yosemite T/S, Sunnydale T/S, and Mariposa T/S. Most T/S structures were built in the 1970s and 1980s and are considered to be in good condition (BCM JV 2010i). However because the structures are used for flow-equalizing dry-weather storage, corrosive sewer gases have caused unanticipated deterioration of the concrete crown of the structures (BCM JV 2010i). Based on available information, the SSIP condition assessment team is projecting that the T/S structures will not need immediate renewal. Current anticipated needs include: minor repair, coating improvements, cleaning, and removing debris (grit and sand accumulation was reported by operations staff to be an ongoing issue).

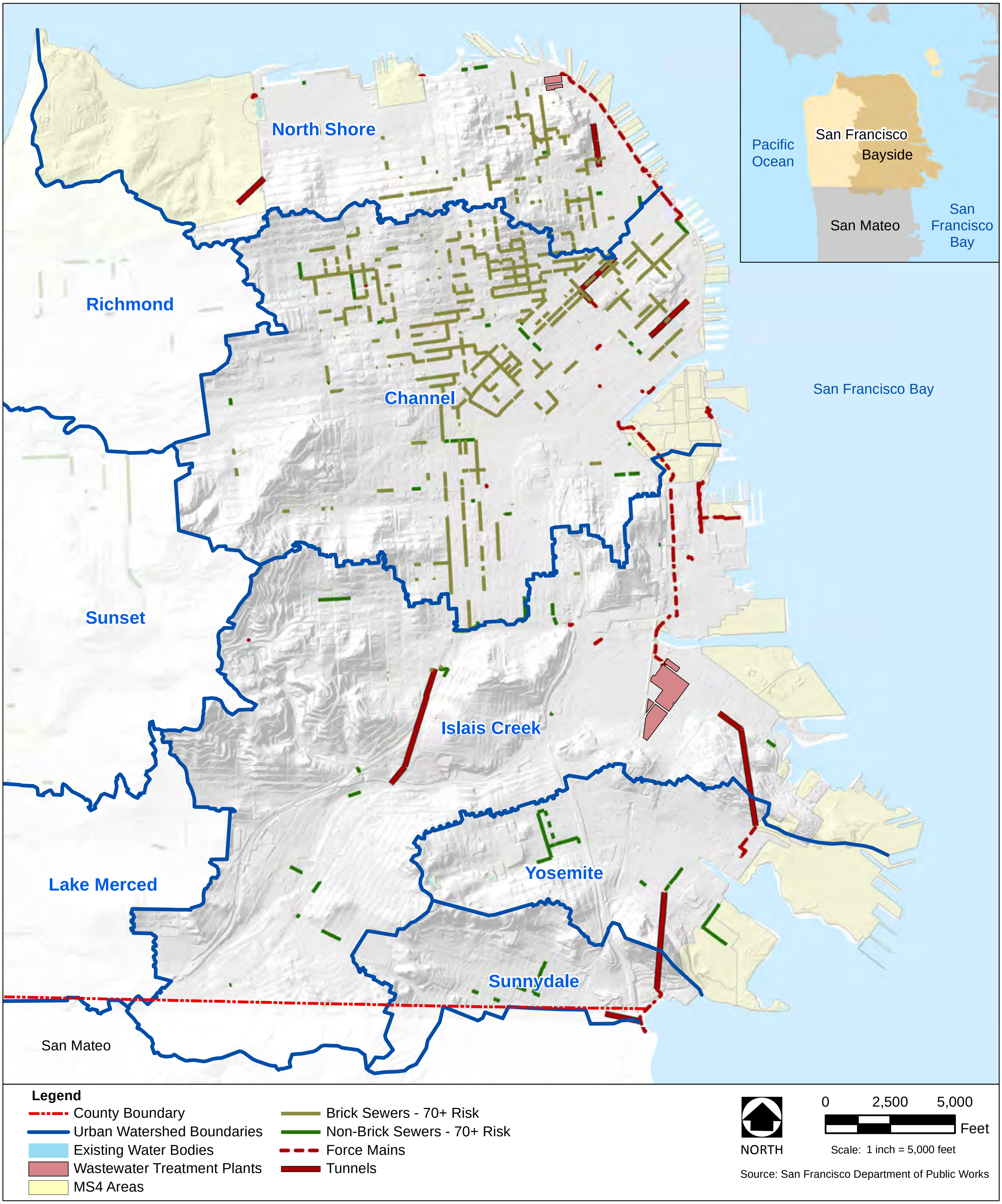

Figure 3.1: Assets in Need of Reliability or Redundancy Improvements

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

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

Minor rehabilitation needs were assumed by the SSIP condition assessment team based on available information. In addition, the Marina T/S has been specifically identified in past reports as having potential seismic reliability concerns. As summarized in Chapter 4 of the SSMP, previous investigations (Treadwell & Rollo 1997) have concluded that the Marina T/S box could experience lateral deformations in the event of a major earthquake (magnitude 7, or a repeat of the 1906 earthquake on the San Andreas Fault) that could range from 6 inches to 3 feet (BCM JV 2010i). Condition assessment of the collection system has been initiated to confirm this information through analysis and field work. The investigations concluded that the most vulnerable portion appears to be the segment between Divisadero and Scott streets, where sliding could occur through the soft Bay Mud layer that underlies loose fill, and a rockfill seawall known as Fair's seawall (see Appendix O of SSMP report for more information). The SSMP recommends that additional investigations be conducted to verify the extent of instability and develop criteria for suitable solutions. Loose fills were also found below a significant portion of the box sewer between Scott and Laguna streets. Liquefaction of the loose fills could cause settlements of the sewer, although the differential settlements may be relatively small.

- *T/S Reliability and Redundancy Needs* – With the exception of corrosion to the concrete crowns and seismic risk to the Marina T/S box, the T/S boxes are expected to be in good condition, requiring only cleaning and minor rehabilitation. Expected reliability needs should be updated after conducting condition assessments of all T/S boxes and following up with recommended investigations related to the Marina T/S box.

<u>Tunnels</u>

Table 3.4 summarizes the information for the seven large tunnels in the Bayside Drainage Basin collection system. The 'tunnel' designation is given based on the construction technique used rather than on the size of the infrastructure. Tunneling is done by cutting under the surface as opposed to "open cut" type of construction. Tunnels tend to be much deeper and use gravity to carry flows from one drainage basin to the next, crossing the drainage divide. Based on SSMP reports, tunnels built before 1920 are expected to be approaching the end of their expected useful lifespan and are at risk of possible structural failure. The tunnels constructed between 1921 and 1957 are expected to need rehabilitation to ensure continued operational reliability (BCM JV 2010i).

Table 3.4
Bayside Drainage Basin Tunnels

Name	Size	Length	Year Constructed	Expected Rehabilitation Needs[1]
Brannan Street	7'6" x 6'0"	2,034ft (0.39 mi)	1873 (relined 1934)	Minor repair, cleaning, and coating
Candlestick	4'0" x 4'6"	3,742 ft (0.71 mi)	1957	Minor repair, cleaning, and coating

Name	Size	Length	Year Constructed	Expected Rehabilitation Needs[1]
College Hill	4’0” x 6’6”	486 ft (0.09 mi)	1909	Major structural rehabilitation
College Hill	4’0” x 6’6”	5,674 ft (1.07 mi)	1925	Minor repair, cleaning, and coating
Hunters Point	6’6”	3,749 ft (0.71 mi)	1955	Minor repair, cleaning, and coating
Hunters Point-Fairfax Extension	6’6”	1,091 ft (0.21 mi)	1955	Minor repair, cleaning, and coating
Locust Street-Presidio	4’0” x 5’6”	63 ft (0.01 mi)	1900	Major structural rehabilitation
North Point Main – Sansome	8’6”	1,699 ft (0.32 mi)	1911	Major structural rehabilitation
North Point Main - Moscone	8’0”	2,381 ft (0.45 mi)	1973	Minor repair, cleaning, and coating
Sunnydale	6’6”	3,264 ft (0.62 mi)	1913	Major structural rehabilitation

Source: BCM JV 2010f.
Note:
[1] Based on information summarized in SSMP reports, particularly TM506 (BCM JV 2010j). To be updated after SSIP condition assessments are conducted.

Based on the recommendations presented in the SSMP, the SSIP condition assessment team is recommending that all tunnels built before 1920 be evaluated for major rehabilitation. Major rehabilitation includes reconstruction of the tunnel within the existing bore. The tunnels built between 1921 and 1957 may require minor rehabilitation beginning in the second decade of the program (approximately 2023). Minor rehabilitation activities for tunnels built between 1921 and 1957 may include cleaning, concrete repair work, and polyurethane coating to protect against future corrosion.

- *Tunnel Reliability and Redundancy Needs* – The following Bayside Drainage Basin tunnels are expected to need major rehabilitation: Brannan Street, College Hill (1909), Locust Street-Presidio, North Point Main - Sansome, and Sunnydale. The following Bayside Drainage Basin tunnels are expected to need minor rehabilitation: Candlestick, College Hill (1925), Hunters Point, Hunters Point-Fairfax Extension, and North Point Main – Moscone. The location of the tunnels is shown in Figure 3.1. Reliability and redundancy needs should be updated after conducting condition assessments of all tunnels.

Brick Sewers

Approximately 51 miles of brick sewers still exist in San Francisco. Almost all brick sewers are egg-shaped and 3 feet by 5 feet. Condition information about the brick sewers was derived from the 2009 Staff Technical Memorandum, "Major Sewer Rehabilitation Program," which assumed that approximately 6% (3 miles) of brick sewers might require replacement. Additionally, preliminary output from the CSAMP indicates that another 29 miles of brick sewers citywide have a Total Risk Score of 70 or greater. A score of 70 is considered "high-risk", and these sewers are expected to need some type of renewal during the lifespan of the SSIP. Renewal may involve trenchless rehabilitation, including cleaning, debris removal, and trenchless lining.

Beyond the 32 miles of sewers identified as requiring renewal in the next 30 years, most of the 51 miles of brick sewers are over 100 years old and, according to the 2009 Staff Technical Memorandum, most are near the end of their useful life. For this reason, the SSIP condition assessment team is projecting that rehabilitation will ultimately continue until all brick sewers have been renewed either by rehabilitation or replacement. It should be noted that the anticipated renewal and replacement of brick sewers may be conducted and funded separately from SSIP. Regardless of the funding mechanism, the breakdown of the anticipated 30-year improvement needs for the Bayside Drainage Basin is summarized below.

- *Brick Sewer Reliability and Redundancy Needs* – The following lengths of Bayside Drainage Basin brick sewers are expected to need improvements within the timeframe of the SSIP: 5.9 miles in North Shore, 25.4 miles in Channel, 0.2 miles in Islais Creek, 0 miles in Yosemite, and 0 miles in Sunnydale. The locations of these sewers are shown in Figure 3.1.

Major Sewers (Greater than 36 inches)

Preliminary results from CSAMP have indicated that approximately 7 miles of non-brick sewers greater than 36-inch have a Total Risk Score of 70 or greater. A score of 70 is considered "High." These results are comparable to the 2009 Staff Technical Memorandum, "Major Sewer Rehabilitation Program," which identified 5 miles of sewers as needing replacement and rehabilitation. Although this information is preliminary and likely to change, it represents the best information available at this time to estimate the miles of major sewers requiring renewal. Based on this information, the SSIP condition assessment team assumed that 7 miles of sewers citywide will be renewed during the first decade of the SSIP (at a rate of approximately 0.7 miles per year for 10 years). As with brick sewers, it should be noted that the anticipated renewal and replacement of major sewers may be conducted and funded separately from SSIP.

As noted in Section 3.1, specific major sewers in the Bayside Drainage Basin have been identified in past reports or interviews as having reliability concerns. These include:

- 5th and 6th street box sewers,
- North Point Main, and

- Early 1900s flat top reinforced concrete junction structures.

Results of preliminary assessments of the 5th and 6th street sewers found that, according to available information, the segment of the 6th Street sewer between Howard and Folsom streets may not be supported on piles (Arup 2006). This section, and the east-west connector sewers that tie into the 5th and 6th street sewers, were identified as likely being the most susceptible to the effects of liquefaction. The preliminary assessments from the Arup report also concluded that the most vulnerable portion of the North Point Main was the segment that crosses the old marshlands south of Market Street. The liquefaction risk along the rest of the length of the North Point Main was considered to be low.

To further evaluate reliability issues in these areas, the Arup report recommended that additional investigations be undertaken along Howard Street between 4th and 7th Streets to examine the thickness of liquefiable fills and develop appropriate mitigation plans, particularly for the new sewer that was planned to be constructed along 7th Street, from the Channel Pump Station to Howard Street. The new sewer was part of the package of flood improvement projects recommended in the 2010 SSIP LOS presentations given to the SFPUC commissioners, but has yet to be constructed.

The length and location of anticipated major sewer rehabilitation needs for the Bayside Drainage Basin is summarized below.

- *Major Sewer Reliability and Redundancy Needs* – The following lengths of major sewers (greater than 36-inches) are expected to need improvements within the first decade of the SSIP: 0.4 miles in North Shore, 1.9 miles in Channel, 1.3 miles in Islais Creek, 1.6 miles in Yosemite, and 0.5 miles in Sunnydale. The locations of these sewers are shown in Figure 3.1.

<u>Force Mains</u>

The two major force mains on the Bayside Drainage Basin are the Channel and North Shore Force Mains. These aging force mains, which lack redundancy and have failed recently due to structural issues, enable dry weather flow to be conveyed from the North Shore and Channel urban watersheds to the SEP. As critical pieces of infrastructure, both force mains are in need of major redundancy improvements to meet the Reliability and Redundancy LOS. In addition, there are approximately 7 miles of SFPUC-owned dry or wet weather force mains in the Bayside Drainage Basin (not including flushing force mains). Many of these force mains were built in the 1970s and 1980s. Assuming a typical useful life of 50-75 years, these force mains will be at or near the end of their useful life in the next 20 years. Although they are not as critical to dry and wet weather conveyance as the two major force mains, they serve an important role by linking low-lying areas to the collection system, feeding the treatment plants. It is likely that these minor force mains will need to be renewed during the timeframe of the SSIP to maintain their reliability.

- *Force Main Reliability and Redundancy Needs* – Major redundancy improvements are needed for the Channel and North Shore force mains. Renewal of all force mains in the Bayside Drainage Basin is also likely, but the specific needs should be reevaluated after the condition assessment is conducted. Expected length of force mains needing improvements (including North Shore and Channel force mains): 1 mile in North Shore, 1.4 miles in Channel, 3.4 miles in Islais Creek, 0.4 miles in Yosemite, and 0.4 miles in Sunnydale. The locations of the force mains are shown in Figure 3.1.

Facilities and Structures

Treatment Plants and Outfalls

During the Program Validation effort, the SSIP team completed a preliminary assessment of all treatment facilities. As a result of the assessments, the team made extensive recommendations regarding the rehabilitation and seismic reliability improvements needed. These results serve as the baseline expected needs, but will be updated as more structural investigations are conducted. See the *Draft SSIP Program Validation Treatment Plant Report* (SSIP-PMC 2013a) for more information. Recommendations for improvements to the SEP and NPF outfalls are also being developed, and the improvements will be implemented as part of the SSIP.

Pump Stations

During the Program Validation effort, the SSIP team completed a preliminary assessment of all pump stations in the collection system in an effort to understand the current condition of the stations, as well as the criticality of the stations in maintaining dry and wet weather flows. Pump stations that conveyed large flows that had no redundancy were considered to be highly critical, while smaller stations or those with redundant capabilities were considered to be less critical. Refer to the *Collection System Validation Report* (SSIP-PMC 2013b) for more information.

The condition and criticality data were used to develop estimated rehabilitation costs to improve the condition and reliability of the station. The criticality data were also used to assign priority to the investment and help determine the scope of expected improvements needed, including work to address seismic criteria. The anticipated improvement needs at each pump station are summarized in Table 3.5. Improvements are expected to include structural, seismic, mechanical, electrical, odor control, instrumentation, and operational controls that are necessary to assure a high level of reliability during dry and wet weather.

Table 3.5
Bayside Drainage Basin Pump Stations Preliminary Assessment of Needs

Pump Station Name	Capacity (MGD)	Construction Date	Dry or Wet Weather	Expected Reliability Needs	Estimated Project Timeframe
20th Street[1]	3.00	1993	Dry/Wet	Rehab	2022
Berry Street	9.21	1997	Wet	Rehab	2027
Bruce Flynn	180	1996	Wet	Rehab	2032

Pump Station Name	Capacity (MGD)	Construction Date	Dry or Wet Weather	Expected Reliability Needs	Estimated Project Timeframe
Cesar Chavez (Army Circle PS)	6.90	1975	Wet	Rehab	2017
Channel Street	103	1979	Dry/Wet	Rehab	2032
Davidson / Selby	1.00	1998	Wet	Rehab	2022
Geary Street Underpass	4.61	1960	Wet	Rehab	2022
Griffith Street	150	1989	Dry/Wet	Rehab	2027
Harriet-Lucerne Wet Weather	7.30	2005	Wet	Minor Improvements	2042
Hudson Avenue Lift	0.25	1999	Dry/Wet	Replace	2017
Mariposa Street[1]	16.0	1954	Dry/Wet	Minor Improvements	2042
Merlin Morris	9.20	1988	Wet	Rehab	2022
North Shore	150	1982	Dry/Wet	Rehab	2032
Palace of Fine Arts #1 and #2	0.43	1967	Dry/Wet	Rehab	2022
Rankin Wet Weather	3.00	1998	Wet	Rehab	2027
Shotwell Wet Weather[1]	3.00	2006	Wet	Minor Improvements	2042
Sunnydale	63.0	1991	Wet	Rehab	2027
Tennessee Street[1]	2.16	1966	Dry/Wet	Rehab	2022

Sources: BCM JV 2010c; SSIP-PMC 2013c.

Note:

[1] These pump stations may be consolidated or eliminated depending upon the final design of the proposed CBSIP.

CSD Structures

The Bayside Drainage Basin has a total of 29 CSD outfalls. A number of the CSD headwalls and outfall pipes are in poor condition. Failure of the discharge point could result in upstream flooding if flows are unable to be discharged to the receiving water body during wet weather events. In addition, other structures are currently undersized or include structural remnants that impede wet weather flow. The SSIP includes a program to inspect and rehabilitate the CSD structures to ensure that they will continue to operate as designed.

Another challenge facing the CSD structures is sea level rise. Currently, under peak high tide conditions, a number of Bayside Drainage Basin CSDs are subject to tidal inflow. If sea levels continue to rise as projected, more Bayside Drainage Basin CSDs could potentially be affected. In addition to consuming storage capacity intended for wet weather flows, the sea water, once in the T/S structures, will have to be treated at one of the two wastewater treatment facilities in the Bayside Drainage Basin. Installation of back-flow prevention devices like tide gates and duck-bill valves will prevent sea water from backing into the collection system, but will still allow CSDs to discharge to the receiving water (SSIP-PMC 2013b).

Although the SSIP assessment of CSD structures has not yet been conducted, SFPUC staff conducted initial inspections of these facilities in May/June 2011 and developed condition ratings for each ranging from 4 (No Immediate Action Recommended) to 1 (Repairs Needed As Soon As Possible). Based on these inspections and other sources of best available information, the SSIP condition assessment team developed preliminary estimates of the expected improvements needed to meet the WWE Goals for performance reliability and climate change adaption (SSIP-PMC 2012a). Specific categories of CSD structure improvements included the following:

- Repairs to address deterioration of existing structure and equipment
- Allowances to address seismic needs
- Improvements to address outfall capacity issues identified previously
- Interim improvements for mitigation of sea level rise

The preliminary list of needs relative to reliability are summarized in Table 3.6. This information should be updated based on the results of the planned CSD condition assessments. CSD structure needs relative to capacity issues and sea level rise are included in the table for completeness. However, it should be noted that these needs relate more directly to the flooding and climate change LOS described in Section 3.2.3 and 3.2.5, respectively.

Table 3.6
CSD Structures: Preliminary Assessment Needs

CSD Location	Anticipated Backflow Prevention Needs[1]	Anticipated Capacity Improvement Needs[1,2]
009 (Baker)	Hydraulic flap gate in existing structure	Extend existing underpass weir structure
010 (Pierce)	Hydraulic flap gate and vault downstream of structure	New horseshoe weir adjacent to existing weir
011 (Laguna)	Hydraulic flap gate and vault downstream of structure	
013 (Beach)	Hydraulic flap gate and vault downstream of structure	New horseshoe weir adjacent to existing weir
015 (Sansome)	Hydraulic flap gate (augment existing)	New weir within existing structure
017 (Jackson)	Hydraulic flap gate and vault downstream of structure	New side sawtooth weir adjacent to T/S Box

CSD Location	Anticipated Backflow Prevention Needs[1]	Anticipated Capacity Improvement Needs[1,2]
018 (Howard)	Hydraulic flap gate (augment existing)	New side sawtooth weir adjacent to T/S Box
019 (Brannan)	Replace existing equipment	New side sawtooth weir adjacent to T/S Box
022 (3rd Street)	Tideflex	
023 (4th Street (N))	Tideflex	
024 (5th Street)	Hydraulic flap gate (augment existing)	New horseshoe weir adjacent to existing weir
025 (6th Street (N))	Replace existing equipment	New horseshoe weir adjacent to existing weir
026 (Division Street)	Replace existing equipment	New side sawtooth weir adjacent to T/S Box
027 (6th Street (S))	Hydraulic flap gate in existing structure	
028 (4th Street (S))	Tideflex	
029 (Mariposa)	Hydraulic flap gate in existing structure	New side sawtooth weir adjacent to T/S Box
030 (20th Street)	Tideflex	
030A (22nd Street)	Tideflex	
031 (3rd Street)	Hydraulic flap gate and vault downstream of structure	
031A (Islais North)	Hydraulic flap gates	
032 (Marin Street)	Hydraulic flap gate (augment existing)	
033 (Selby Street)	Hydraulic flap gate (augment existing)	New side sawtooth weir adjacent to overflow structure
035 (3rd Street (S))	Hydraulic flap gate and vault downstream of structure	New side sawtooth weir adjacent to existing 7 ft sewer and replace outfall pipe
037 (Evans Street)	None; Outfall above 2050 design tide	
038 (Hudson Street)	None; Outfall above 2050 design tide	
040 (Griffith)	Tideflex	
041 (Yosemite)	Hydraulic flap gates	New side sawtooth weir adjacent to overflow structure

CSD Location	Anticipated Backflow Prevention Needs[1]	Anticipated Capacity Improvement Needs[1,2]
042 (Fitch)	Tideflex	
043 (Sunnydale)	Hydraulic flap gates	

Notes:

[1] From *Collection System Validation Report* (SSIP-PMC 2013b). Anticipated backflow technology listed are listed only for costing purposed and do not represent final design,

[2] Estimated capacity improvements needed to meet current 5-year design flow. Does not take into account potential increases in storm frequency or intensities due to climate change.

[3] Structural estimates based on facility size and condition rating per May/June 2011 SFPUC Inspections. Numerical ratings from those inspections ranged from “4 – No Immediate Action Recommended” to “1 – Repairs Needed As Soon As Possible”. Marin and Selby outfalls were the only CSD structures identified in the inspections as needing repairs “as soon as possible.”

[4] Estimated construction costs (without contingency) *from CSD Improvements Cost Estimate – Methodology and Assumptions – Preliminary Draft* (SSIP-PMC 2012a).

Summary of Needs to Meet LOS

Table 3.7 presents a summary of anticipated redundancy, seismic reliability, and performance reliability needs in each urban watershed within the Bayside Drainage Basin. The needs will be updated based on the results of the condition assessment analyses.

3.2.3 Integrate Green and Grey Infrastructure to Manage Stormwater and Minimize Flooding

WWE LOS: Control and manage flows from a storm of a three-hour duration that delivers 1.3 inches of rain.

For many years, a rainstorm with a 5-year return frequency has been established as the “design storm” for controlling excess flow (i.e., ponded stormwater and/or surcharged[50] combined flow) within the SFPUC sewer service area. Within the WWE LOS objectives, this storm event has been defined as 1.3 inches of rainfall over a 3-hour duration.

This Level of Service does not require elimination of all water that is either standing/pooling or moving along the land surface during the LOS storm event. Some instances are acceptable because the presence of surface water presents no material risk to public safety or property. Furthermore, where such surface water may present a material risk to public safety and property, the LOS does not require elimination; rather, it requires *control* and *management* to *maximize protection of the City*.

[50] Surcharge results when the sewer system is overloaded with a greater volume of combined flow than the system can convey per unit of time. This can result in combined flow being discharged from the system to the surface via manholes and catch basins, causing flooding in areas that are at a lower elevation than the system water level.

The UWA approach follows six steps to determine what projects and programs will be recommended to achieve the LOS to control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain. The approach considers the likelihood and potential consequences of water that is either standing/pooling or moving along the land surface during the LOS storm event that has been determined to represent potential material risk to public health and property and should be controlled and managed in order to properly protect public safety and property.

1. Using hydrologic and hydraulic modeling and recorded observations of known flooding events, identify areas of the City with high likelihood that water generated in the LOS storm event will pond or move on the surface at depths or with velocity great enough to potentially cause a risk to public safety or property. Such areas will be identified as susceptible to flooding during the LOS storm event. Areas with surface water in depths or with velocities that likely will not cause risk to public safety or property during the LOS storm event are defined as meeting the WWE LOS criteria.
2. Develop/refine a methodology for estimating the potential consequences in the areas potentially susceptible to flooding identified in sec. 1 above. The flooding consequences evaluated are to include the following:
    - Public Safety impacts – based on industry standards related to flood hazards, quantified in the context of surface water ponding and velocity thresholds and recognizing that exposure to some water on the land surface of the City may constitute a public health risk.
    - Property damages – based on the number and type of roadways and property subject to flooding, and their relative importance.
3. Prioritize the list of flooding areas identified in sec. 1 above, based on the potential risks and consequences defined in (2) above.
4. Develop Urban Watershed Assessment Alternative Recommendations for prioritized areas that include suites of management and regulatory controls, and capital projects that incorporate both grey and green infrastructure, that provide an appropriate level of protection in the LOS storm event, and that accommodate the best available information about potential future conditions related to climate change.
5. Compare and contrast project alternatives using Triple Bottom Line analyses.
6. Present alternatives to SFPUC WWE management and, upon approval, to SFPUC Commission.

Table 3.7
Bayside Collection System: SSIP Reliability and Redundancy Needs[1]

WWE Levels of Service		Bayside Collection System SSIP Improvement Needs by Urban Watershed Relative to LOS				
		North Shore	Channel	Islais Creek	Yosemite	Sunnydale
Provide a Compliant, Reliable, Resilient, and Flexible System that can Respond to Catastrophic Events						
Critical functions are built with redundant infrastructure		Redundancy for vulnerable portion of North Shore Force Main	Redundancy for Channel Force Main			
Primary Treatment, with disinfection, must be on-line within 72 hours of a major earthquake[2]	Treatment Plants and Outfalls	NPF and NP Outfall Reliability Improvements		SEP and Bay Outfall Reliability Improvements (including Southeast Lift Station and Booster Pump Station)		
	Pump Stations	Pump Station Reliability Improvements (Palace of Fine Arts, North Shore)	Pump Station Reliability Improvements (Berry, Merlin/Morris, Geary Underpass, Channel, Shotwell, Harriet-Lucerne)	Pump Station Reliability Improvements (Mariposa, 20th Street, Tennessee, Bruce Flynn, Rankin, Davidson, Hudson)	Griffith Pump Station Reliability improvements	Sunnydale Pump Station Reliability Improvements
	CSD Structures	Backflow prevention, capacity improvements, and rehabilitation at CSD outfalls	Backflow prevention, capacity improvements, and rehabilitation at CSD outfalls	Backflow prevention, capacity improvements, and rehabilitation at CSD outfalls	Backflow prevention, capacity improvements, and rehabilitation at CSD outfalls	Backflow prevention and rehabilitation at CSD outfalls
	T/S Boxes	Additional seismic investigations of Marina T/S Box Cleaning and minor rehabilitation of Marina and Jackson T/S Boxes	Cleaning and minor rehabilitation of Channel T/S Box	Cleaning and minor rehabilitation of Mariposa and Islais Creek T/S Boxes	Cleaning and minor rehabilitation Yosemite T/S Boxes	Cleaning and minor rehabilitation of Sunnydale T/S Box
	Tunnels	Major rehabilitation of North Point Main – Sansome and Locust St/Presidio	Minor repair, coating, and cleaning of Brannan Street Tunnel and North Point Main – Moscone	Major rehabilitation of College Hill Tunnel (built 1909) Minor repair, coating, and cleaning of College Hill Tunnel (built 1925)	Minor repair, coating, and cleaning of Hunters Point Tunnel	Major rehabilitation of Sunnydale Tunnel Minor repair, coating, and cleaning of Candlestick Tunnel
	Brick Sewers	5.9 miles of high-risk brick sewers to be renewed or replaced	25.4 miles of high-risk brick sewers to be renewed or replaced	0.2 miles of high-risk brick sewers to be renewed or replaced		
	Major Sewers (>36in)	0.4 miles of high-risk major sewers to be renewed or replaced	1.9 miles of high-risk major sewers to be renewed or replaced, likely including sections of the North Point Main, 5th and 6th Street box sewers, and several flat-top junction structures	1.3 miles of high-risk major sewers to be renewed or replaced	1.6 miles of high-risk major sewers to be renewed or replaced	0.5 miles of high-risk major sewers to be renewed or replaced
	Force Mains	Approx. 200 feetof force mains to be renewed	Approx. 1.4 miles of force mains to be renewed	Approx. 3.4 miles of force mains to be renewed	Approx. 0.4 miles of force mains to be renewed	Approx. 0.4 miles of force mains to be renewed

Notes:
[1] Treatment plant and outfall needs are outside the purview of the Urban Watershed Assessments. More information about planned treatment plant improvements can be found in *Draft Validation Treatment Plant Report* (SSIP-PMC 2013a).
[2] The renewal and replacement needs are anticipated based on best available information as of October 2012, but should be updated pending the results of the SSIP condition assessment work. Some needs may be addressed by SFPUC initiatives outside of SSIP.

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Managing the flows from this design storm will help to reduce the impact of excess flow to homes and businesses, and to protect public health and safety. Current levels of excess flow will be reduced through the installation of both green and grey infrastructure as part of the SSIP. The balance between green and grey infrastructure will be defined through the Urban Watershed Assessment, which employs a Triple Bottom Line evaluation. The following needs analysis defines particular areas within the CSS service area that need improvements to meet the flooding LOS, and then prioritizes those areas of need according to the magnitude of the risks caused by excess flow.

Areas Susceptible to Excess Flow

Chapter 2.0, "Urban Watershed Characteristics," details the stormwater runoff and drainage characteristics within San Francisco and explains common causes of excess flow. Excess flow is defined in this analysis as model-predicted surface flow greater than two inches in depth. Flow depths of two inches or less are screened out and discounted for two primary reasons:

1. Modeling precision, especially as related to land surface elevations and predicted surface flows, prohibits confidence at such shallow flow depths; and
2. Flow depths of two inches or less are considered incidental, as stormwater runoff may reach such a relatively shallow depth as it flows to the storm drain.

Particular areas in the City that are likely to experience excess flow during the LOS design storm have been identified via several methods:

- CCSF H&H Model simulation of the LOS design storm with documentation of predicted localized ponding and surcharge locations;
- Interviews with SFPUC and SFDPW staff about known locations of excess flow within the collection system; and
- Flood claims from the public.

The City receives input on sewer problems, including flooding, from the public based on their experiences and observations during wet weather events via the 311 system. These issues are logged in the Maximo database, which can be queried and analyzed. Obtaining information from Maximo specific to wet-weather sewer issues is complicated; however, because the database contains a variety of other information not related to wet weather and it does not contain a dedicated field to explicitly document whether the reported issue resulted from wet weather. Further, there are generally multiple time stamps associated with a single instance in the Maximo database and those time stamps are sometimes delayed or erroneous, which makes it hard to correlate any particular instance with a wet-weather day. The SFPUC is currently conducting an intensive analysis of the Maximo database specific to sewer performance issues.

Potential Impacts of Excess Flow

Two types of potential impacts that can result from excess flow during the LOS design storm were selected for analysis:

- Property Damage
- Physical Injury

The general approach, specific methodology, and results for these two analyses are presented in the following sections.

3.2.4 Risk-Based Approach

The general approach was to perform a risk analysis in order to estimate the risk posed by the potential impacts that could result from excess flow during the LOS design storm. The method of determining the location-specific risk score was to first estimate the likelihood that excess flow will cause a negative impact at any given location, and then to multiply that likelihood by the consequence of a potential impact at that location. The risk score was normalized to a scale of 1 to 10 for both analyses to allow for comparison of relative risk between different types of potential impacts. The geographically distributed risk scores represent the magnitude of risk in terms of each of the potential impacts being analyzed.

Risk Score = (Likelihood of Excess Flow Causing an Impact) X (Consequences of Potential Impact)

This approach is similar to the risk-based approach taken by CSAMP, which is being employed by the SFPUC to plan sewer replacement in San Francisco. In fact, the Physical Injury risk analysis uses the CSAMP evaluation criterion, *Proximity to Population,* to help estimate the consequences of potential public safety impacts across the City.

The likelihood that excess flow will cause an impact is the product of the likelihood of a consequential storm event occurring and the likelihood of property or public safety being impacted by surface flow resulting from that storm. The LOS design storm was simulated by the CCSF H&H Model to determine a representative geographic distribution of excess flow during a consequential storm event.[51] Once the geographic distribution of excess flow during that storm was defined, a spatial analysis was performed based on flow characteristics to estimate the likelihood that a negative impact (i.e., property damage and/or physical injury) might result.

The consequences of impacts from excess flow vary by the potential impact being analyzed. The Property Damage risk analysis focused on the magnitude of potential financial impacts that could result from excess flow using roadway and parcel characteristics to help estimate the potential consequences of such impacts. The Physical Injury risk analysis focused on potential impacts to public safety, and it used

[51] The LOS design storm has a 5-year return period; therefore, it has a 20-percent chance of occurring during given year. However, the LOS storm is not the only storm event with the potential to negatively impact property or public safety. Larger storms occur less frequently than every five years, but have the potential to cause significantly more damage. Conversely, smaller storms may cause less damage, but occur more frequently. Focusing on the LOS design storm does not capture the full range of impacts that might be caused by all possible storm events, but rather it is intended to provide a standard measure so that the areas of the CSS in need of improvements to meet the flooding LOS can be identified and prioritized according to the magnitude of their overall risk.

the CSAMP evaluation criterion, *Proximity to Population,* to estimate the potential consequences of such impacts.

Risk Analyses. A risk analysis was performed for both types of potential impacts discussed above. Several key variables were used to calculate risk scores for each analysis, as detailed in the following subsections. In addition to those variables, site-specific conditions can determine whether one site with a certain risk score is more or less vulnerable to impacts from excess flow than another site with the same risk score. For example, a building with at-grade openings is more likely to be flooded by excess flow adjacent to the building than a building with an elevated foundation. Thus, impacts during a storm event will not be spread evenly across multiple sites assigned the same risk score. Since it is not practical to analyze individual site conditions at this stage of the Urban Watershed Assessment, the general magnitude of expected impacts are correlated to different risk score ranges. Five classifications of risk scores were established for the corresponding ranges shown in Table 3.8, and each was assigned a qualitative assessment of the associated potential hazard level.

Table 3.8
Risk Score Classifications

Risk Score Range	Potential Hazard Level	Description[1]
0 < RS < 2	Negligible[2]	Hazard indicators are present, but at very low levels. No significant impacts expected.
2 ≤ RS < 4	Low	Minor impacts possible at vulnerable sites. No Major impacts expected.
4 ≤ RS < 6	Medium	Minor to moderate impacts possible at vulnerable sites. No Major impacts expected.
6 ≤ RS < 8	High	Minor to moderate impacts possible at most sites. Major impacts possible at vulnerable sites.
8 ≤ RS ≤ 10	Very High	Minor to major impacts possible at most sites.

Notes:
[1] Minor impacts are considered to be nuisances, but do not cause permanent damage. Moderate impacts are assumed to require minor repair in the form of materials replacement (surfacing and contents), but no structural work. Major impacts are assumed to require major repair or replacement.
[2] Not shown on the risk score maps in this section.

The analyses described herein were performed strictly within the context of an occurrence of the LOS design storm event. Using only the LOS design storm as the basis for analysis does not explicitly evaluate CSS performance during storms with different intensities and durations, and it does not capture the cumulative likelihood that impacts will occur during any given period of time (e.g., annually). Rather, the LOS design storm was chosen as a representative storm because the SFPUC's WWE Goal is to manage and control flows during a storm of that intensity and duration.

The geographically distributed risk scores resulting from each of the three analyses are intended to represent the general magnitude of risk in terms of property damage and physical injury that could potentially result from excess flow during the LOS design storm. The risk analyses described herein do not attempt to predict or quantify actual damages that would result from an occurrence of the LOS design storm. Based on the calculated risk scores, areas of concentrated risk were identified and prioritized to help inform selection of improvement projects that would help attain the SFPUC's WWE Goals.

Input Data for Risk Analyses. The CCSF H&H Model has the ability not only to determine the quantity of surface flow, but also to route that flow on the surface prior to entering the CSS. Thus, the model provides data for expected maximum velocity, depth, and footprint of surface flow. These data from the CCSF H&H Model were used to identify areas where excess flow during the LOS design storm could potentially cause conditions hazardous to property and/or public safety.

Additional data was used in conjunction with the model results to evaluate the likelihood that hazardous conditions caused by the design storm would result in negative impacts to property and/or public safety. Parcel, building, and land use data were used in conjunction with the footprint and depth of excess flow to assess the risk of property damage. The CSAMP criterion, Proximity to Population, was used in conjunction with flow depth and velocity to estimate the physical injury risks of public exposure to concentrated surface flow. The scoring method for the CSAMP Proximity to Population criterion is summarized in Table 3.9; this criterion was not modified for this application, but was rather used in its existing form.

Table 3.9
CSAMP Scoring Method for Its Proximity to Population Criterion

Relative Consequence of Failure	Score	Description of Criteria
Negligible	1	Includes General Residential Areas and other area of little or no population
Low	4	Includes areas that provide Low to Moderate possibilities of exposure, including areas near BART stations, MUNI stations, or other transportation hubs
Moderate	7	Includes areas that provide Moderate possibilities of exposure, including areas with high foot traffic, i.e., medium to high commercial districts that include retail, commercial, and office uses

Relative Consequence of Failure	Score	Description of Criteria
Severe	10	Includes areas that provide Severe possibilities of exposure, including areas with Public Facilities, including schools, hospitals, etc.

Source: SFPUC 2012g.

Specific methodologies for each of the two risk analyses are detailed in the following subsections.

Property Damage Risk Analysis Methodology

Definition of *Property Damage* = financial expense to repair or replace structures, automobiles, and contents therein that may be damaged by excess flow.

Streets and buildings potentially impacted by excess flow were identified using the following spatial data layers:

- Depth of surface flow (CCSF H&H Model output)
- Streets map (City streets data)
- Buildings map (City buildings data)

Consequence was calculated using the following spatial data:

- Depth of surface flow (CCSF H&H Model output)
- Parcels:
  - Number of facilities potentially flooded (City buildings data)
  - Square footage of facility footprints potentially flooded (City buildings data)
  - Type of facilities potentially flooded (County Assessor land use data)
- Length of roadway potentially flooded (City streets data)

The property damage risk analysis was conducted with the intent to evaluate the risk of flood damage during the LOS design storm to buildings that are likely to experience surface flow adjacent to the structure, and to cars in roadways with a modeled flow depth greater than 12 inches. The susceptibility of a building to flood damage depends on the elevation of its foundation relative to surrounding grade. It was not practical to evaluate the relative elevation of individual building foundations, so a Flow Depth Factor based on the depth of adjacent flow was assigned to account for the likelihood that a building might flood. The Flow Depth Factor was then used in conjunction with the County Assessor's land use classification to calculate the risk score for a building; a base risk score of 1 to 10 was assigned based on land use, then scaled down if flow depth was less than 12 inches. During the opportunities analysis land uses will be evaluated in more detail to account for nuances, vacant land or government land uses. For cars in the street, damage was assumed to occur only when flow depth exceeded 12 inches; therefore, a Flow Depth Factor of one was assigned to depths greater than 12 inches in the street, and a factor of zero was assigned to all flow depths 12 inches or less.

The steps taken to perform the *Property Damage* spatial analysis include:

1. Determine the maximum footprint and maximum depth of surface flow during the LOS design storm
   a. Export geographic data layer from the CCSF H&H Model containing surface flow data during LOS design storm
2. Identify streets that are likely to have flow depths of more than 12 inches
   a. Overlay areas of surface flow on the street layer to identify lengths of roadway likely to be inundated with more than 12 inches of surface flow
   b. Tally the total flooded roadway area, assuming an average 50-foot roadway width
3. Identify buildings that might be impacted, and assign a likelihood factor based on flow depth during the LOS design storm
   a. Perform a spatial analysis of flow depth adjacent to buildings and in the street
   b. Categorize depth of adjacent flow and assign Flow Depth Factor per Table 3.10
   c. Overlay parcel and land use data layers with the potentially flooded buildings
   d. Tally the number and square footage of potentially flooded buildings, classify by depth of flooding (Table 3.10) and land use type (Table 3.11)
4. Calculate risk scores based on expected magnitude of repair and replacement costs resulting from excess flow in buildings and streets
   a. Multiplying the base risk score for different land use classifications (Table 3.11) by the Flow Depth Factor (Table 3.10)

Table 3.10
Flow Depth Factors

Depth of Adjacent Flow	Flow Depth Factor	Description[1]
<2 inches	0.0	No damage expected.
2-6 inches	0.4	Minor to moderate damage possible to susceptible buildings. No damage expected to buildings with elevated foundations. No damage expected to cars in street.

Depth of Adjacent Flow	Flow Depth Factor	Description[1]
6-12 inches	0.7	Moderate to major damage likely to susceptible buildings. Minor to moderate damage possible to buildings with elevated foundations. No damage expected to cars in street.
> 12 inches	1.0	Moderate to major damage likely to susceptible buildings. Moderate to major damage possible to buildings with elevated foundations. Damage expected to cars in street.

Note:
[1] Susceptible buildings are defined as those with low-lying or at-grade foundations. Assumptions regarding foundation heights approximated from F-RAM foundation height assumptions (Table C-2 in DWR 2008).

Table 3.11
Base Risk Score for Potential Property Damage
(by Land-Use Classification)

Land Use Classification[1]	Base Risk Score[2]
Street	2
Open Space	4
Residential	7
Institutional	8
Mixed Use	9
Commercial / Industrial	10

Notes:
[1] Land Use Classification grouped from County Assessor's Use Codes.
[2] Base Risk Score for buildings approximated from estimated replacement costs by land use type (Table C-3 in DWR 2008).

Physical Injury Risk Analysis Methodologies

Definition of *Physical Injury* = bodily injury caused by fast-moving surface flow and possibly associated debris.

Areas of surface flow and its characteristics were identified using the following spatial data layers:

- Footprint of surface flow with maximum depth and velocity (CCSF H&H Model output)

Consequence was calculated using the following spatial data:

- Footprint, maximum velocity, and maximum depth of surface flow (CCSF H&H Model output)
- CSAMP criterion *Proximity to Population* (see Table 3.9)

The Physical Injury risk analysis was conducted with the intent to evaluate the risk of physical human injury resulting from exposure to fast and deep surface flow, and possibly associated debris, that may occur during the LOS design storm. The "Flood Risks to People" methodology formulated by the British government (Defra/Environmental Agency, 2005) was used to estimate the personal hazard level given flow of a certain depth and velocity. That metric, called the Flood Hazard Rating (FHR), was then used in conjunction with the CSAMP Proximity to Population score to calculate the overall risk score. The CSAMP score provided a baseline value of 1 to 10, and that value was scaled down for FHR values less than two (see Table 3.12 for an explanation of FHR values).

The steps taken to perform the *Physical Injury* spatial analysis include:

1. Determine the extent and intensity of surface flow
   a. Export geographic data from the CCSF H&H Model containing the maximum footprint, depth, and velocity of surface flow resulting from the LOS design storm
2. Calculate the FHR
   a. Apply the "Flood Risks to People" methodology to calculate the FHR per the following equation:

      $$FHR = d \times (v + 0.5) + DF$$

      Where:

      d = depth of flooding (m);

      v = velocity of floodwaters (m/sec)

      DF = debris factor (0.5 for $d \leq 0.25$m, 1.0 for $d > 0.25$m) (Surendren et al. 2008:Table 4)
   b. The resultant FHR value is classified into the categories listed in Table 3.12
3. Estimate the population density around hazard areas
   a. Overlay the footprint of surface flow with CSAMP rankings for *Proximity to Population* criterion, and apply the corresponding CSAMP criterion value to each hazard area
4. Calculate the Physical Injury Risk Score
   a. Multiply the FHR (step 2) by the CSAMP criterion value (step 3), and then divide by 2 to normalize the results to a scale of 1 to 10 (resultant risk scores > 10 are rounded down to 10)

Table 3.12
Thresholds and Categories for Flood Hazard Rating

Flood Hazard Rating (FHR) Value Thresholds	Degree of Flood Hazard	Description
< 0.75	Low	Caution - "Flood zone with shallow flowing water or deep standing water"

0.75-1.25	Moderate	Dangerous for some (i.e. children) - "Danger: Flood zone with deep or fast flowing water"
1.25-2.0	Significant	Dangerous for most people - "Danger: flood zone with deep fast flowing water"
> 2.0	Extreme	Dangerous for all - "Extreme danger: flood zone with deep Fast flowing water"

Source: Surendren et al. 2008:Table 2.

Results of Risk Analysis

Summary tables and maps are presented below to illustrate the results of the two risk analyses performed for potential property damage and physical injury in the Bayside Drainage Basin. Additional tabular results and detailed discussions of the results for each of the five Bayside Drainage Basin urban watersheds are also summarized in the following subsections.

Risk of Property Damage. Table 3.13 provides a summary of the roadway areas predicted to have at least 12 inches of flow during the LOS design storm event in the Bayside Drainage Basin, and the building areas predicted to have at least 2 inches of flow. Potential damage to cars in the roadway is assumed to start at depths greater than 12 inches, and all depths greater than that are considered in this analysis to pose equal risk for property damage to cars. Flow depths adjacent to buildings are classified by ranges of depth, with greater depth corresponding to greater risk (see Table 3.10). Building areas are taken as the footprint of the building structure, assuming the entire bottom floor is at equal risk. Yellow cells in Table 3.13 indicate areas predicted to be at medium risk, orange indicate high risk, and red indicate very high risk. Cells shown in white in the table are not considered to be at risk.

Table 3.13
Summary Results of Bayside Drainage Basin Areas at Risk for Potential Property Damage

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of total drainage basin)]						
	Land Use Classification[2]						Total Area by Depth
	Roadways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
2-6 inches	N/A[4]	N/A[4]	99 (0.54%)	6.2 (0.03%)	2.8 (0.02%)	38 (0.21%)	146 (0.79%)
6-12 inches	N/A[4]	1.5 (0.01%)	30 (0.16%)	2.9 (0.02%)	0.3 (0.00%)	19.6 (0.11%)	54 (0.29%)
>12 inches	17 (0.09%)	1.0 (0.01%)	19.9 (0.11%)	1.9 (0.01%)	0.6 (0.00%)	11.7 (0.06%)	52 (0.28%)
Total Area by Land Use	17 (0.09%)	2.5 (0.01%)	149 (0.81%)	11 (0.06%)	3.7 (0.02%)	69 (0.38%)	253 (1.37%)

Low Risk	Medium Risk	High Risk	Very High Risk

Notes:
[1] Flow depth for buildings is taken as flow adjacent to buildings because the CCSF H&H Model does not allow flow to enter buildings.
[2] Areas are tallied by summing the footprints of potentially flooded streets and buildings.
[3] Street areas assume a roadway width of 50 feet.
[4] Not included because this classification has a risk score of less than 2.

Residential and commercial/industrial land uses have 95% of the total area potentially at risk for significant impacts from excess flow (i.e., medium or higher risk). Residential land uses have approximately 37% (868,000 ft^2) of the building area potentially at risk for significant damage, and commercial/industrial land use have approximately 58% (1,363,000 ft^2). Mixed use and government/institutional land uses have the remaining 5% of the building area potentially at risk for major flood damage. Flooding in roadways, which could potentially damage cars, and in open space is not considered to pose a risk for damage.

In terms of geographical distribution, the Channel urban watershed contains the greatest quantity and density of property at risk for potentially significant flood damage. Islais Creek watershed has a slightly lower, but still substantial, quantity and density of at-risk property. Yosemite urban watershed also has a relatively high density of at-risk property, but not a large quantity due to the small watershed size. The North Shore and Sunnydale urban watersheds have significantly lower quantities and densities of at-risk property. Areas of concentrated risk are discussed in the following subsections.

Risk of Potential Physical Injury. Proximity to population and FHR, which is based on flood depth and velocity, were the two primary determinants in estimating the risk for potential physical injury. Characteristics of areas in different risk categories are summarized in Table 3.14.

Table 3.14
Physical Injury Risk Category by
Land Area Type and Flood Hazard Rating

Land Area Type	Flood Hazard Rating (FHR)			
	Very Low	Low	Medium	High
Areas near BART, Muni, or other transportation hubs with medium concentrations of surcharged flow	1<FHR<2	2<FHR<3	3<FHR<4	4<FHR
Areas with high foot traffic (e.g., commercial districts) with low concentrations of surcharged flow	0.6<FHR<1.1	1.1<FHR<1.7	1.7<FHR<2.3	2.3<FHR
Areas that are home to public facilities such as schools or hospitals with low concentrations of surcharged flow	0.4<FHR<0.8	0.8<FHR<1.2	1.2<FHR<1.6	1.6<FHR

Low Risk	Medium Risk	High Risk	Very High Risk

Areas not covered by the four risk categories described in Table 3.14 are considered to have negligible risk for physical injury during the LOS design storm event. Table 3.15 provides a summary of the total areas predicted to be at various levels of risk, organized by urban watershed.

Table 3.15
Summary Results of Bayside Drainage Basin Risk Analysis for Potential Physical Injury

Risk Score Classification	Areas at Risk for Potential Physical Injury [acres (% of total urban watershed or total drainage basin)]					
	North Shore	Channel	Islais Creek	Yosemite	Sunnydale	TOTAL
Low	2.9 (0.10%)	9.8 (0.17%)	7.1 (0.11%)	0.9 (0.05%)	0.7 (0.07%)	21.5 (0.12%)
Medium	0 (0%)	0.8 (0.01%)	1.6 (0.02%)	0 (0%)	0 (0%)	2.5 (0.01%)
High	0 (0%)	1.7 (0.03%)	1.4 (0.02%)	0 (0%)	0.1 (0.01%)	3.2 (0.02%)
Very High	0 (0%)	0.1 (0.00%)	0.7 (0.01%)	0 (0%)	0 (0%)	0.8 (0.00%)
Total Area At Risk	3.0 (0.10%)	12.4 (0.22%)	10.9 (0.16%)	1.0 (0.05%)	0.8 (0.09%)	28.1 (0.15%)

Low Risk	Medium Risk	High Risk	Very High Risk

According to the results of this analysis, almost 97% of the areas that pose a significant risk for physical injury during the LOS design storm are located in Channel and Islais Creek urban watershed. The vast majority of those areas are located along historical creek channels. Excess flow in flat, low-lying areas generally has a low enough velocity that it does not pose a serious risk for physical injury, with one major exception in SoMa where excess flow occurs at a high relative depth.

Areas of concentrated risk are discussed in the following subsections.

Potential Impacts of Excess Flow

The following subsections described the risk of property damage and physical injury by urban watershed.

North Shore Urban Watershed

Risk of Property Damage. The areas in the North Shore urban watershed that are at risk for potentially significant flood damage are concentrated in several neighborhoods. Areas in Cow Hollow on either side of Steiner Street are considered to be at medium risk. Another small pocket considered to be at medium risk is on either side of Lombard Street between Broderick and Baker streets. There is a small, high-risk area just west of Fort Mason; however, site investigation is recommended to validate that predicted risk. The densest area of flood risk is in Fisherman's Wharf along the Embarcadero and extending inland along Powell and Mason streets.

Table 3.16 summarizes the roadway areas in the North Shore urban watershed predicted to have at least 12 inches of flow during the LOS design storm event, and the building areas predicted to have at least 2 inches of flow. Residential land uses have the most area at risk for potentially significant property damage in the North Shore urban watershed, mostly in the Marina, Cow Hollow, and North Beach neighborhoods. These same neighborhoods, plus Fisherman's Wharf, contain most of the other areas that are considered to be at significant risk for flooding, which are predominantly commercial.

Table 3.16
Area at Risk for Property Damage in North Shore Urban Watershed

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of North Shore urban watershed)]						
	Land Use Classification[2]						Total Area by Depth
	Road-ways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
2-6 inches	N/A[4]	N/A[4]	23.3 (0.77%)	0.4 (0.01%)	0.4 (0.01%)	4.9 (0.16%)	29.1 (0.95%)
6-12 inches	N/A[4]	0.1 (0.00%)	3.5 (0.12%)	0 (0%)	0.1 (0.00%)	1.1 (0.04%)	4.8 (0.16%)
>12 inches	0 (0%)	-	1.9 (0.06%)	0.2 (0.01%)	0.2 (0.01%)	0.4 (0.01%)	2.7 (0.09%)
Total Area by Land Use	0 (0%)	0.1 (0.00%)	28.8 (0.94%)	0.6 (0.02%)	0.7 (0.02%)	6.4 (0.21%)	36.6 (1.20%)

Low Risk	Medium Risk	High Risk	Very High Risk

Notes:
[1] Flow depth for buildings is taken as flow adjacent to buildings because the CCSF H&H Model does not allow flow to enter buildings.
[2] Areas are tallied by summing the footprints of potentially flooded streets and buildings.
[3] Roadway areas assume a roadway width of 50 feet.
[4] Not included because this classification has a risk score of less than two.

Risk of Physical Injury. There are no large zones in the North Shore urban watershed that are predicted to pose a significant threat to physical safety during the LOS design storm. There are some clusters of low-risk areas in the Marina, Cow Hollow, Fisherman's Wharf, and Financial District neighborhoods. Low velocities prevent the risk of injury in these areas from becoming significant. There is a small, high-risk area near the intersection of Bay Street and the Embarcadero, but the validity of that predicted risk seems questionable based on site characteristics.

Channel Urban Watershed

Risk of Property Damage. The areas in the Channel urban watershed that are at risk for potentially significant flood damage are concentrated primarily in four zones, two of which correspond to the location of historical creek channels. Medium to high-risk areas stretch along the historical Hayes Creek channel in the Western Addition neighborhood, from near the intersection of Sutter and Pierce streets zigzagging down to the intersection of Market Street and Van Ness Avenue. The densest concentration of at-risk areas is located along the historical Mission Creek channel in the Inner Mission neighborhood, running northerly from the intersection of Folsom and 18th streets to 13th Street before turning east and running through the Design District on Division Street towards the existing Mission Creek slough. The third concentration of at-risk areas is located in central SoMa, south of Folsom Street along 5th and 6th streets. There are other intermittent pockets of at-risk locations in SoMa. The final concentration of at-risk areas is located along the Panhandle Parkway between Oak and Fell streets, and along Fulton Street running parallel three blocks to the north. Flows from that area then zigzag southeast and back up around the intersection of Market and Church streets, creating some scattered medium to high-risk areas.

Table 3.17 summarizes the roadway areas in the Channel urban watershed predicted to have at least 12 inches of flow during the LOS design storm event, and the building areas predicted to have at least 2 inches of flow. Commercial/industrial land use contains the most area at risk for potentially significant property damage in the Channel urban watershed. Most of these areas are in the Western Addition along Fillmore Street, the Hayes Valley commercial district, the Inner Mission, and southwestern SoMa. Residential land use in the Western Addition and Inner Mission contain most of the other areas considered to be at risk for significant flood damage.

Table 3.17
Area at Risk for Property Damage in Channel Urban Watershed

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of Channel urban watershed)]						
	Land Use Classification[2]						Total Area by Depth
	Roadways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
2-6 inches	N/A[4]	N/A[4]	26.0 (0.46%)	1.4 (0.03%)	1.1 (0.02%)	16.5 (0.29%)	45.0 (0.79%)
6-12 inches	N/A[4]	0.4 (0.01%)	7.3 (0.13%)	1.0 (0.02%)	0.2 (0.00%)	8.7 (0.15%)	17.5 (0.31%)
>12 inches	4.7 (0.08%)	0.3 (0.01%)	4.7 (0.08%)	0.1 (0.00%)	0.3 (0.01%)	5.1 (0.09%)	15.3 (0.27%)
Total Area by Land Use	4.7 (0.08%)	0.7 (0.01%)	38.1 (0.67%)	2.5 (0.04%)	1.5 (0.03%)	30.3 (0.53%)	77.8 (1.37%)

Low Risk	Medium Risk	High Risk	Very High Risk

Notes:
[1] Flow depth for buildings is taken as flow adjacent to buildings because the CCSF H&H Model does not allow flow to enter buildings.
[2] Areas are tallied by summing the footprints of potentially flooded streets and buildings.
[3] Roadway areas assume a roadway width of 50 feet.
[4] Not included because this classification has a risk score of less than two.

Risk of Physical Injury. There are three zones in the Channel urban watershed that are predicted to pose significant risk for potential physical injury during the LOS design storm. As with the Property Damage risk analysis, there is a strong pattern of risk along the historical Hayes and Mission creek channels and in a portion of SoMa. The first zone is mostly low-risk areas along the historical alignment of Hayes Creek, but there are small intermittent pockets of medium- and high-risk areas. The most intense zone of high-risk area is predicted along the historical alignment of Mission Creek from around the intersection of Folsom and 18th streets to the intersection of Harrison and 13th street, then turning east along Division Street in the Design District. The final zone includes medium- to high-risk areas in SoMa south of Folsom Street, between 5th and 6th streets, particularly around the Caltrain yard.

Islais Creek Urban Watershed

Risk of Property Damage. The areas in the Islais Creek urban watershed that are at risk for potentially significant flood damage are located primarily along the historical channels of Precita and Islais creeks, near their historical outlets to the Bay. There are sporadic spots of medium to high risk in the upper reaches of the urban watershed, especially in the Excelsior, Outer Mission, and southern Glen Park neighborhoods. The sporadic distribution of risk in those neighborhoods indicates that the volume of water creating the risk at each specific location is relatively low and could potentially be remedied with smaller, distributed projects.

Table 3.18 summarizes the roadway areas in the Islais Creek urban watershed predicted to have at least 12 inches of flow during the LOS design storm event, and the building areas predicted to have at least 2 inches of flow. Flood risk in the Islais Creek urban watershed is similar in profile to, if slightly less intense than, the flood risk in the Channel urban watershed. Commercial/industrial land use contains the most area at risk for potentially significant property damage, but proportionately, more of that area is industrial than in the Channel urban watershed. Most of the industrial land use is in the Bayview-Hunter's Point neighborhood and flood risk is concentrated to the west of the SEP. The Cesar Chavez contains many commercial and residential areas considered to be medium to high risk for potential property damage. Residential land use in the upland neighborhoods that comprise the urban watershed headlands and in Bayview-Hunter's Point contain most of the other areas considered to be at risk for significant flood damage. It is worth noting that a lot of the deep flows in the Islais Creek urban watershed occur in the streets, particularly along the Alemany Boulevard corridor.

Table 3.18
Summary Table for Property Damage Risk Analysis in Islais Creek Urban Watershed

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of Islais Creek urban watershed)]						
	Land Use Classification[2]						Total Area by Depth
	Roadways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
2-6 inches	N/A[4]	N/A[4]	33.4 (0.50%)	2.0 (0.03%)	0.8 (0.01%)	12.2 (0.18%)	48.4 (0.72%)
6-12 inches	N/A[4]	1.0 (0.01%)	13.5 (0.20%)	1.2 (0.02%)	0 (0%)	7.6 (0.11%)	23.3 (0.35%)

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of Islais Creek urban watershed)]						
	Land Use Classification[2]						Total Area by Depth
	Roadways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
>12 inches	11.9 (0.18%)	0.7 (0.01%)	8.8 (0.13%)	0.6 (0.01%)	0.1 (0.00%)	4.6 (0.07%)	26.7 (0.40%)
Total Area by Land Use	11.9 (0.18%)	1.7 (0.03%)	55.8 (0.83%)	3.7 (0.06%)	0.9 (0.01%)	24.4 (0.36%)	98.4 (1.47%)

Low Risk	Medium Risk	High Risk	Very High Risk

Notes:
[1] Flow depth for buildings is taken as flow adjacent to buildings because the CCSF H&H Model does not allow flow to enter buildings.
[2] Areas are tallied by summing the footprints of potentially flooded streets and buildings.
[3] Roadway areas assume a roadway width of 50 feet.
[4] Not included because this classification has a risk score of less than two.

Risk of Physical Injury. The two most intense and extensive zones in the Islais Creek urban watershed that are predicted to pose significant risk for potential physical injury during the LOS design storm occur along the historical Islais and Precita creek channels. There are medium- to high-risk areas along the Cesar Chavez corridor from Guerrero Street down to Potrero Avenue, corresponding to the historical alignment of Precita Creek. There is a large pocket of high-risk area along lower Alemany Boulevard on either side of Highway 101, coinciding with the historical alignment of Islais Creek. There is also a small area of medium to high risk just north of Islais Creek Slough west of Indiana Street; that area is undeveloped City land that is currently fenced off. There is another short stretch of small, intermittent, high-risk areas southwest of Glen Park that runs for a couple blocks along Foerster Street north of Monterey Boulevard.

Yosemite Urban Watershed

Risk of Property Damage. The areas in the Yosemite urban watershed that are at risk for potentially significant flood damage correspond to the historical Yosemite Creek channel. While the at-risk areas are relatively evenly distributed throughout the urban watershed, the highest concentration is near the historical outlet to the Bay, west of the remaining Yosemite Creek slough in southern Bayview-Hunter's Point.

Table 3.19 summarizes the roadway areas in the Yosemite urban watershed predicted to have at least 12 inches of flow during the LOS design storm event, and the building areas predicted to have at least 2 inches of flow. Commercial/industrial land use contains the most area at risk for potentially significant property damage. Most of the industrial land use is in the flatlands near the Bay, and the commercial center is located along the 3rd Street corridor. Traveling further inland to the west, residential becomes the dominant land use, and it contains most of the other areas considered to be at risk for significant flood damage. The Yosemite urban watershed contains a higher percentage of government/institutional land use at risk for flood damage than any other Bayside Drainage Basin urban watershed.

Table 3.19
Summary Table for Property Damage Risk Analysis in Yosemite Urban Watershed

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of Yosemite urban watershed)]						
	Land Use Classification[2]						Total Area by Depth
	Roadways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
2-6 inches	N/A[4]	N/A[4]	10.2 (0.50%)	0.9 (0.05%)	0.2 (0.01%)	3.8 (0.19%)	15.2 (0.75%)
6-12 inches	N/A[4]	0 (0%)	2.7 (0.13%)	0.3 (0.01%)	0 (0%)	1.6 (0.08%)	4.7 (0.23%)
>12 inches	0.4 (0.02%)	0 (0%)	2.4 (0.12%)	0.6 (0.03%)	-	1.2 (0.06%)	4.7 (0.23%)
Total Area by Land Use	0.4 (0.02%)	0 (0%)	15.3 (0.75%)	1.9 (0.09%)	0.2 (0.01%)	6.7(0.33%)	24.5 (1.20%)

Low Risk	Medium Risk	High Risk	Very High Risk

Notes:
[1] Flow depth for buildings is taken as flow adjacent to buildings because the CCSF H&H Model does not allow flow to enter buildings.
[2] Areas are tallied by summing the footprints of potentially flooded streets and buildings.
[3] Roadway areas assume a roadway width of 50 feet.
[4] Not included because this classification has a risk score of less than two.

Risk of Physical Injury. There are no large zones in the Yosemite urban watershed that are predicted to pose a significant threat to physical safety during the LOS design storm. There are several stretches of low-risk areas, but low velocities generally prevent the risk of injury in these areas from becoming significant. There is a very small medium-risk area near the intersection of Phelps Street and Bancroft Avenue, but the extent of that area barely spreads beyond the intersection.

Sunnydale Urban Watershed

Risk of Property Damage. The Sunnydale urban watershed contains the lowest quantity and concentration of areas at risk for potentially significant flood damage of any Bayside Drainage Basin urban watershed. The main hot spot is in the eastern part of the urban watershed along Bayshore Boulevard, west of the Bayshore Caltrain station. The Visitacion Valley Redevelopment Project, currently under construction, should remedy the drainage problems in this area. Another high-risk area is a small warehouses district just northwest of the Geneva Avenue and Bayshore Boulevard intersection. Other small spots of at-risk areas are scattered throughout the lowlands of Visitacion Valley.

Table 3.20 summarizes the roadway areas in the Sunnydale urban watershed predicted to have at least 12 inches of flow during the LOS design storm event, and the building areas predicted to have at least 2 inches of flow. Residential land use contains the most area at risk for potentially significant property damage, followed by commercial/industrial, and then government/institutional land uses. Similar to the Yosemite urban watershed, most of the industrial land use in the Sunnydale urban watershed is in the flatlands near the Bay. Land use transitions to more commercial traveling inland to the west, then by residential which becomes the dominant land use in the interior urban watershed. Also similar to Yosemite, Sunnydale urban watershed contains a relatively high percentage of government/institutional land use at risk for flood damage.

Table 3.20
Summary Table for Property Damage Risk Analysis in Sunnydale Urban Watershed

Flow Depth[1]	Street and Building Areas at Risk for Flooding [acres (% of Sunnydale urban watershed)]						
	Land Use Classification[2]						Total Area by Depth
	Roadways[3]	Open Space	Residential	Government/ Institutional	Mixed Use	Commercial/ Industrial	
2-6 inches	N/A[4]	N/A[4]	6.1 (0.63%)	1.4 (0.15%)	0.4 (0.04%)	0.8 (0.08%)	8.7 (0.89%)
6-12 inches	N/A[4]	0 (0%)	2.6 (0.26%)	0.4 (0.04%)	0 (0%)	0.6 (0.06%)	3.7 (0.37%)
>12 inches	0.1 (0.01%)	-	2.1 (0.21%)	0.3 (0.04%)	0 (0%)	0.3 (0.03%)	2.9 (0.30%)
Total Area by Land Use	0.1 (0.01%)	0 (0%)	10.8 (1.11%)	2.2 (0.23%)	0.4 (0.04%)	1.7 (0.17%)	15.2 (1.56%)

Low Risk	Medium Risk	High Risk	Very High Risk

Notes:
[1] Flow depth for buildings is taken as flow adjacent to buildings because the CCSF H&H Model does not allow flow to enter buildings.
[2] Areas are tallied by summing the footprints of potentially flooded streets and buildings.
[3] Roadway areas assume a roadway width of 50 feet.
[4] Not included because this classification has a risk score of less than two.

Risk of Physical Injury. There are no large zones in the Sunnydale urban watershed that are predicted to pose a significant threat to physical safety during the LOS design storm. There are sporadic small pockets of medium- to high-risk areas on both sides of Bayshore Boulevard in the central urban watershed. The larger of these areas are east of Bayshore Boulevard in the Visitacion Valley Redevelopment Project, currently under construction, which should remedy those drainage problems. There is a stretch of medium- to high-risk area in a parking lot running along the northern border of a small warehouses district just northwest of the Geneva Avenue and Bayshore Boulevard intersection.

Summary of Needs to Meet LOS

Table 3.21 presents a summary of anticipated excess flow control needs in each Bayside Drainage Basin urban watershed relative to the SFPUC WWE Goal to integrate green and grey infrastructure to manage stormwater to minimize flooding. The extent of each need area is presented in Table 3.21 as: Small, Medium, Large, or Very Large. The measured area ranges associated with each of those qualitative groupings are defined as:

Small:	less than 20 acres
Medium:	between 20 – 50 acres
Large:	between 50 – 100 acres
Very Large:	more than 100 acres

The risk levels predicted by the risk analyses are variable within each identified need area. Table 3.21 summarizes the highest respective risk level for each potential impact that has significant occurrence in the need area. These are shown by location on Figure 3.2. Figure 3.2 also identifies 311 calls related to excess water. 311 calls from the public regarding excess water were logged in the Maximo database. Screening criteria were applied to these calls to isolate calls most likely to be associated with system capacity issues. These criteria included screening out records where:

- The reported date did was not around the time of a storm event, indicating the occurrence is not related to wet-weather capacity.
- The problem was associated with a sewer lateral or an individual building, indicating the problem is isolated to a parcel.
- The location is not in a CSS service area, indicating flows do not occur in a combined sewer area.
- The problem is due to a broken or clogged pipe, which is more of a maintenance problem.

A priority level of Low, Medium, High, or Very High was determined for each need area by factoring both the extent of the need area and the intensity of the predicted risk within that area relative to the potential impacts analyzed (i.e., property damage and physical injury). That priority level, which is specific to needs related to controlling excess flow, may be used to prioritize potential improvement projects in terms of sequencing.

Table 3.21
Bayside Collection System: Manage Stormwater and Minimize Flooding Needs

Area Name	Location Description	Extent	Predicted Risk Level by Potential Impact	Priority
WWE LOS: Control and manage flows from a storm of a three-hour duration that delivers 1.3 inches of rain				
North Shore				
Baker Street	Baker Street between Filbert and Chestnut Streets. Predicted property damage risk extends northeasterly one block to the intersection of Broderick and Chestnut Streets due to transition grade and increased flow depth.	Small	Property Damage: High Physical Injury: Low	Low
Marina Boulevard	Primarily a one block stretch of Marina Boulevard from Pierce to Scott Streets. Backwater conditions extend the predicted zone of potential property damage several blocks inland to the south.	Small	Property Damage: Medium Physical Injury: Low	Low
Steiner and Pierce Streets	Areas in Cow Hollow on either side of Steiner Street then shifting over to Pierce Street for a couple blocks north of Lombard Street into the Marina.	Medium	Property Damage: High Physical Injury: Low	Medium
Embarcadero, Mason, and Powell[1]	The Embarcadero from Chestnut to Taylor Street, then reaching inland on Mason and Powell Streets for six blocks almost to Lombard Street.	Large	Property Damage: Very High Physical Injury: Low	High
Financial District	A corridor running westerly for several blocks from the Ferry Building to Front Street between California and Washington Streets.	Small	Property Damage: Medium Physical Injury: Low	Low

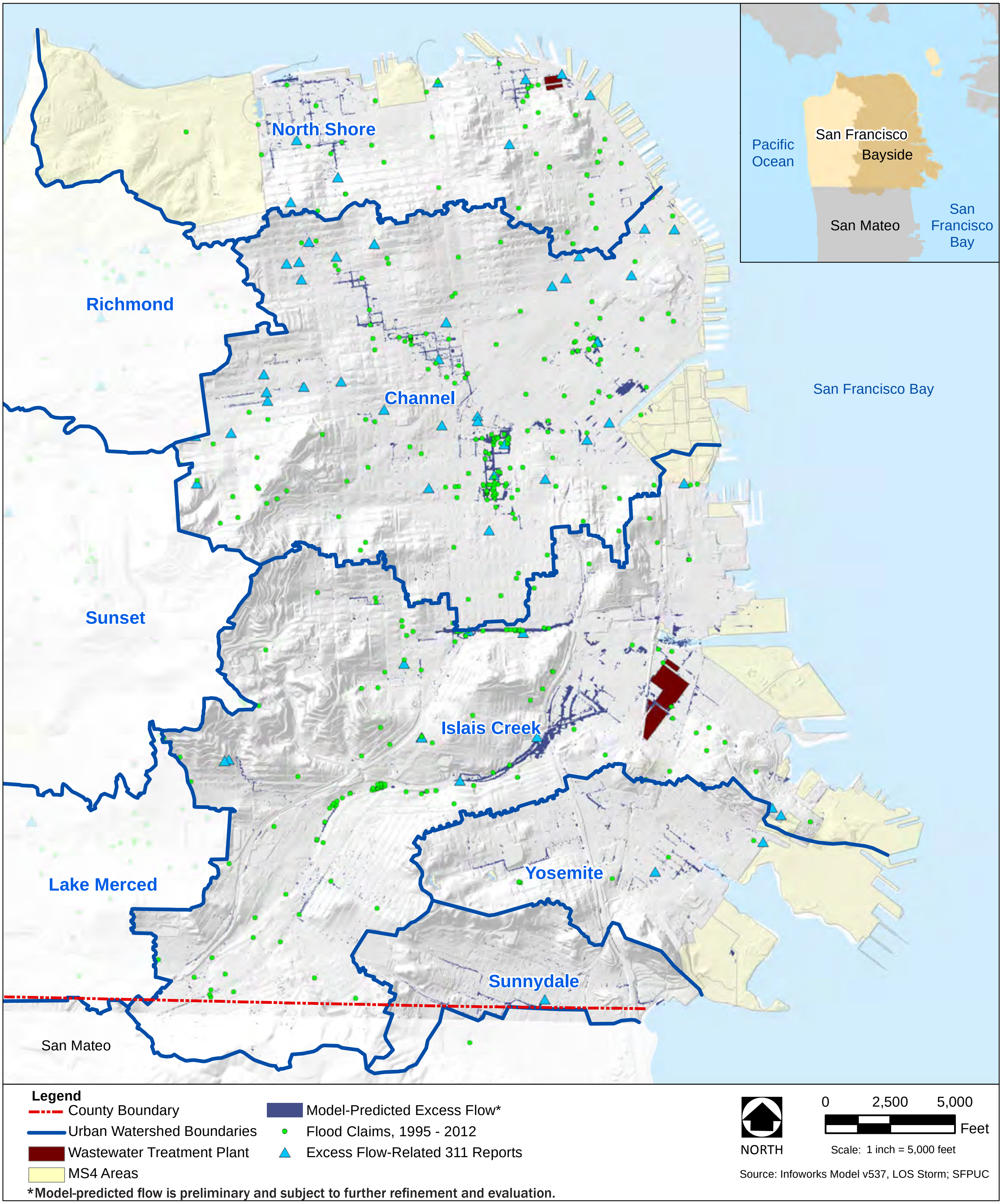
Area Name	Location Description	Extent	Predicted Risk Level by Potential Impact	Priority
Channel				
Panhandle	Oak and Fell Streets running along the Panhandle Parkway. Additional property damage risk is predicted along Fulton Street running parallel three blocks to the north, and also further downstream near the intersection of Market and Church Streets.	Medium	Property Damage: High Physical Injury: Low	Medium
Western Addition	Along the historical Hayes Creek channel from near the intersection of Sutter and Pierce Streets zigzagging down to the intersection of Market Street and Van Ness Avenue.	Very Large	Property Damage: Very High Physical Injury: High	Very High
Inner Mission	Along the historical Mission Creek channel running between Treat Street and South Van Ness Avenue from 18th Street northerly to 13th Street. Backwater conditions extend the property damage risk zone to the northwest along Mission Street from 15th Street to South Van Ness Avenue.	Very large	Property Damage: Very High Physical Injury: High	Very High
Design District	Division Street running easterly from 13th Street through the Design District towards the existing Mission Creek slough. Backwater conditions extent the property damage risk zone as far south as 17th Street.	Large	Property Damage: High Physical Injury: High	High
South of Market	The third concentration of at-risk areas is located in central SoMa south of Folsom Street along 5th and 6th streets. There are other intermittent pockets of at-risk locations in SoMa.	Large	Property Damage: Very High Physical Injury: High	Very High

Area Name	Location Description	Extent	Predicted Risk Level by Potential Impact	Priority
Islais Creek				
Cesar Chavez[1]	The Cesar Chavez corridor running easterly from Guerrero Street to Potrero Avenue, corresponding to the historical Precita Creek channel. Backwater conditions extend the property damage risk zone further west to Church Street and southwest as far as Randall Street.	Large	Property Damage: Very High Physical Injury: Very High	Very High
Cayuga/Alemany	The lower Alemany Boulevard corridor on either side of Highway 101, coinciding with the historical Islais Creek channel. This area fans out on the east side of Highway 101 and extends to just past Oakdale Avenue.	Very Large	Property Damage: Very High Physical Injury: Very High	Very High
Lower Islais Creek	Scattered across the lowland areas surrounding Islais Creek Slough.	Large	Property Damage: Very High Physical Injury: High	High
Islais Creek Slough[2]	An area just north of Islais Creek Slough and west of Indiana Street that is comprised mostly of undeveloped City land.	Small	Property Damage: Negligible Physical Injury: High	Low
Excelsior and Outer Mission	Sporadic small areas in the upper reaches of the urban watershed located in the Excelsior, Outer Mission, and southern Glen Park neighborhoods.	Medium	Property Damage: High Physical Injury: High	Medium
Yosemite				
Lower Yosemite Creek	Areas along the historical Yosemite Creek channel, especially the historical lower reach, slough, and tidal wetlands that are now Bay fill.	Large	Property Damage: Very High Physical Injury: Low	High

Area Name	Location Description	Extent	Predicted Risk Level by Potential Impact	Priority
Sunnydale				
Visitation Valley[1]	Scattered throughout the lowlands of Visitacion Valley with hotspots occurring at the Visitacion Valley redevelopment project along Bayshore Boulevard west of the Bayshore Caltrain station and at a small warehouses district just northwest of the Geneva Avenue and Bayshore Boulevard intersection.[4]	Medium	Property Damage: Very High Physical Injury: High	Medium

Notes:

[1] Improvements are in planning or design phase as part of SFPUC's interim CIP, see Section 2.8.1, SFPUC Projects, for more details.
[2] This particular area is contained within the larger Lower Islais Creek need area, but is distinct due to the predicted intensity of flows.
[3] Southern Glen Park only; the other neighborhoods have low or negligible risk.
[4] Drainage problems in this area are expected to be remedied by the Visitacion Valley Redevelopment Project, which is currently under construction.



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

Figure 3.2: Areas of Modeled and Observed Excess Flow

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

Figure Note: Version 537 of the hydraulic and hydrologic model was calibrated using 2011-2012 monitoring data, for which 87% of meters with good depth data throughout the city met the WaPUG

3.2.5 Provide Benefits to Impacted Communities

Projects that are developed through the Urban Watershed Assessment process should provide benefits to the communities in which they are implemented and should seek to minimize any negative disproportionate environmental impacts in environmental justice areas of concern.

The Bayside Drainage Basin has a number of needs which can be addressed in order to do so.

> *WWE LOS: Be a good neighbor. All projects will adhere to the Environmental Justice and Community Benefits policy.*

The SFPUC defines community benefits as those positive effects on a community that result from the SFPUC's operation and improvement of its wastewater services, including but not limited to meaningful and authentic stakeholder engagement in the design, implementation and evaluation of programs and projects, providing workforce and economic development opportunities, environmental projects that preserve and expand natural resources and reduce negative environmental impacts, support for arts and educational programs, maximization of land use to support community health and sustainability, and promotion of diversity and community inclusion.

Environmental Justice Areas of Concern and Disadvantaged Communities

Further, through the implementation of the Environmental Justice Policy, the SFPUC seeks to promote the equal treatment and protection of all racial and ethnic groups served and/or impacted through the delivery or improvement of wastewater services. Therefore, projects that are developed through the Urban Watershed Assessment process should ensure the equitable compliance with environmental regulations and performance, regardless of race, ethnicity or income, so that no one group bears a disproportionate share of negative environmental consequences resulting from the operations of the SFPUC.

Providing a compliant, reliable and resilient wastewater system is a fundamental component of being a good neighbor and adhering to the SFPUC's Community Benefits and Environmental Justice policies. In particular, ensuring the equitable compliance with all federal, state and local environmental regulations and performance goal across all service areas is the first step in ensuring that the SFPUC is not contributing to disproportionate environmental impacts and ensuring minimum compliance with the Environmental Justice policy. For example, where CSDs, flooding or odor issues exist in environmental justice areas of concern or disadvantaged communities, strategies and projects that will address those compliance issues should receive the highest priority, thereby minimizing or mitigating any potential disproportionate impacts. For example, where CSDs cannot be avoided, operational strategies should prioritize projects or operations to discharge in areas that are not located in environmental justice areas of concern or disadvantaged communities.

Ensuring meaningful stakeholder engagement in the process for those communities most impacted is also a fundamental priority for adherence with the Community Benefits and Environmental Justice policies. Because disadvantaged communities and those populations living in environmental justice areas of concern are the most vulnerable to suffering the negative impacts associated with the operation of our wastewater system, ensuring meaningful and authentic engagement in the process directly supports adherence with the Community Benefits and Environmental Justice policies. For example, due to cumulative impacts, the potential health risks associated with flooding or CSDs may pose greater health risks to those populations living in environmental justice areas of concern and therefore ensuring meaningful engagement in the process with such populations is fundamental to being a good neighbor.

Community Benefits and Triple Bottom Line Evaluation

Similarly, meaningful and transparent stakeholder engagement will help inform the prioritization of positive benefits that may be derived from a particular strategy or project. For example, improvements that increase pedestrian safety may be of a higher priority to a community that suffers from unusually high rates of pedestrian accidents whereas providing new open space may be of a higher priority in those neighborhoods that are particularly deficient in open space. In either case, meaningful input from communities will also be taken into consideration as part of defining needs and identifying possible synergy opportunities to provide multiple benefits. As a result, these needs will be further defined through the Opportunities Analysis that follows Urban Watershed Characterization because it includes various community and stakeholder engagement activities. Triple Bottom Line evaluation will also provide a comparative evaluation of social, environmental, and economic costs and benefits.

Bike and Pedestrian Safety

Bike and pedestrian safety is a high priority civic benefit since it directly impacts personal health and safety. A San Francisco city goal is to have a comprehensive network of walkable and bikable streets that provide safe transportation for multiple modes. The SSIP has the potential to improve this network and incorporate traffic calming features and improve pedestrian safety, for example, with stormwater detention facilities such as flow through planters. In choosing locations within San Francisco's Bayside Drainage Basin for these facilities, SSIP should, wherever possible, abide by the recommendations in the *Better Streets Plan*, WalkFirst, and *Bicycle Plan*.

The *Better Streets Plan*, WalkFirst and *Bicycle Plan* recommend that street improvements be made in order to improve the pedestrian environment and increase safe bicycle use. The *Better Streets Plan* defines techniques to improve the pedestrian environment and calm traffic. WalkFirst builds upon the *Better Streets Plan* and identifies high injury corridors and key walking streets as well as criteria for prioritizing pedestrian improvements. The *Bicycle Plan* identifies areas to refine and expand the bicycle route network.

In general, concentrations of higher need areas exist in the Downtown, Chinatown, Financial District, South of Market, Western Addition, and Mission neighborhoods. High pedestrian injury corridors concentrate in Downtown, the Mission, and parts of Western Addition and South of Market. The number of key walking streets is also concentrated in the Downtown, South of Market, and Mission neighborhoods. However, almost every neighborhood in the Bayside Drainage Basin has at least one key walking street.

Open Space Needs

Parks and open spaces are a civic benefit, providing residents with recreational opportunities and environmental connection. A San Francisco city goal is to have a comprehensive network of open space that complements the vibrancy and livability of the city. The SSIP has the potential to provide additional open space, for example, with multi-purpose stormwater detention facilities such as creek daylighting or dry ponds. In choosing locations within San Francisco's Bayside Drainage Basin for these facilities, SSIP should, wherever possible, abide by the recommendations in the ROSE of the *San Francisco General Plan* (San Francisco Planning Department 2011).

ROSE recommends that all residents have access to open space within a reasonable walking distance from their homes, where a reasonable walking distance, based on the mobility of children and seniors, is a quarter mile. ROSE also defines areas in the City with a need for open space, based on population densities, densities of children, densities of seniors, and income levels. Areas with the greatest need for open space are those with high population densities, high densities of children, high densities of seniors, and low median incomes. Using these sociodemographic trends and the quarter mile access radius, ROSE creates an ordinal need index with five gradations from less need to greater need, as shown in Figure 3.3.

Concentrations of higher need areas exist in the Downtown, Chinatown, Western Addition, and Mission neighborhoods. Moderately high areas of need for open space exist at dispersed locations throughout the Bayside Drainage Basin, including an area in the eastern Bayview and South of Market neighborhoods, in the western Excelsior neighborhood, in the northern Crocker Amazon neighborhood, and in the central Visitacion Valley neighborhood.

Habitat Restoration Priorities

Healthy, resilient, natural habitat within the City of San Francisco preserves the peninsula's legacy of species biodiversity and environmental richness. SSIP projects that create a significant amount of landscape can restore habitat and bolster habitat connectivity. Areas where SSIP projects could contribute to habitat and habitat connectivity will be evaluated based on complementary land use, avoidance of habitat 'sinks', and favorable location. Each of these habitat priorities is defined and discussed below.

Areas best suited for habitat are quiet and dark areas; areas with high levels of urban noise and light pollution are not ideal zones for habitat and habitat corridor development. Quiet residential neighborhoods, for example, are generally more suitable habitat locations than bustling downtown commercial districts. Habitat 'sinks' are urban elements that threaten species. For example, mirrored glass is a common habitat 'sink' for birds, who risk flying into the glass. High-traffic roads are another typical habitat 'sink,' where animals are at greater risk of being run over by vehicles or impeded by high-speed traffic and large expanses of paved roadway. A suitable habitat location would have minimal high-volume street crossings. Favorable locations are those near other habitat areas, as they foster habitat connectivity. Proximity to other habitat is quantified as being within a 150-foot radius of an existing habitat. This radius represents the approximate distance that a small bird will travel to access habitat.[52] Note that favorable locations are not only within 150 feet of existing habitat, but also within 150 feet of proposed 'green connectors' in the City's forthcoming *Green Connections Plan*. Where habitat connectivity cannot be created through contiguous corridors, the 150-foot radius provides a meaningful threshold for the distance between habitat 'stepping stones.'

<u>Additional Needs</u>

During the opportunities phase, projects will be evaluated on their ability to satisfy additional goals and needs within each urban watershed as they are identified through community engagement and developed by the SFPUC Community Benefits Team. These additional criteria will include, but are not limited to the following:

- Environmental Justice and promotion of positive environmental impacts
- Job Creation
- Public Safety
- Education
- Arts and Cultural Enhancements

52 While empirical research is limited in urban contexts, a study in Washington State shows that the Yellow-Rumped Warbler will cross a maximum gap of clear-cut forest of approximately 150 feet. The Yellow-Rumped Warbler can be used as a representative bird for other small native birds in San Francisco.

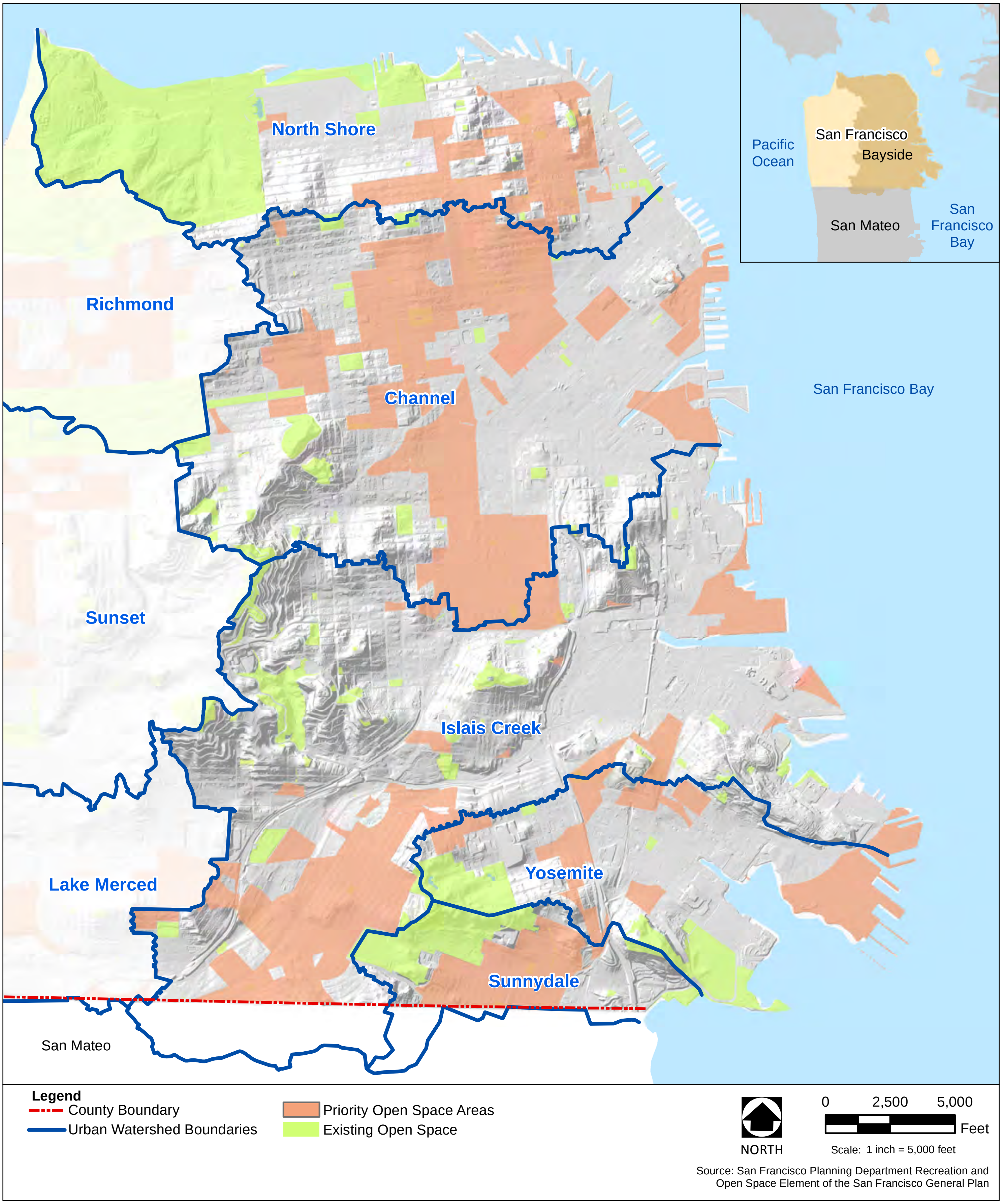


Figure 3.3: Priority Open Space Areas

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Collection System Odor Challenges

Odor Issues

The San Francisco CSS consists of almost three thousand miles of sewer lines and over 35,000 catch basins. The main line sewers include unique elements such as large T/S boxes along the perimeter of the City that capture and convey flows. The characteristics of this collection system, which has been designed to carry wet-weather storm runoff in addition to the City's wastewater, create conditions which allow unappealing odor issues to develop at various locations. Though the City does currently have measures in place to identify and mitigate these odor issues, further study and development of additional strategies will continue to address this challenging situation.

The City's 2030 SSMP included a technical memorandum titled: "Odor Control for Collection System," which provided a detailed look at the odor issues and control strategies being employed (through 2007) (BCM JV 2009a).

Odor within the sewer system is caused by a number of issues, the primary one being slow moving or stagnant wastewater that creates anaerobic conditions which result in odor production. Odor production is at its worst during periods of dry and warm weather conditions, when sewage is diluted by little to no stormwater, flows and velocities are at their lowest, and solids and debris settle out within the system. Large sewer pipes and T/S boxes have a high likelihood of odor production during these weather conditions, as they are running at significantly less than capacity and have a large volume of empty space in which odorous gases can accumulate.

Many older structures and pipes, especially those along the waterfront, have settled over the years resulting in improper slopes which allow wastewater and debris to be retained. Hydraulic drops (through manholes or boxes) are also located throughout the system, which result in turbulence and a corresponding increase in odor production.

Preliminary Indicators

The CCSF H&H Model was utilized to identify areas that have the potential for odor issues based on the characteristics of the CSS network. The baseline hydrologic and hydraulic model was run for the 24-hour dry weather flow in order to indentify hydraulic indicators in sewer pipes with either low velocities or turbulence. These indicators are as follows:

- 30-inch and larger pipes with maximum velocity less than 3.3 feet per second – a hydraulic indicator of slow moving flow.
- 30-inch and larger pipes with invert drop of 2 feet or more - a hydraulic indicator of turbulence due to sudden drop in flow.

Identifying the pipes with these characteristics provides a first layer of information to indicate where potential odor issues might occur. The pipes identified through the model, along with other facilities with likely odor issues such as T/S boxes and treatment plants, are contained in Figure 3.4.

Another source of information is available from the 311 database of historical (1999-2011) odor complaints. The 311 data was refined to identify those complaints which may have some relationship to sewer odor issues, and this information was compiled and processed based on the frequency of odor complaints occurring across the urban watershed. By layering this complaint data over the facilities exhibiting indicators for potential sources of odor, the areas that have the most likelihood of odor issues can be identified. This data is displayed in Figure 3.4 as well.

The eastern portion of the North Shore urban watershed has multiple locations where a higher density of odor complaints are found in the same location as structures with characteristics with the capacity for odor issues, especially at the Jackson and Marina T/S boxes and in the Financial District area around Sacramento and Sansome streets. The Channel urban watershed has numerous areas located throughout which feature a higher density of odor complaints, as well as a large proportion of pipes with low modeled velocities, with overlap occurring often at locations adjacent to the Market Street corridor, at the end of Mission Creek, and around the Panhandle. Within the Islais Creek urban watershed, the primary location with likely odor issues is the area surrounding the SEP. Based on the data available, there are no locations which have a strong overlap of odor complaints and hydraulic indicators within the Yosemite and Sunnydale urban watersheds.

The presence of odor issues at these locations, and throughout the Bayside Drainage Basin, will be further studied in a forthcoming modeling exercise which will take place throughout 2013.

<u>Additional Odor Modeling</u>

To provide a more detailed analysis of odor issues, a consultant will develop a calibrated site specific Wastewater Aerobic / Anaerobic Transformation in Sewers (WATS) model of the SFPUC collection and transport system. The output from the model will be utilized to provide specific odor control system improvements. The initial step will be setting up the WATS model for the Bayside Drainage Basin collection system at a catchment scale, based on the network geometry and flow data, and performing an initial rough calibration. This model will be run to simulate the system in its current state, to assess variability and risk, and to identify data needs.

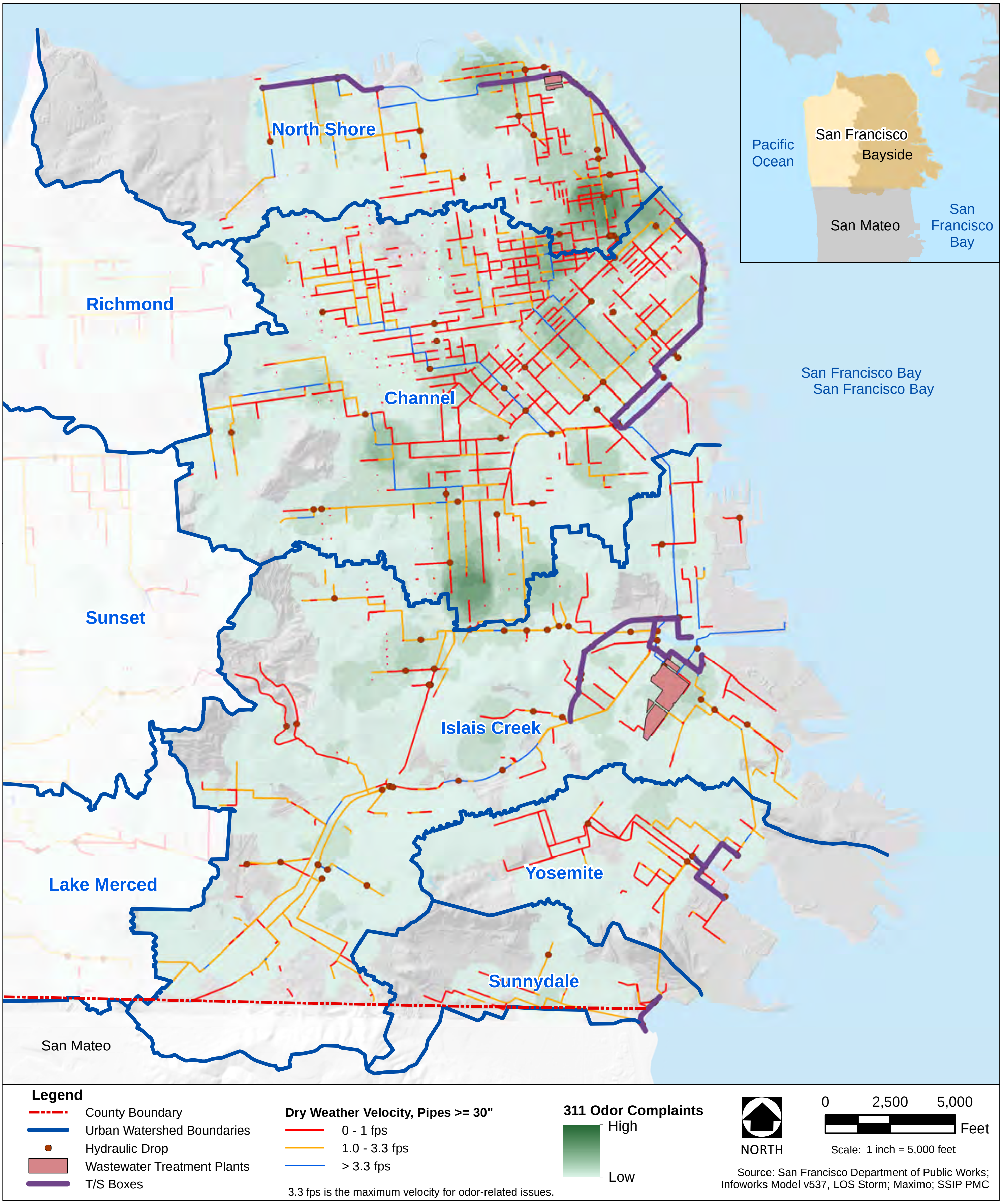

Figure 3.4: Collection System Odor Challenges

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Following this initial model development, a thorough calibration and validation process will be performed. This will involve identifying up to 10 measurement locations where data will be gathered to improve the model. Simulations will again be run to assess the system as it currently exists, followed by simulations which assess the impact of various management strategies (chemical dosing, forced ventilation, sewer reconstruction, etc). There will then be a number of future scenarios (changes in flow, changes in wastewater quality, new urban development, etc) simulated in order to inform the planning and development of wastewater infrastructure.

After completion of the existing and future simulations, the management strategies with the highest potential will be identified for the SFPUC. These strategies will be implemented and monitored in order to evaluate their effectiveness and optimize their operation.

3.2.6 Modify the System to Adapt to Climate Change

Rainfall Intensity and Frequency Adjustment

As part of the SSIP, the PMC team reviewed the design storms currently being used by SFPUC. The last such analysis was conducted in 2006 as part of the SSMP (by Metcalf and Eddy). Since then, additional sources of rainfall information have become available; most notably the supplementary rainfall publication of Atlas 14 for California in 2011.

The purpose of analysis currently being conducted is twofold:

1. Determine if an update is warranted to currently used design storms (Task 1) and,
2. Develop methodologies that will account for the effect climate change may have on frequency and intensities of design storms (Task 2).

At the publication of this document the work conducted as part of Task 1 was in draft form and Task 2 has not yet been initiated. The summary below describes the work conducted as part of Task 1, the review of the Intensity-Duration-Frequency (IDF) rainfall curves, spatial variation factors, and temporal distribution currently used by SFPUC.

Climate Change Task 1 Draft Summary and Recommendations

IDF Curves. The analysis conducted in Task 1 indicates the IDF curves presented in Atlas 14 Volume 6 are appropriate to use for San Francisco. In order to assess the city's current IDF curves several methodologies were employed as presented in this technical memorandum. The purpose of these analyses was to conduct a comparison of the rainfall estimates developed by the PMC team and the published estimates in Atlas 14 Volume 6. A Generalized Extreme Value (GEV) analysis using L-moment estimators was used to fit the most recent 30 years of hourly rainfall observations from the National Weather Service San Francisco Downtown gauge (NWS SF - formerly known as the Federal Office Building (FOB) gauge), to a statistical distribution in order to estimate rainfall depths and intensities for several storm durations and return periods. The analysis of the 30 years of data produced IDF curves that fell within the 90th percentile confidence intervals of the Atlas 14 values. This means that there have been no significant changes in rainfall depths or intensities over the past 30 years of precipitation at the NWS SF Downtown gauge.

Based on the results of the Task 1 analysis of the rainfall data from the NWS SF Downtown gauge and the published Atlas 14 values, the PMC developed a recommendation that the storm depths published in Atlas 14 Volume 6 (2011) be utilized for further study and should be adopted by the SFPUC for future work. Table 3.22 presents the recommended design storm depths for the 3 month to 100-year return periods from the 1 hour to 24 hour duration as provided at the NWS SF Downtown Gauge.

Table 3.22
Proposed Partial Duration Depth-Duration (in) Estimates - Derived from Atlas 14 Volume 6 (2011)

	3-M	6-M	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
1-HR	0.38	0.44	0.48	0.59	0.74	0.87	1.04	1.18	1.32
3-HR	0.65	0.76	0.84	1.02	1.27	1.48	1.78	2.01	2.26
6-HR	0.93	1.07	1.14	1.39	1.74	2.03	2.44	2.77	3.11
12-HR	1.14	1.33	1.49	1.84	2.33	2.74	3.33	3.81	4.32
24-HR	1.44	1.70	1.91	2.38	3.05	3.62	4.44	5.1	5.81

Spatial Variation. The PMC team also analyzed available city-wide rain gauge data to estimate the amount of spatial variation throughout the city. The largest storms in the available period of record were identified and compared to the storm characteristics recorded at the city-wide gauge. The analysis indicates that spatial variation in Atlas 14 may not reflect the actual variation within the city. However, the analysis also indicates potential anomalies with the city-wide gauge data. Therefore, it is recommended that Atlas 14 be used for spatial variation at the present time.

Temporal Variation. For temporal variation, the city currently uses a block, or balanced, distribution where the peak depth for each duration period matches values that can be found on the IDF curve for a given design storm. This produces a storm that will be the appropriate depth no matter what duration is examined, and will also be conservative. The distribution provided in Atlas 14 is significantly less conservative compared to the storms currently used. Therefore, the PMC recommends using the current block distribution to develop design storms, which is consistent with past computations, however that the decision should be discussed with SFDPW before a final decision is made.

It is important to note that the model output presented and used for analysis to develop the Urban Watershed Characterization was produced using the City's current IDF curves and standard design storm as previously presented. The proposed depth-duration estimates and IDF curves will be used to evaluate various scenarios and only be used for LOS considerations based upon approval of SFPUC and SFDPW Bureau of Engineering.

Following this task, work will be conducted for Task 2 of this analysis. Task 2 will extrapolate the impacts of future climate change on IDF curves through the year 2100.

Sea Level Rise, Tide Levels, and Storm Surge

Approach for Addressing Sea Level Rise and Storm Surge

The PMC team will be developing localized estimates of sea level rise and coastal storm hazards along the entire shoreline of the City and County of San Francisco. Although this analysis was not available at the time this document was produced, the following sections provide a brief overview of the approach to characterize the projected changes in water levels and coastal storm hazards (storm surge and wave hazards) over the next century.

The relevant hydrodynamic, wave, and coastal erosion data for existing conditions within San Francisco Bay and along the open Pacific coast along the San Francisco shoreline will be reviewed and summarized. The relevant climate change predictions for sea level rise, and any associated projections for changes in extreme coastal storm events, will also be reviewed and summarized. This task will include coordination with ongoing activities and modeling underway by the U.S. Geological Survey (USGS) and other agencies associated with Our Coast Our Future. Recommendations will be made under this task regarding the sea level rise and storm surge scenarios to be evaluated under each future time horizon under consideration (e.g., 2030, 2050, 2070, and 2100).

This task will rely on readily available information from the following (as well as additional research and regional guidance documents):

- National Research Council (2012). Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Committee on Sea Level Rise in California, Oregon, and Washington; Board on Earth Sciences and Resources; Ocean Studies Board; Division on Earth and Life Studies; National Research Council
- Sea-Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT). 2010. State of California Sea-Level Rise Interim Guidance Document. Developed with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust, October 2010.
- Knowles, N., 2010. Potential inundation due to rising sea levels in the San Francisco Bay region. San Francisco Estuary and Watershed Science, 8(1).
- California Natural Resources Agency. 2009. 2009 California Climate Adaptation Strategy, a Report to the Governor of the State of California in Response to Executive Order S-13-2008.

- Vermeer, Martin and Stefan Rahmstorf (Vermeer and Rahmstorf). 2009. Global sea level linked to global temperature. PNAS, December 22, 2009, volume 106, number 51. pp 21527-21532.
- Intergovernmental Panel on Climate Change (IPCC), 2007, and related updates that occur in advance of the full 2014 update.

Climate science is an ever-evolving field with a high-degree of uncertainty based on the vast array of assumptions required to project future conditions. The farther in the future the predictions are made, the greater the uncertainties. The State of California's *2010 Sea-Level Rise Interim Guidance Document* presents the state-of-the-science as of the date of its publication, and many local agencies, including the San Francisco Bay Conservation and Development Commission (BCDC) have adopted the guidance document and recommended the use of the 16-inch, 27-inch and 55-inch sea level rises associated with 2050, 2070, and 2100 conditions, respectively. However, the more recent 2012 National Research Council (NRC) report, which investigates sea level rise along the Pacific coast, provides a more in-depth look at regional sea level rise. The report includes recent advances in climate science, particularly with respect to the glacial contributions, as well as land movements (subsidence, uplift, and tectonics) which impact relative sea level rise. The NRC report projects average sea level rise values for San Francisco Bay of 6", 12", and 36" for 2030, 2050, and 2100 respectively. This updated projection of 36" of sea level rise for 2100 is significantly lower than the current recommendation of 55". The State of California's climate action team is currently reviewing the NRC report and updating the State's guidance based on NRCs findings. The revised guidance document is expected to be released for comment in the spring of 2013 and will be used to inform this analysis.

The primary climate change stressors and scenarios developed under the "climate science data review and analysis" phase will be used to develop inundation maps and other GIS-based information that can be used to inform the Urban Watershed Assessment and other SSIP tasks. Expected products to inform the Urban Watershed Assessment Task include:

- Detailed inundation maps will be produced for four sea level rise scenarios and under three tide/storm conditions. The data generated from this analysis can also be used to evaluate the shoreline overtopping potential in select areas of the San Francisco shoreline where critical SSIP infrastructure resides.
- Detailed inundation maps that use the most recent 2010 USGS/NOAA LIDAR collected along the coastline, and that account for both depth and extent of inundation, as well as extreme storm surge events and wave hazards, can prove useful in evaluating the climate change risks and planning for climate change resiliency.

The inundation mapping will leverage the latest mapping methodologies developed by the NOAA coastal services center, resulting in a series of high-resolution inundation raster files. The raster (gridded) files can be overlain with GIS files of various infrastructure elements, such as stormwater outfalls, and the depth of inundation and/or change in water surface elevation under each scenario can be specifically calculated at each outfall location.

3.2.7 Achieve Economic and Environmental Sustainability

One of the goals of the SSIP is to achieve economic and environmental sustainability. Meeting this goal involves developing the capability to beneficially reuse all of the biosolids and biogas generated at WWE treatment facilities, stabilizing life cycle costs to achieve economic stability, and eliminating or offsetting the use of potable water for all non-potable demands at WWE facilities. The UWA has the potential to help achieve the goal of meeting the non-potable demand at WWE facilities.

> *WWE LOS: Use non-potable water sources to meet 100% of WWE facilities non-potable water demands.*

Non-Potable Offset at WWE Facilities

Throughout the Bayside Drainage Basin, SFPUC-owned facilities are operated by the WWE. Many of these facilities have demands that could be supplied from non-potable sources. The WWE facilities that currently have an appreciable non-potable demand were identified by gathering input and information from City and consultant staff with knowledge about the operation of these facilities. These include the wastewater treatment plants, which have restroom, irrigation, and system flushing demands, as well as the Islais Creek T/S box. The largest non-potable water demand exists at the SEP, which is a significantly larger facility than the NPF and operates year round. NPF operates only during rain storms for about 10-15 days a year. The treatment process and the water use patterns are very different between these two treatment plants. The Islais Creek T/S box is typically filled with water and pumped out after each storm event, as well as once a week during dry weather to flush out sediment and debris. The total current non-potable demand at WWE facilities is summarized in Table 3.23, and the location of these facilities is displayed in Figure 3.5.

Table 3.23
Current Non-Potable Demand at WWE Facilities

Facility	Non-potable Demand	Annual Volume (MG)
Southeast Water Pollution Control Plant (SEP)	Process water and flushing treatment plant facilities. Flushing toilets, landscape irrigation.	1,350
North Point Wet Weather Facility (NPF)	Process water and flushing treatment plant facilities. Flushing toilets, landscape irrigation.	47
Islais Creek T/S box	Flushing after rain event and during dry weather	87
	Total	1,484

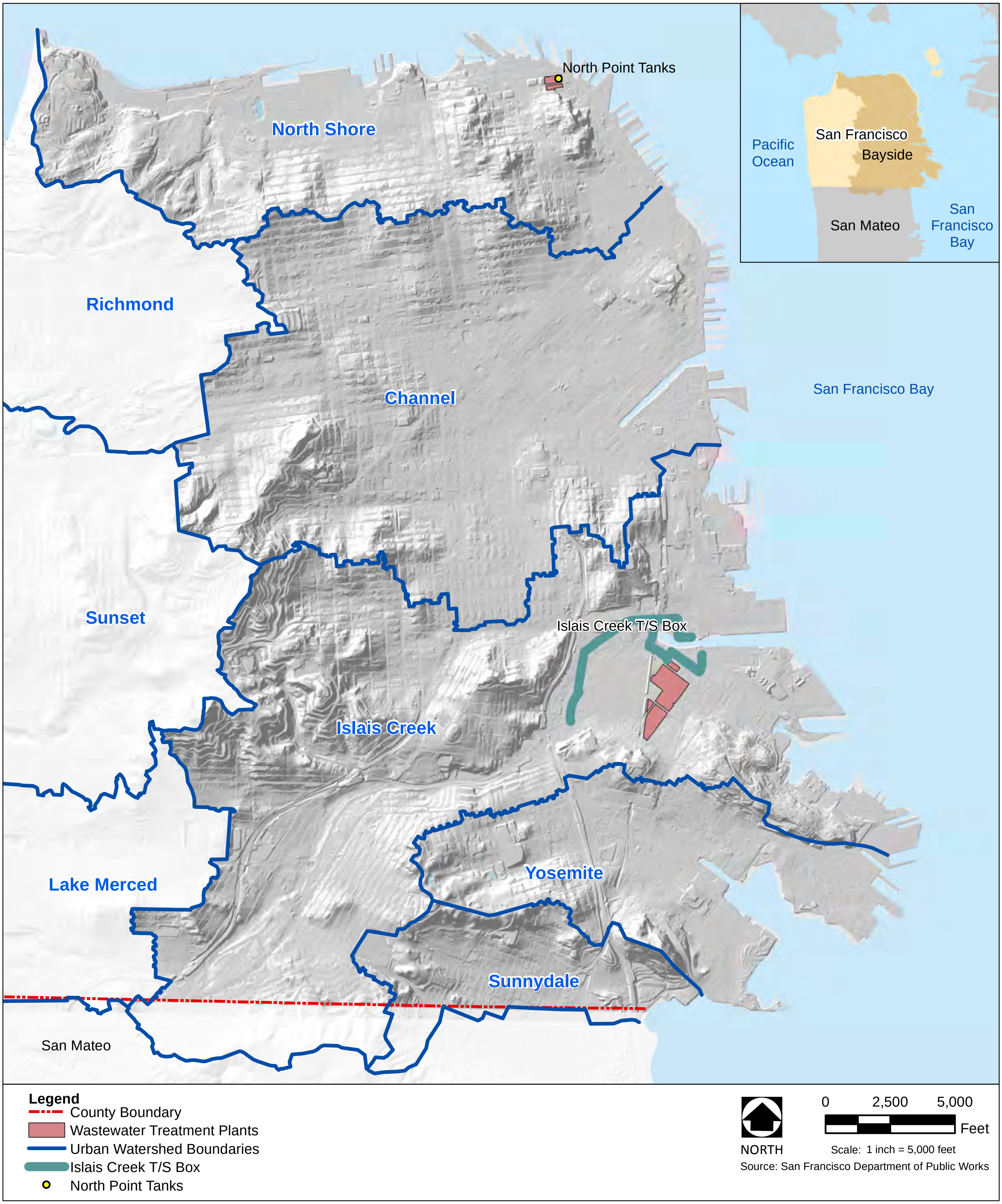

Figure 3.5: Non-Potable Offset at WWE Facilities

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The bulk of this demand is already being supplied from a non-potable source in the form of recycled water produced from the SEP. The total amount being met with recycled water is 1,340 MG at the SEP and all of the water used at the Islais Creek T/S box. In addition, there are currently plans in development to construct a 24-inch water main from SEP to NPF in order to bring recycled water to that facility.

With these recycled water supplies, the actual amount of non-potable demand that could still be offset is considerably lower. Table 3.24 summarizes the remaining non-potable demands that are not currently using, or planning to use, non-potable supply. These volumes are difficult to determine based on available data, but were estimated to get a general sense of what volume of water might still need to be offset. These estimates were made based on the footprint area of the section of each treatment plant that contains the administration buildings, typical water use for office buildings[53], and the typical ratios of office water use between potable and non-potable demands.[54]

Table 3.24
Potable Supply Used for Non-Potable Demand at WWE Facilities

Facility	Non-potable Demand	Annual Volume
Southeast Water Pollution Control Plant (SEP)	Flushing toilets, landscape irrigation.	10 MG
North Point Wet Weather Facility (NPF)	Flushing toilets, landscape irrigation.	2 MG
	Total	12 MG

There are additional facilities which do not currently have a non-potable demand, but have the potential for non-potable water usage with future improvements. These include the remaining T/S boxes, North Point Main, and some pump stations, which could all benefit from flushing systems. The demand for potential future non-potable water at each facility is estimated on an annual basis in Table 3.25.

Table 3.25
Potential Future Non-Potable Demands at WWE Facilities

Facility	Non-potable Demand
Marina, Jackson, Channel, Sunnydale, and Yosemite T/S boxes	Dry weather flushing
North Point Main	Dry weather (esp. sediment) flushing

[53] A report published by the Santa Clara Valley Water District, "Commercial, Institutional, Industrial (CII) Water Use & Conservation Baseline Study", determined an average daily water use of 147 gallons per 1,000 ft^2 for office buildings, based on a survey of 14 sites (SCVWD 2008).
[54] These ratios were based on typical California usage within the report "Waste Not, Want Not: The Potential for Urban Water Conservation in California" published by the Pacific Institute.

Facility	Non-potable Demand
Wet wells for smaller pump stations	Sunnydale WW, GFS

The opportunities phase of the UWA process will identify concepts to offset potable use by supplying all remaining non-potable demand from non-potable sources. Developing non-potable sources to supply this demand at each facility directly will be considered; however, there may not be a feasible method of achieving this at the facility. In order to ensure that the goal of offsetting 100% of this volume is met, the proposed concepts may include in-kind potable offsets equal to the WWE facility use. This would involve identifying other projects, within the same urban watershed as the WWE facility, which have the capacity to offset an equivalent amount of potable demand.

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4.0 CONCLUSIONS

Urban Watershed Characterization is the first step in developing and prioritizing an implementation plan for SSIP policy and capital improvement projects to address surface drainage and collection system needs. Subsequent phases include the Opportunities Analysis, Alternatives Development, Alternatives Evaluation, and Recommendations. The Triple Bottom Line Analysis will take into account a range of social, environmental, and economic costs and benefits. Projects that achieve multiple benefits – optimizing community and environmental benefits and minimizing capital and life-cycle costs – while meeting performance goals will be prioritized over those with fewer ancillary benefits. Each of these phases of the Urban Watershed Assessment includes a set of analytical processes to implement the integrated, urban watershed-wide approach, outlined in the Urban Watershed Framework, and develop a recommended suite of projects for each urban watershed to meet all WWE Goals and LOS in each urban watershed.

4.1 Additional Analysis and Continuous Updates

The PMC team is continually developing information that will be used by the Urban Watershed Assessment Process. The team expects to continue to receive additional data from external sources that will influence both the evaluation of the CSS and the opportunities analysis. For some analyses, the primary sources of data are pending (e.g., condition assessment and climate change), while some other analyses rely on dynamic data sets that are continually being updated (e.g., CSAMP and H&H modeling). Although some of these sources have been identified in previous sections of this document, the primary sources of information that provide input data for the tasks listed below will be updated at each major milestone of the Urban Watershed Assessment as new or updated information becomes available.

- *The Condition Assessment Task*: The PMC team is currently evaluating existing conditions of the CSS including major infrastructure elements such as pump stations and force mains. As the Condition Assessment task identifies new issues and develops recommendations for upgrades and other improvements to the CSS, the Urban Watershed Assessment team will incorporate this information into its evaluation of the WWE Goal to *Provide a Compliant, Reliable, Resilient, and Flexible System that can Respond to Catastrophic Events*.
- *Climate Change*: Analysis related to climate change is currently being performed and will yield multiple memorandums, analyses and reports. Sea level rise projections, predicted storm surge elevations and potential inundation maps will be created, and these will influence the evaluation of infrastructure along the shoreline. Additionally, the climate change task will also yield projections for changes to design storm intensity and frequency. Needs and corresponding opportunities to address those needs will be evaluated with respect to both the existing design storm as well as the projected design storms.

- *Geotechnical*: Improvements to a citywide geotechnical boring database will also provide better geotechnical information for the Urban Watershed Assessment team to evaluate. The team is currently working with relatively sparse data regarding groundwater, bedrock, and soil permeability that will be updated once additional borings are digitized and incorporated into the database.
- *CSAMP*: The CSAMP database is continually updated as more detailed information becomes available and inspection technology improves. The CSAMP database combines background information (i.e., pipe length, condition, material, type, use, class, date installed, location, public safety) along with visual inspection results to develop risk scores that correlate to the need for replacement or repair of collection system assets. The Urban Watershed Assessment team has periodically retrieved copies of this data and will continue to do so throughout the assessment. The CSAMP database was most recently accessed on November 9, 2012.
- *Hydrologic and Hydraulic (H&H) Model*: Similar to CSAMP, the current CCSF H&H simulation model is continually updated with new information and improvements and refinements to the CSS. The H&H model will be used to run various alternative scenarios and boundary conditions throughout the Urban Watershed Assessment.
- *The Capital Improvement Projects (CIP) Database*: The city-wide CIP database is also continually updated by the city agencies that contribute to the database. Similar to CSAMP, the PMC team will continue to periodically access this information to review the latest and most complete data related to projects planned for the street rights-of-way and existing moratoria.
- *Community Engagement:* Community engagement activities that occur through Opportunities Analysis and other phases of the Urban Watershed Assessments will provide additional information to inform the identification and prioritization of possible synergy opportunities, public preference and community needs to provide multiple benefits within each urban watershed.

4.2 Future Considerations

The Bayside Drainage Basin Urban Watershed Characterization provides a snapshot of existing conditions throughout the urban watershed and the needs understood within that context. These conditions will undoubtedly change over time as neighborhoods evolve, new and redevelopment areas are constructed, and the impacts of climate change are better understood. Operational needs will likely increase over time as large redevelopments in the MS4 areas are completed with new separate sewer systems under the operational jurisdiction of the City. Additional staff resources may need to be dedicated to ongoing compliance in proportion to potential increases in regulatory oversight and O&M needs, primarily at Mission Bay and Hunters Point. Improvements to the collection system will need the flexibility to adapt to climate change by considering the impacts of sea level rise and storm surges with the Bay and changes in the storm frequency and intensity.

There may be additional future needs in terms of meeting the SSIP WWE Goal of eliminating or offsetting the use of potable water for all non-potable demands at WWE facilities. At present, the vast majority of non-potable demand is being met, or is planned to be met soon, with non-potable supplies. However, there are potential future non-potable demands associated with proposed operational improvements. These include flushing the T/S boxes, North Point Main, and some pump stations. If non-potable demand cannot be offset directly at a facility, it will be offset indirectly by equivalent non-potable reuse at future proposed SSIP projects in the same urban watershed.

In addition, implementation of the integrated, urban watershed-wide approach will identify projects for both green and grey infrastructure as well as new programs and policies. Effective solutions may require changes to existing policy as well as the development of new programmatic initiatives. Some examples include the current effort to update the CCSF's utility standards in response to the Board of Supervisors approved resolution urging interagency cooperation for street improvement projects that have overlapping jurisdictions. In addition, this Resolution recommended that agencies 'modernize codes, standards, regulations, and other guidelines to ensure that the City's collective public policy interests are advanced.' The SFPUC is also reviewing flood plain management policies, Americans with Disabilities Act (ADA) design requirements in the streetscape, bond spending guidelines for SSIP, and processes for project construction and asset acceptance. These are some examples of policy initiatives that will clarify planning goals and objectives, physical parameters for project design and construction, and procedures for project implementation across the City family. The future policy environment that results will ultimately influence project feasibility. Potential policy changes therefore also represent future considerations that will evolve during the UWA planning process and project implementation through the SSIP.

4.3 Identifying Opportunities from Needs and Characteristics

Urban Watershed Characterization is the due diligence phase of work associated with the Urban Watershed Assessment, and its purpose is to identify the existing conditions and needs within each of the eight urban watersheds in San Francisco. The wealth of data collected and analysis performed during this task is in preparation for all subsequent phases of work. Most notably, the Opportunities Analysis will use this information to:

1. Target specific needs
2. Develop the foundation for locating potential solutions based on physical attributes
3. Align potential solutions with opportunities to meet LOS

As a lead into to the Opportunities Analysis, an example opportunities analysis was performed as a final phase of the Urban Watershed Characterization to demonstrate the general approach for the future opportunities work. During the opportunities phase, each urban watershed in the Bayside Drainage Basin will be analyzed to identify and prioritize potential locations for green and grey infrastructure projects that will address needs identified in the memorandum. The general approach proposed to initiate that task is illustrated through a series of maps (Figures 4.1 to 4.9). The maps are meant to demonstrate how the appropriate scale of analysis is determined and how various data layers are grouped and analyzed to determine potential project locations.

The opportunities analysis begins at the urban watershed scale, in this case using Channel urban watershed. This scale allows for the identification of multiple areas with high probabilities of excess water within the different sub-basins. Figure 4.1 shows the boundaries of the thirteen sub-basins in the Channel urban watershed and the model-predicted locations and depths of excess flow. In the example analysis, the potential for excess water is the primary LOS consideration, and sub-basin 30-B is chosen as the study area.

By zooming into the sub-basin scale, smaller areas that directly contribute to potential excess water and surcharging manholes can be identified using the sewer network and topography data layers. Figure 4.2 uses a finer scale to highlight the boundaries of sub-basin 30-B and identify a specific area within the larger urban watershed that contributes directly to a location of potential excess water, in this case at the southeast corner of the sub-basin at the drainage outlet.

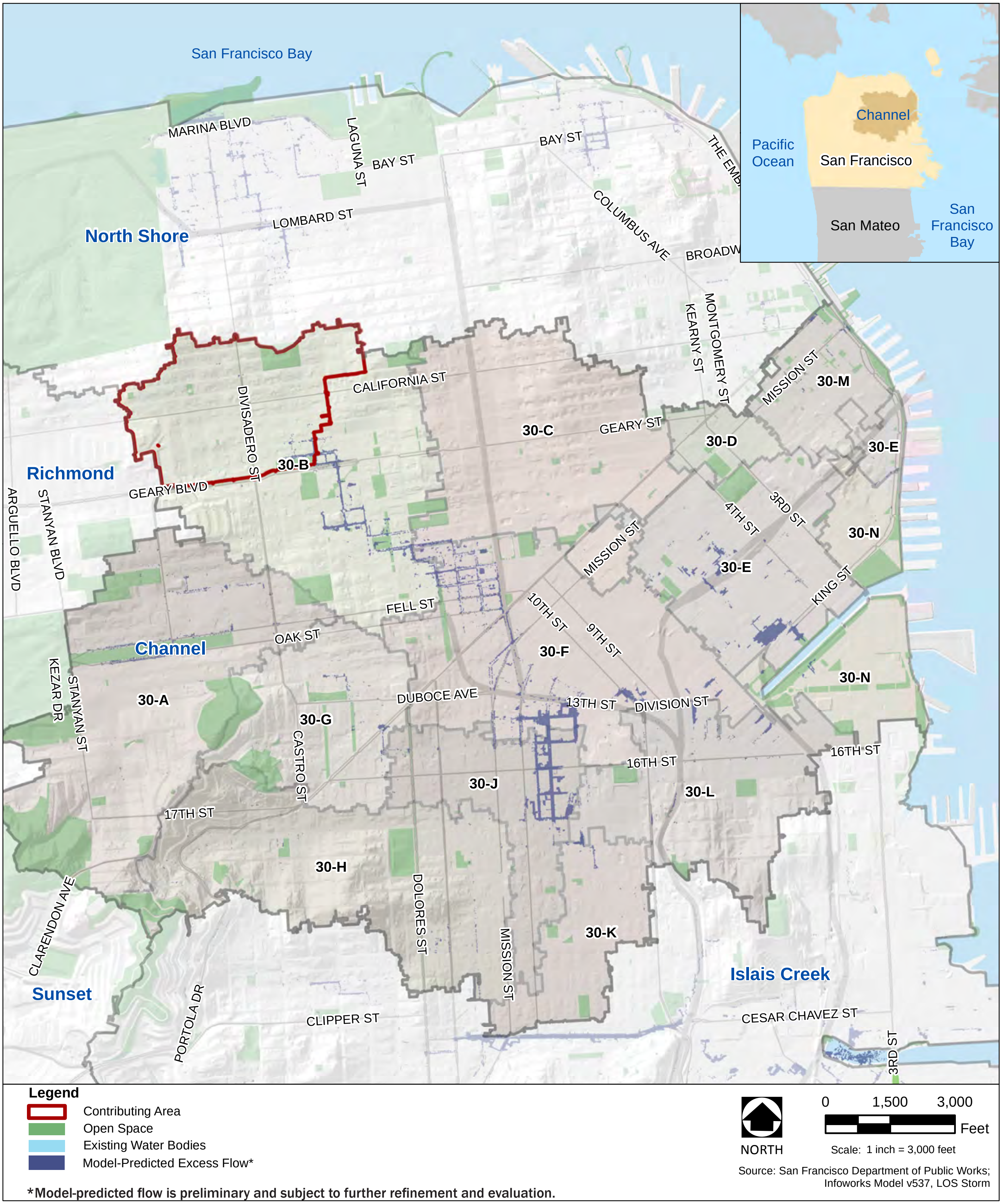

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Figure 4.1: Channel Model-Predicted Excess Flow

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Figure Note: Version 537 of the hydraulic and hydrologic model was calibrated using 2011-2012 monitoring data, for which 87% of meters with good depth data throughout the city met the WaPUG

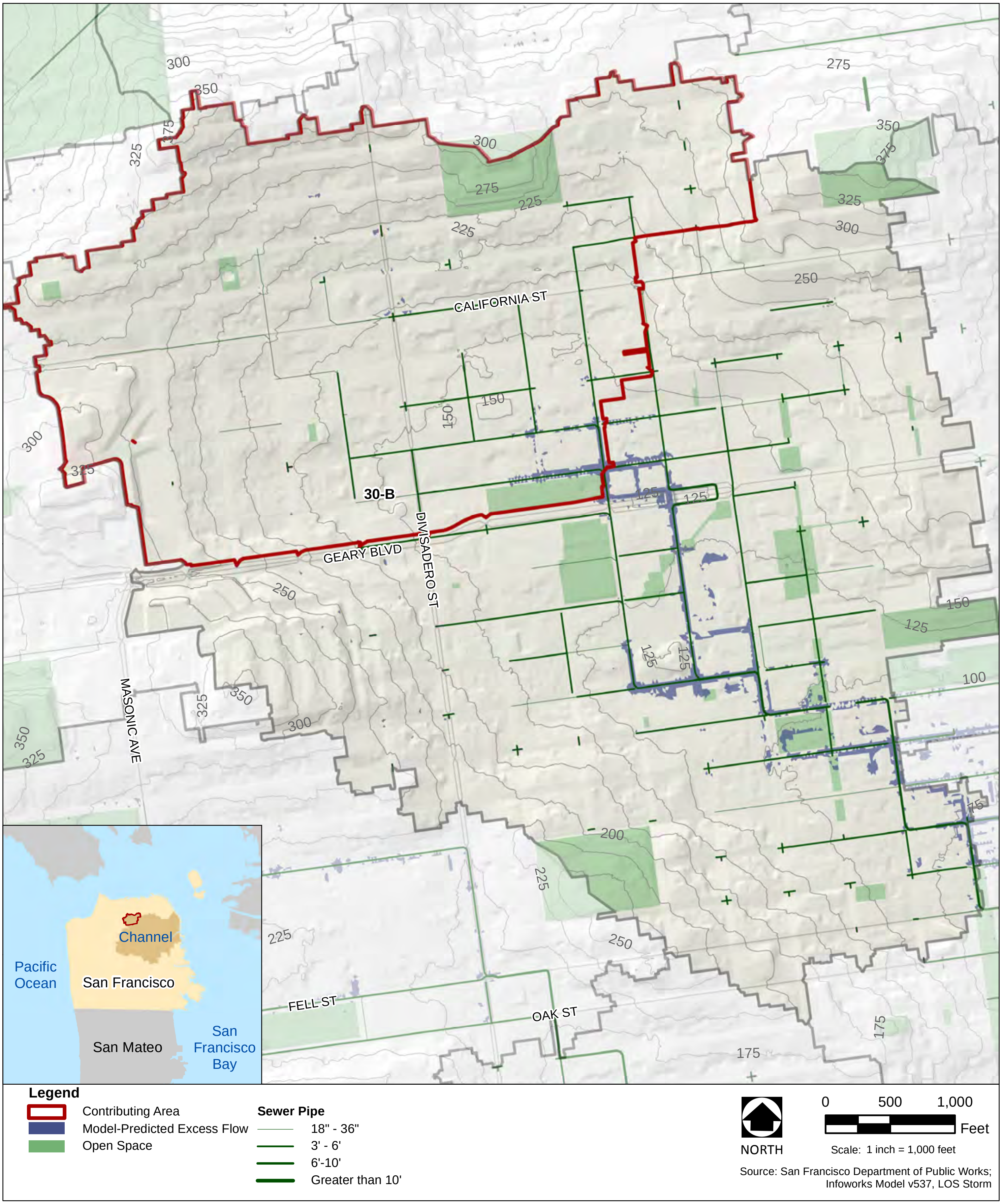

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Figure 4.2: Contributing Watershed - 30-B

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Figure Note: Version 537 of the hydraulic and hydrologic model was calibrated using 2011-2012 monitoring data, for which 87% of meters with good depth data throughout the city met the WaPUG

Once the tributary drainage area is delineated, the view is zoomed into 500-scale, or 1 inch equal to 500 feet. This scale was determined as the optimal scale for identifying potential opportunities because it provides block-by-block detail and allows for a view of the connectivity of the area's hydrology and sewer network. At this scale, the tributary area can be both: 1) assessed to determine potential hazards related to excess water and their contributing factors, and 2) analyzed to determine potential infrastructure project locations with opportunities to meet other LOS goals.

The first factor that is assessed is the existing site conditions. The existing impervious area, surface soil, and topography are assessed alongside the locations of large sewer conduits to further identify the existing conditions that lead to excess flow. Figure 4.3 shows the existing conditions of the tributary area at 500-scale. It is evident from the map that the majority of the tributary area is impervious (shown as grey) with steep topography (shown as dense contour lines) at the top that quickly flattens out at the bottom. These conditions cause flow to accelerate downhill then slow down and swell when the terrain flattens out. Thus, potential projects in the tributary drainage area that decrease stormwater flow either through detention or retention will help alleviate excess water at the downstream end similar to how downstream projects that increase conveyance or alleviate backwater conditions can improve excess water.

The second factor that is assessed is the existing risk of potential property damage and potential personal injury. This identifies specific blocks or buildings that will be protected by infrastructure projects located not only in the direct vicinity of the problem, but also upstream.

With the existing conditions and risk potential assessed, potential opportunities can now be analyzed. To optimize the process, opportunities are broken into different categories and displayed on the same map. The initial opportunities categories identified are: infiltration; land use, street geometries, public safety, and planned green connections; potential synergy with CIP projects, and social improvement.

Areas of high permeability represent opportunities to develop infrastructure projects that retain and infiltrate stormwater, which provides multiple benefits to the CSS. As such, soil infiltration capacity is one of the primary layers used. Figure 4.4 shows the soil borings and design permeability rates interpolated from soil borings, helping to identify locations where retention-based projects are possible. This map identifies a large area in the lower part of the sub-basin, roughly the southeastern quadrant, with favorable soil design permeability.

The existing land use, street geometries, and planned green connections are then analyzed. The land uses are valuable in determining potential partner institutions or possibly to identify areas to encourage the disconnection of downspouts in order to minimize the roof runoff to the sewer system. The street geometries provide insight into which blocks have underutilized or available space to potentially accommodate surface infrastructure projects, these factors include large rights of way, low traffic volumes and wide sidewalks. The planned green connections present areas where

San Francisco Water Power Sewer
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Figure 4.3: Upstream Surface Conditions

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

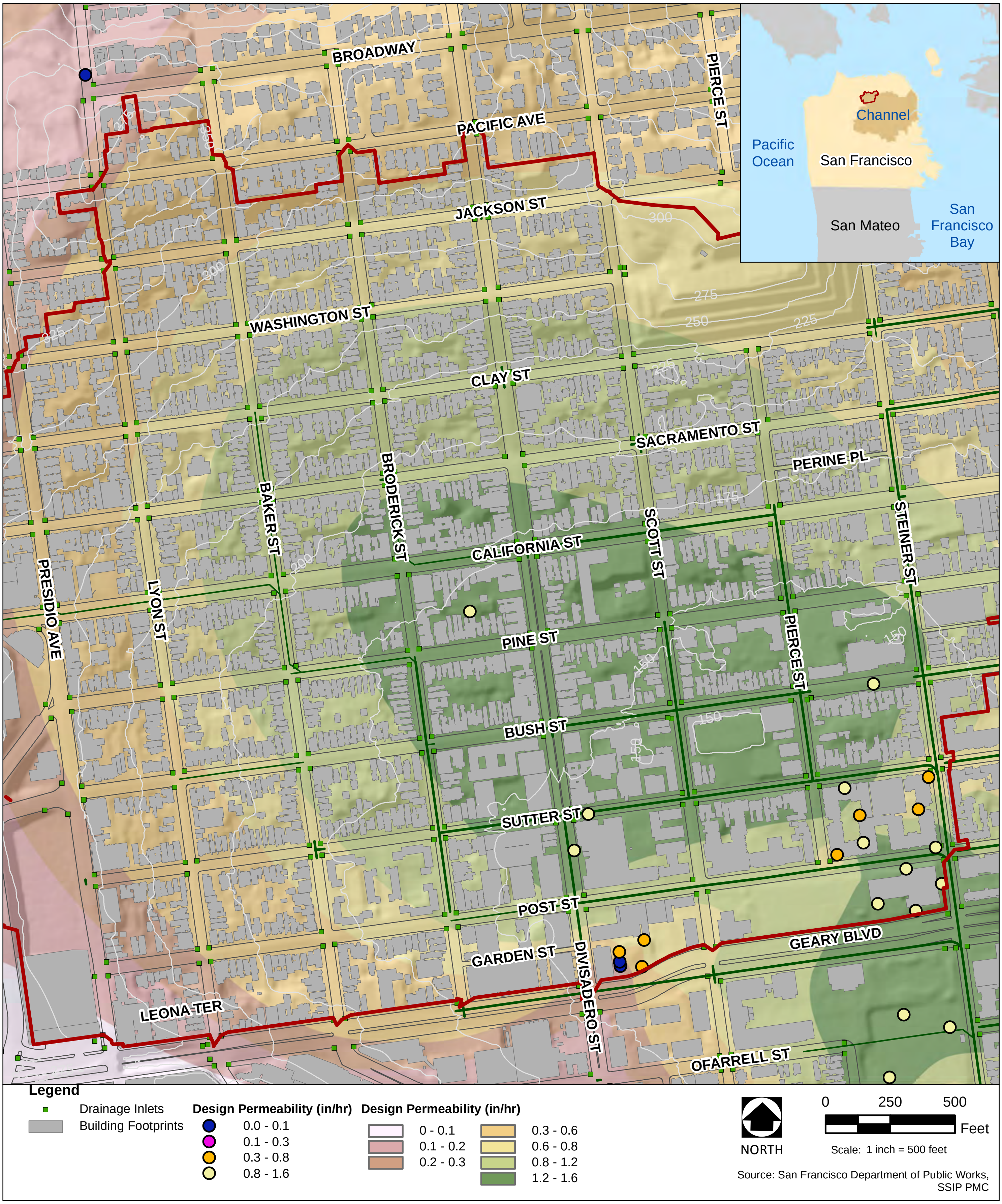

Figure 4.4: Infiltration Opportunities

San Francisco Water Power Sewer

Services of the San Francisco Public Utilities Commission

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

infrastructure projects can contribute to habitat restoration and open space connectivity. Figure 4.5 shows that there are many potential partnering institutions, blocks with extra width for infrastructure projects, and two green connections within the study area.

In addition to the planned green connections, project conflict and synergy opportunities with other City agencies and private utilities are analyzed by reviewing the CIP database. These CIP projects represent either potential cost-saving opportunities to incorporate infrastructure projects into planned projects or potential conflicts (e.g., the City's paving moratorium). Figure 4.6 shows locations within the sub-basin where projects will be occurring in the next several years. A more detailed analysis will account for these projects including the temporal aspects of when these projects are scheduled to be implemented.

Social improvement opportunities are also analyzed by mapping the city districts with disadvantaged communities and locations of reported street-safety related crimes and accidents. Figure 4.7 shows that lower half of the tributary area is within Western Addition and the upper half is in Pacific Heights. Within Western Addition there are more hotspots of reported crime and a large portion is considered a disadvantaged community. Locating certain types of infrastructure projects within these locations can enhance neighborhoods and potentially reduced crime by adding activity or "eyes on the street".

By considering all of these different data layers, and others not shown in this example, potential infrastructure project locations can be identified and eventually optimized for maximum benefit to achieve the WWE LOS and provide ancillary benefits to the City's neighborhoods. Figure 4.8 presents the initial output of this example by identifying suitable locations for surface based projects such as streetscape projects, large retention projects, and potential project partners. Also, Figure 4.8 includes a table that identifies the analyzed opportunities for each potential streetscape identified and how well each project aligned with opportunity layers.

In addition to the surface based projects, the opportunities analysis will use many of the same layers to identify potential underground projects, such as pipe, detention vaults or pump stations. The opportunities analysis process will continue to be optimized during the ensuing phase to create a standardized methodology and balanced approach that identifies future infrastructure projects based on the foundation developed during the Urban Watershed Characterization.

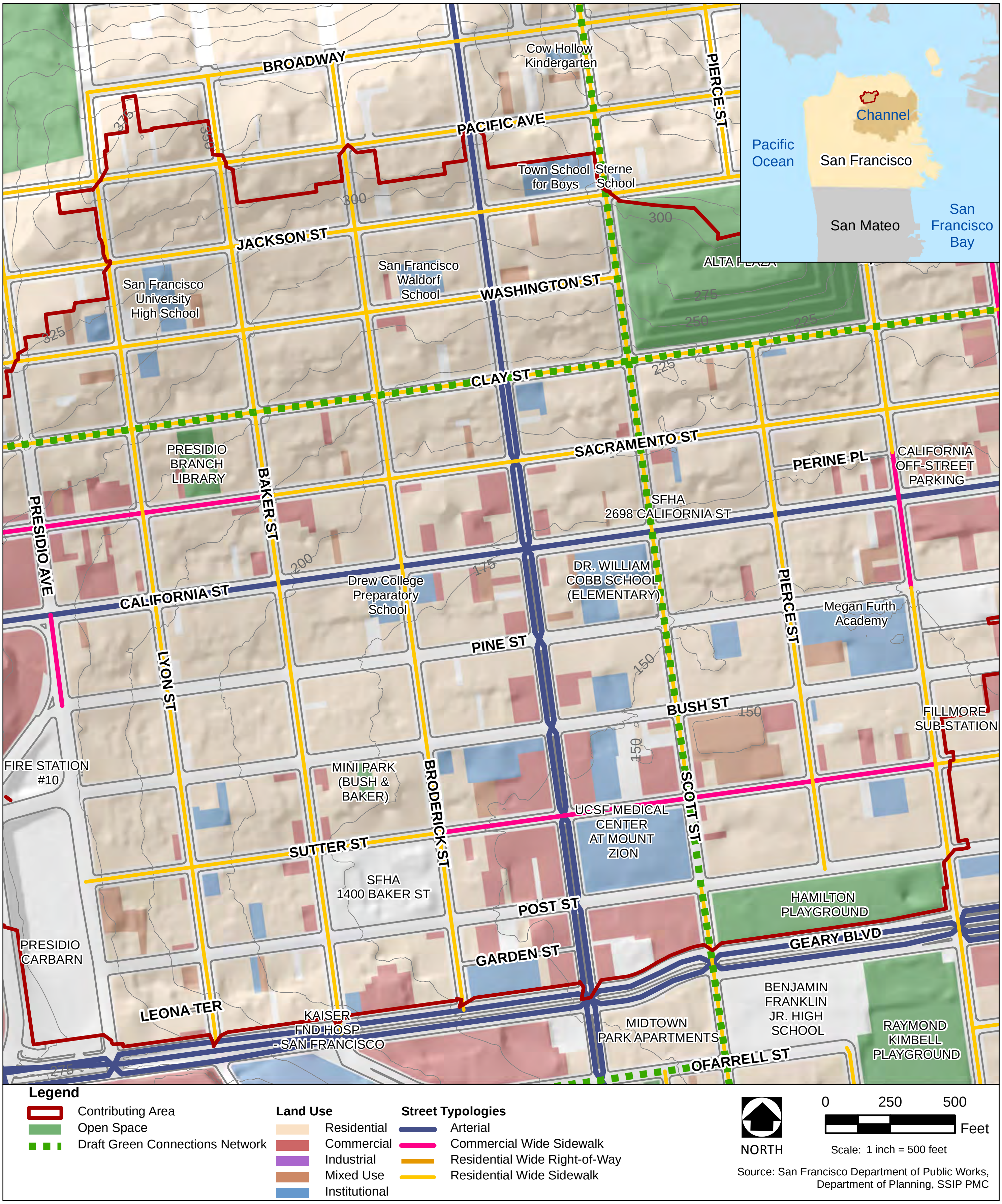

Figure 4.5: Land Use Opportunities and Street Geometries

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San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
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Legend

Contributing Area

Capital Improvements Program Projects

WATER	PAVING
SEWER	PACBELL
PG&E	DPT

NORTH

0 250 500 Feet

Scale: 1 inch = 500 feet

Source: San Francisco Department of Public Works

Figure 4.6: Potential Synergy Opportunities

San Francisco Water Power Sewer
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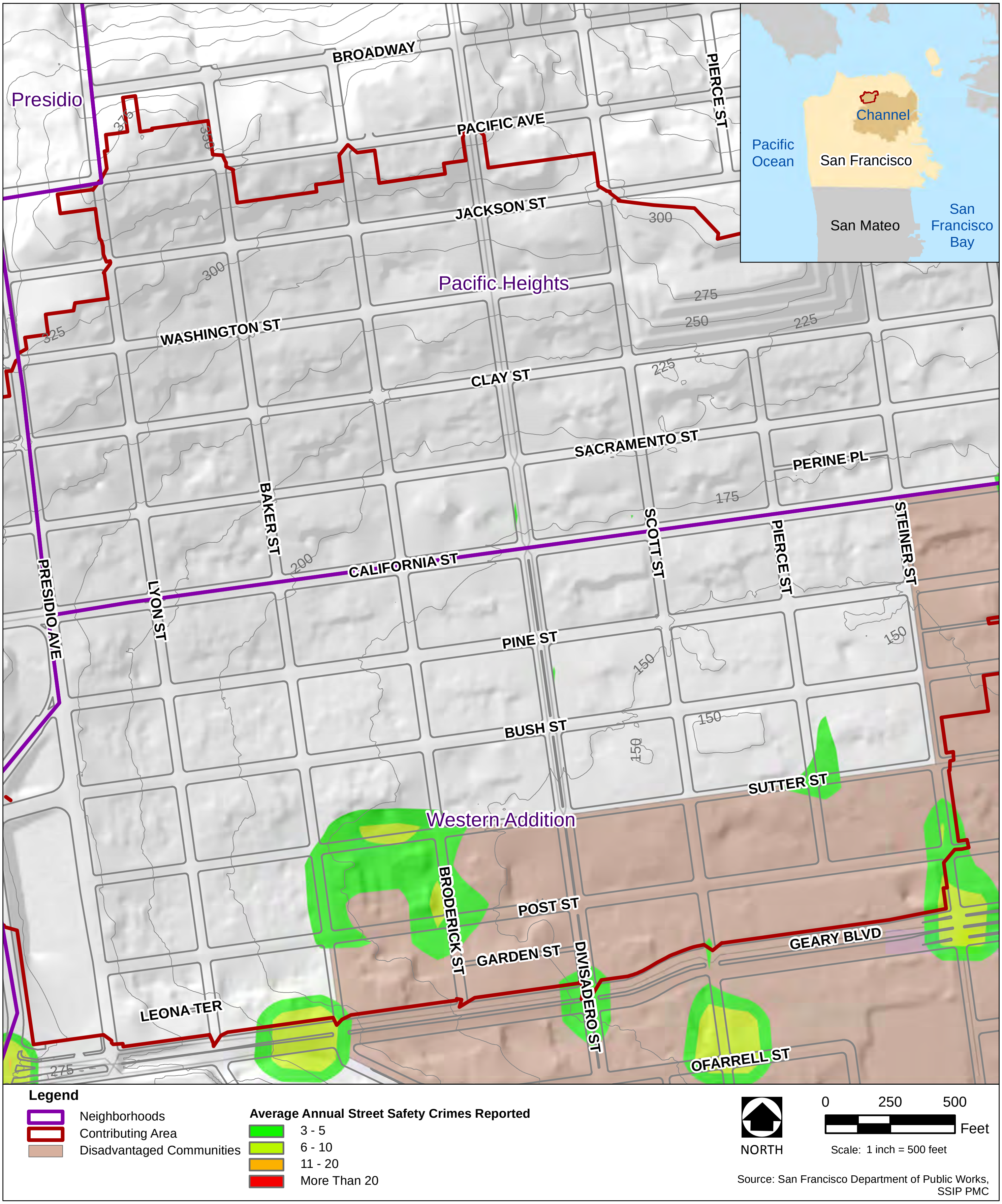

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Figure 4.7: Social Improvement Opportunities

San Francisco Public Utilities Commission Sewer System Improvement Program
Bayside Drainage Basin Urban Watershed Characterization
FINAL DRAFT Technical Memorandum (July 2013)

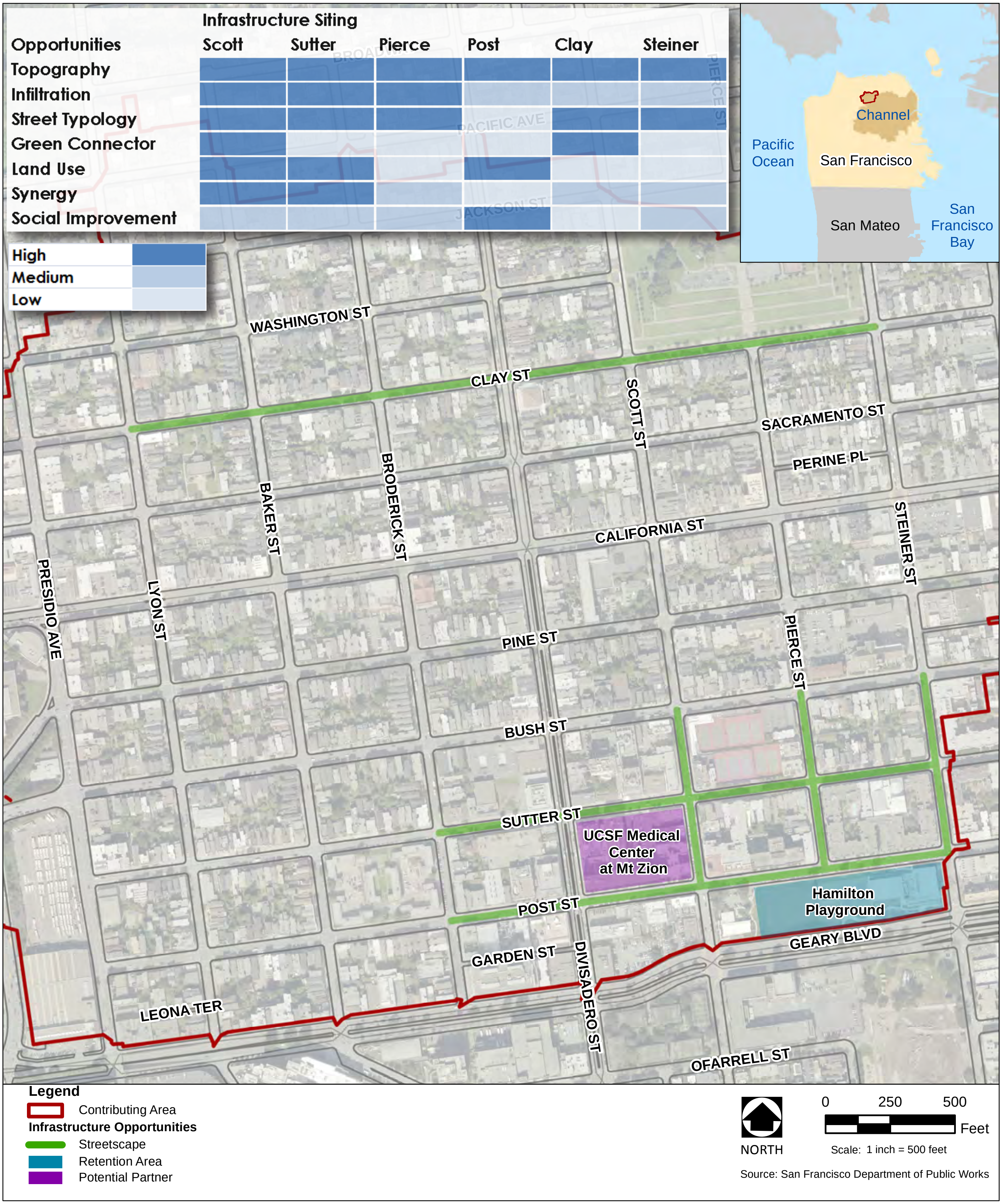

Figure 4.8: Potential Infrastructure Siting

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APPENDICES

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APPENDIX A

URBAN WATERSHED CHARACTERIZATION INPUTS

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Appendix A
UrbanWatershed Characterization Inputs

DATA SOURCES

Geospatial Data

The Urban Watershed Assessment team has assembled data from several different sources to be utilized in the Urban Watershed Characterizations. Most of this data is contained in a geospatial format, housed in GIS format. Sources for this data include the following:

- San Francisco Department of Technology (DT) - The DT manages the City's base geospatial data and keeps it up to date. DT recently launched a new platform to house this data online, data.sfgov.org. These are the City's official data layers for lots, blocks, roads, parks, city-owned parcels, and other such information. Additionally, this clearinghouse has provided a resource for social data such as crime reporting. DT has also acted as a liaison for the Urban Watershed Assessment team to access data from city agencies other than the SFPUC and the SFDPW.
- SFPUC Spatial Database Engine (SDE) - The SFPUC SDE contains several base data layers and data specific to the water, power, and sewer enterprises of the SFPUC. It is the main data location for the SFPUC and is constantly being updated. The data contained within the SFPUC SDE is predominantly related to the water and power enterprises, as SFDPW maintains the spatial data related to the CSS.
- SFDPW - The SFDPW manages all data related to the sewer collection system in addition to other data sets. This includes all of the pipes, manholes, urban watershed boundaries, subcatchments, and other related data. The SFDPW also maintains the City system-wide surface drainage and collection system hydrologic and hydraulic model. An File Transfer Protocol (FTP) drive allows users at the SFPUC to view this data. Information is kept in an Oracle Spatial database that is updated through GIS and Computer-Aided Design (CAD). A predefined package of files is exported from the database to GIS format as necessary for users not connected to the Oracle Spatial database. SFDPW is constantly updating these data based on new information regarding locations, material and size of infrastructure, and hydrology model output. A protocol for updating this data has been established to ensure the Urban Watershed Assessment team is utilizing the most recent model upgrades.
- San Francisco Department of Public Health (DPH) - The DPH has various data layers related to public and environmental health. Several of these layers are stored on the Healthy Development Measurement Tool FTP site. The Urban Watershed Assessment team has downloaded the data available on the FTP site. With the help of DT, the Urban Watershed Assessment team has also made contacts at DPH who are working to get updated data and other data that is not available through the FTP.

- **Other Agencies** - As described above, the Urban Watershed Assessment team has established a protocol with the SFPUC and the DT to request data from other city agencies through DT. To date, this protocol has been utilized to successfully interface with the DPH, the Planning Department, and the SFRPD. Data yielded through this process includes data related to the ecological values of existing open spaces, planning and redevelopment projects, and air and noise pollution. Data acquisition is an ongoing process, and as needs arise, the Urban Watershed Assessment team will continue to request data through the established protocol.

Technical Reports

Several urban watershed and collection system studies have been conducted to date on San Francisco's drainage basins. The studies provide background information on existing conditions in the urban watershed, highlight problem or opportunity areas, and present the results of hydrological and hydraulic modeling analyses. In general, the reports fall into one of the following categories:

- Wastewater Systemwide Reports
- Low Impact Design (LID) and Collection System Modeling Analyses
- Urban Watershed Management Program Reports
- Water Supply Reports
- Groundwater Reports

Planned Project Information

The following sections describe various planned projects by different departments of the San Francisco City family of agencies. Projects are generally focused on capital infrastructure improvements or physical changes to communities ranging from paving projects to land use changes. Some projects are less specific regarding physical changes and reflect community improvements through economic initiatives or long-term community improvement goals.

<u>Utility Excavation and Paving 5 Year Plan Database</u>

The *Utility Excavation and Paving 5 Year Plan* (5 Year Plan) project database contains all planned projects in the City that are funded and will occur within the street right-of-way. The Planning Projects Module of the database includes information for similar projects that are planned but have not yet received funding. This database is maintained by SFDPW's Bureau of Street Use and Mapping (BSM). The platform can export spreadsheets which can then be joined to existing GIS data to locate the projects. Access is limited to a few individuals, so the Urban Watershed Assessment team has exported information to be utilized within the Urban Watershed Characterizations. Daily updates of 5 Year Plan project list and map are available through the SFDPW website (sfdpw.org). Also available through the website is a list of all streets currently under the five year excavation moratorium. Figure 2.41 shows the locations of 5 Year Plan projects that are most relevant to the Urban Watershed Assessment process.

Planning and Redevelopment Reports

In order to develop a picture of planning and redevelopments projects in the City of San Francisco, the team reviewed relevant plans. The City of San Francisco's Planning Department website (www.sfplanning.org) under *Plans and Programs* was accessed to identify relevant planning documents as well as planning projects that are currently underway. The *San Francisco General Plan* as well as all area plans relevant to the eight urban watersheds in the City were reviewed for economic, social, environmental, health, and traffic issues, as well as proposed projects in each the applicable urban watersheds (see Table A-1 for a list of plans that were reviewed). Figure 2.40 displays the boundaries of each of the San Francisco planning area plans. The goal of this review was to identify nexus opportunities for urban watershed/stormwater management with planned projects in each of the urban watershed basins as well as to gain a clear understanding of the goals for and values of the different neighborhoods in the City. Existing issues, challenges, or constraints that may limit future stormwater management opportunities were also identified.

Table A.1
General and Area Plans Reviewed
for the Urban Watershed Characterization

Plan	Applicable Urban Watershed(s)	Date
San Francisco General Plan	All	Date varies by element
Balboa Park Station Area Plan	Islais Creek	2008
Bayview Hunters Point Area Plan	Islais Creek	2010
Candlestick Point Subarea Plan	Yosemite	2007
Central Corridor Existing Conditions Assessment	Channel	2011
Eastern Neighborhoods--Central Waterfront Area Plan	Islais Creek	2008
Eastern Neighborhoods--East South of Market (SoMa) Area Plan	Channel	2008
Eastern Neighborhoods--Mission Area Plan	Channel	2008
Eastern Neighborhoods--Showplace Square/Potrero Area Plan	Channel	2008
Executive Park Neighborhood Plan	Sunnydale	2011
Fisherman's Wharf Public Realm Plan	North Shore	2010
Glen Park Community Plan	Islais Creek	2011
Hunters Point Shipyard Area Plan	Yosemite	1997
India Basin Shoreline Subarea Plan	Islais Creek	2009
Japantown Better Neighborhoods Plan	Channel	2009
Market and Octavia Area Plan	Channel	2007

Plan	Applicable Urban Watershed(s)	Date
Northeast Embarcadero Study	North Shore	2010
Northeastern Waterfront Area Plan	North Shore	1998
Rincon Hill Area Plan	Channel	2005
Transit Center District Plan	Channel	2009
Upper Market Community Plan	Channel	2007
Visitacion Valley Schlage Lock Development Plan	Sunnydale	2009
West SoMa Community Plan	Channel	2011

In addition to the *San Francisco General Plan* and area plans relevant to the eight urban watersheds, other programs and plans, as well as important working groups and organizations operating in the City of San Francisco, were reviewed for the Urban Watershed Characterization (summarized in Tables A.2 and A.3). The standards, guidelines, goals, and policies contained in these plans and programs were identified in order to understand opportunities as well as constraints when it comes to implementation of potential future stormwater management elements. Some of these plans and programs also describe specific projects and improvements; these were taken note of with the goal of identifying synergistic opportunities for urban watershed/stormwater management.

Table A.2
Other Programs or Plans Reviewed
for the Urban Watershed Characterization

Program or Plan	Date
Better Neighborhoods Program	2002
Better Streets Policy and Plan	2010
City Design Group	N/A[1]
Downtown and SoMa Transportation and Public Realm Plan	N/A[2]
The Downtown Streetscape Plan	1995
Fourth and King Street Railyards Study	2011
Green Connections	2012
Mission District Streetscape Plan	2010
Pavement to Parks: Location Selection	2009
Planning Code	Last amendment approved February 6, 2013 (effective March 8, 2013)

Program or Plan	Date
Zoning Maps	Last updated January 2009-October 2012 (depending on the map sheet)
Recreation and Open Space Element (ROSE) of the San Francisco General Plan	2011
Rincon Hill Streetscape Master Plan, Draft	2007
San Francisco's 1% for Art Program	1985
Transit First Policy	1973
Urban Forest Master Plan	2013
WalkFirst	2010
Yerba Buena Street Life Plan	2011

Notes:
[1] The City Design Group is a San Francisco Planning Department program, not a dated plan or project.
[2] Plan has not been completed.

Table A.3
Other City Plans, Projects, and Initiatives Reviewed for the Urban Watershed Characterization

Name	Date
Bicycle Plan	2009
Central Subway	Estimated project completion date 2017
Eastern Neighborhoods Transportation Implementation Planning Study	2011
High Speed Rail	2008
Mayor's Interagency Transbay Working Group Report	2006
One Bay Area http://www.onebayarea.org/	2012
SB 375 & the Bay Area's Sustainable Communities Strategy	2008
SFpark	Took effect in April 2011
Third Street Light Rail Transit Project	2007
Transit Effectiveness Project	2008
Transbay Redevelopment Project Area Streetscape and Open Space Concept Plan	2006
Transbay Transit Center Project	Ongoing

COLLECTION SYSTEM OPERATIONS DATA

Collection systems operations data, such as storage box levels, rain gage data, and flow meter information, is primarily used to monitor conditions in the collection system in support of its real time operation.

DISTRIBUTED CONTROL SYSTEM

Monitoring data for managing the sewer system is collected in the distributed control system (DCS) for use during operations and is stored in a historical archive database for reporting and access offline. This system is within a secure data firewall environment at the Southeast Water Pollution Control Plant (SEP) and Oceanside Water Pollution Control Plant (OSP). Currently, SFPUC is planning to collect all operations data in an enterprise-wide historian software called eDNA to assist in improving access for use outside of the treatment plant. Data for all controllable devices, such as Transport /Storage (T/S) box levels, levels at select outfalls, pumping rates, and flows within the treatment plant, are included. Current plans are to add additional monitoring equipment at all outfall locations to provide improved flow data. Data is stored in one and five minute increments with some summary hourly and daily data.

1. Collection System – Currently no data is collected or stored from the sewer collection system outside of levels within the T/S boxes and overflow points. Current plans are to increase the number of flow meters and have the data collected in the DCS system and eDNA historian for enterprise access. See description in the Appendix A section "Collection System Flow Meter Network" for more information.
2. Pumping – Detailed information about pump operations are available, including revolutions per minute, flow, power usage, set point overrides, etc. Additional related data is available as well, such as tide gate operations, positions, and local box levels.
3. Overflow and Control Structures – Currently this data can be limited, as some data are missing where remote sensors or telemetry has failed and not all overflow points are currently monitored. Current plans are to increase data collection at these points and begin developing redundancy for data collection telemetry. Controllable structures (primarily tide gates in the Channel area) have good data sets except where telemetry was sporadic or other data sensors or communication problems caused data loss.
4. Treatment Plant – Because the DCS is primarily used by plant operations staff, the plant data is useful for plant operation analysis.
5. Effluent – Effluent flow is metered to meet regulatory reporting requirements. Effluent flow during wet weather operations are complicated by the flow split within the plant and outfall system at SEP.

RAIN GAGE NETWORK

Understanding local rainfall patterns and developing statistical design storms requires ongoing analysis of historical rainfall records. There are two primary sources of historical rainfall data in San Francisco:

1. **National Oceanic Atmospheric Association's (NOAA) National Weather Service (NWS)** – There are two historical NWS rain gages in San Francisco. One is located at the OSP and the other in Duboce Park. The OSP gage has a period of record dating back to the late 1940s when it was located at the Richmond/Sunset Treatment Plant. The Duboce gage, which is commonly referred to as the "FOB" gage after its prior location at the Federal Office Building or the "downtown" gage, has a period of record dating back to 1907. In general, the historical data from the Duboce gage is considered more reliable than the data from the Richmond/Sunset gage. For this reason, and because of its centralized location and extra forty years of historical record, the Duboce gage has been the source of historical rainfall data for San Francisco's previous design storm analyses (SFDPW, 1972; Phanartzis, 1981; SFPUC, 2006). All NWS data is only collected in 1 hour increments.

2. **San Francisco Rain Gage Network** – As a part of the 1970s master plan, San Francisco developed a robust system of rain gages and sewer flow meters known as San Francisco Hydraulic-Hydrologic Data Acquisition Rain gages (SFHHDAR). The network collected five minute rainfall data at thirty gages distributed throughout the City from July 1972 to April 1986. After the 1970s master plan, this system deteriorated due to lack of attention, but was ultimately re-evaluated to become the current system of 21 rain gages strategically located throughout the City as shown in Figure A.1. The current network has operated since October 1996. From 1996 to present, several gages have had periods of inoperability due to maintenance requirements. Rain Gage data is automatically uploaded via wireless telemetry to Telog server every 12 to 24 hours and at the time of this writing, plans are underway to integrate the rain gage data automatically into the DCS system.

   In addition to the historical rainfall analyses conducted by the City (SFPDW, 1941; SFDPW, 1971; Phanartzis, 1981; SFPUC, 2006), the NWS and California Department of Water Resources (DWR) also analyze available historical rainfall data to develop depth-duration-frequency (DDF) curves and return period design events. NWS recently released NOAA Atlas 14, Volume 6 (NWS, 2011) which includes DDF curves for California, including curves for the San Francisco downtown and Oceanside gages (http://hdsc.nws.noaa.gov/hdsc/pfds/index.html). CA DWR DDF curves are available for numerous San Francisco rain gages; however, this information has not been updated since 2005 (http://www.water.ca.gov/floodmgmt/hafoo/hb/csm/engineering/). Currently, the City uses the 24-hour design storms developed in the mid-1980s. The Urban Watershed Assessment team will re-evaluate and update as necessary these design storms as part of implementing the Urban Watershed Assessments. Evaluation will incorporate the latest rainfall data available and assess the potential impacts of climate change.

COLLECTION SYSTEM ASSET MANAGEMENT DATA

These data track the condition of SFPUC wastewater infrastructure and facilities throughout the City.

Collection System Asset Management Program (CSAMP)

CSAMP is an asset management program that evaluates the risk of failure for pipes within the collection system. The original version of CSAMP evaluated pipes for risk of failure based on pipe properties such as age and material. The Collection System Division has begun examining the condition of pipes by video. The pipes that have been filmed have been assigned scores that reflect the observed condition of the pipe. The overall risk score is a combination of the condition of the pipe and other factors such as consequence of failure. CSAMP is contained within a database that is accessed on the SFPUC server through a web viewer. The Urban Watershed Assessment team has been provided access to this database, and has exported spreadsheets (database access occurred on November 9, 2012) that are being utilized in conjunction with other data layers in a standalone GIS environment as shown in Figure 2.39.

Maximo® Asset Management Software

SFPUC uses Maximo® Asset Management software to maintain comprehensive lifecycle condition assessment information and issue work orders for maintenance of the CSS. Maximo® tracks all service requests through an automated link to the 311 database via the Work Order Transfer System (WOTS), provides priorities for work orders, and maintains information about completed work orders. In 2011, San Francisco upgraded to Maximo® version 7.0 to improve the overall maintenance management functionality, including improved integration with Sewer GIS, to enhance spatial tracking of work order information. The integration with GIS will be further expanded with the planned migration to Maximo® Spatial, which is currently in prototype implementation phase.

In addition to upgrading the tool's spatial capabilities, the SFPUC has also recently improved the process for how WWE captures public complaint field data. To report sewer problems such as flooding, a resident or property owner in San Francisco can either go online to SF 311 or call 311. While this system is a convenience to the residents of San Francisco, 311 focuses more on quickly generating a work order to get service to the caller, and less on attempting to diagnose the exact source of the problem. The SFPUC dispatcher populates the work order based on relatively little knowledge of the actual situation. Since 311 was first launched in 2007, it has not been historical practice for the field responders to go back and correct the sometimes faulty work order information entered by the 311 Call Center.

The recent Maximo® improvement, however, improves San Francisco's ability to more accurately capture the true character and cause of reported sewer problems. Field Crews are now equipped with on-board laptops that they use to record work order information. They are now able to capture three key pieces of information, including:

- Confirmation of Flooding Event
- Problem/Cause/Remedy
- Approximate Extent of Flooding

Following the Maximo® upgrade, SFPUC trained their field crews and implemented the new data entry requirements in November 2011. Therefore, it is expected that the subsequent Maximo® data set is providing San Francisco with more reliable and instructive information for CSAMP and SSIP prioritization activities.

Storm Watch

The SFPUC/SFDPW Storm Watch program is comprised of three principal components: (1) emergency response, (2) storm event field analysis and reporting, and (3) storm event complaint mapping.

Emergency response is a multi-phased component that includes:

- Pre-storm maintenance and inspection of inlet structures, such as catch basins, to ensure runoff can properly enter the collection system;

Figure A.1: Rain Gauges

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- In-storm response by Sewer Operations staff to address flooding problems and complaints; and
- Post-storm evaluation to determine the long-term course of action needed to resolve problem areas identified during the storm event.

In addition to the emergency response, Storm Watch periodically dispatches field teams, primarily from SFDPW Hydraulics, to assess collection system performance under different storm events. The teams document the extent of observed flooding and discharge events and submit a post-storm report to SFPUC and SFDPW management.

Storm Watch mapping system is an online map of real time 311 call data read from the WOTS. Storm Watch maps calls related to storm and flooding related reports. These maps can be viewed through a SFDPW Web Application.

AVAILABLE MODELING AND MONITORING DATA

City and County of San Francisco Hydrologic and Hydraulic Model

The SFPUC developed a *Draft Sewer System Master Plan* (SSMP) in 2006. A hydrologic and hydraulic model of the sewer system was developed and calibrated under the Draft SSMP in 2006 and further refined under the SFPUC's *Detailed Drainage Modeling Plan* (DDMP) in 2008. The DDMP model was further refined with additions and modifications up to 2010 to evaluate LOS on the sewer system under a variety of climatic and capital improvement scenarios. This 2010 LOS model was basis for the results presented in the *Draft Technical Memorandum on Wastewater Enterprise Sewer System Improvement Program (SSIP) Level of Service (LOS) Flooding Analysis Support for July 27th 2010 SFPUC Commission Presentation.*

Since July 2010, the hydraulic and hydrologic model has been continually improved. Under the SSIP, the model was further refined and calibrated using flow monitoring data collected during the 2011-2012 rainy season. In addition, the model network was migrated to an improved version of the software – City and County of San Francisco Hydrologic and Hydraulic Model (CCSF H&H Model) – which integrates the one-dimensional pipe network modeling with two-dimensional modeling of overland (i.e., surface) flows. Model results presented in the Urban Watershed Characterization Technical Memorandum are based on the calibrated version of the CCSF H&H Model. For further information regarding the details and most current status of the model, refer to the hydrologic and hydraulic model documentation technical memorandum.

Combined Sewer Discharge Water Quality Monitoring

Both the OSP NPDES permit (No. CA0037681) and the SEP NPDES permit (No. CA0037664) require monitoring of CSD structures in order to effectively characterize overflow impacts and efficacy of combined sewer overflow controls. In accordance with these requirements, the SFPUC submitted a two year summary of results for bayside monitoring (June 2012) and submits an annual monitoring status report for Westside monitoring with a final report summarizing the five-year monitoring effort due September 2014. These reports are submitted to the San Francisco Bay RWQCB.

The Westside report generally summarizes three separate sets of monitoring data:

- Water quality parameters (TSS, chemical oxygen demand [COD], and BOD, pH, and oil and grease), polycyclic aromatic hydrocarbons (PAHs), and total metals from the CSD-002 (Vicente) which has been designated as the representative station for the Westside T/S system.
- Beach Monitoring, Beach Posting, and Recreational Use Activities during and following CSD events.
- Flow monitoring of specific T/S structure systems in conjunction with the flow monitoring, samples for TSS and COD were collected and analyzed to assist in the evaluation of T/S efficacy for removal of pollutants.

The location of past or current CSD water quality sampling locations are summarized in Table A.4 and shown in Figure A.2. In addition to the water quality sampling locations listed in the table, water quality is also monitored at points within the collection system that are upstream of the discharge locations. For more information about the monitoring program, refer to the *Monitoring to Effectively Characterize Overflow Impacts and the Efficacy of CSO Control* annual status report.

The bayside water quality sampling efforts comprised the constituents summarized in Table A.4 and Table A.5.

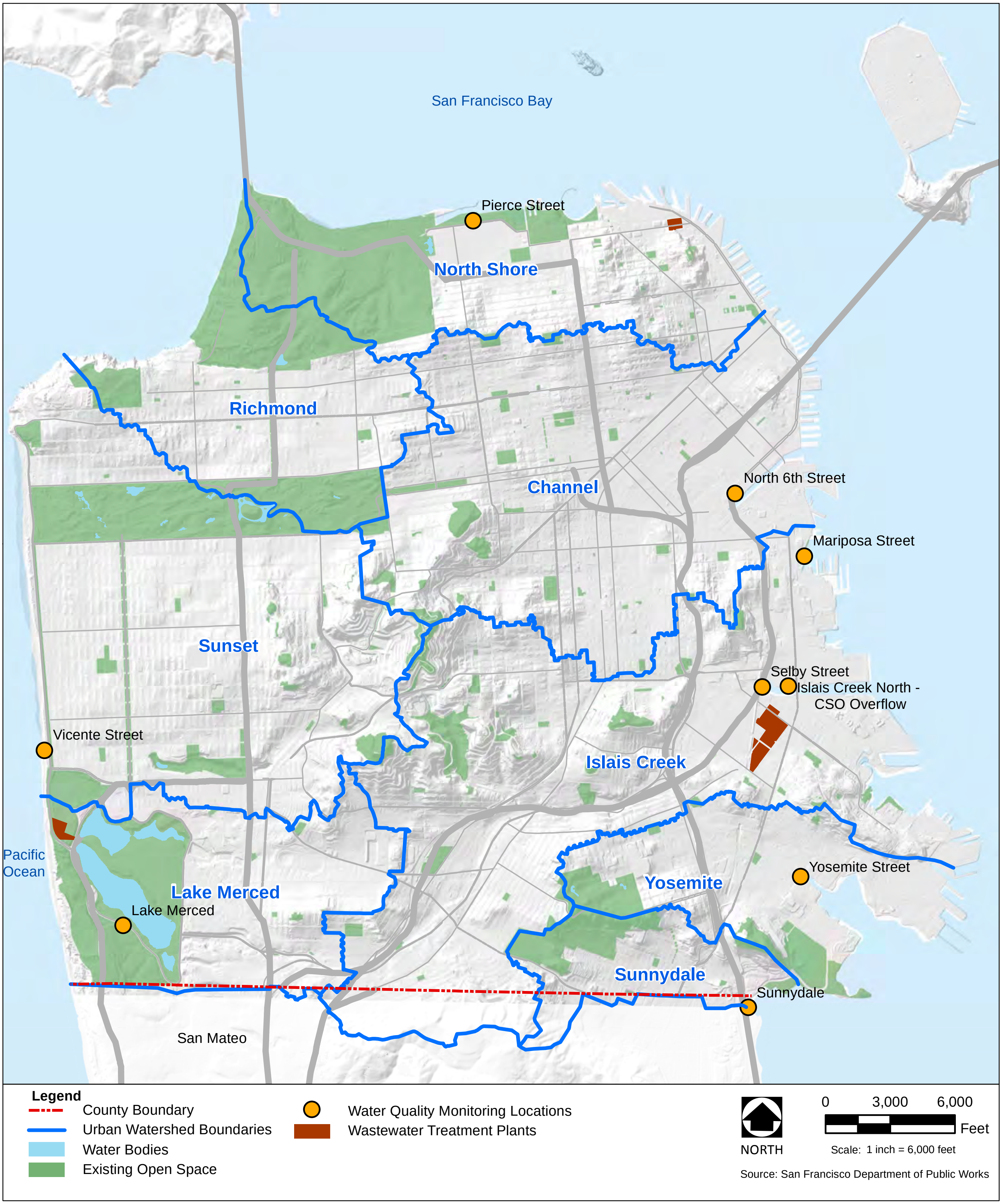

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Figure A.2: Water Quality Monitoring Locations

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Table A.4
Historical and Current CSD Water Quality Sampling Locations

Period of Sampling	Lake Merced (001)	Vicente (002)	Lincoln (003)	Pierce (010)	6th Street North (025)	Mariposa (029)	North Islais (031-A)	Selby (033)	Yosemite (041)	Sunnydale (043)
1997 - 2002	X	X		X	X	X		X	X	X
2005 - 2010		X		X	X	X	X		X	X
2009 - 2010	X		X							
2010 - Current	X	X	X	X	X	X	X		X	X

Table A.5
Constituents - Historical and Proposed for
2010 - 2012 Bayside Sampling

	COD	Chloride	TSS	NH3-N	Oil & Grease	pH	Pentachloro-phenol	Pesticides (Method 608)	Trace Metals	PAH (Method 610)	CN
1997 - 2002	X		X	X	X	X		X	X	X	X
2005 - 2010	X		X		X				X		
2010-2012	X	X	X	X	X	X	X	X	X	X	X

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ACCESS PORTALS FOR DATA

A summary of the data sources, data stewards, and means of access is provided in Table A.6. Descriptions of the primary data portals are provided in the following paragraphs.

Table A.6
Summary of Principal Data Sources

Data Source	Current Data Steward	Access Point for Urban Watershed Assessment Team	Primary Application of Data within Urban Watershed Assessment
Urban Watershed Geospatial Data			
Geology GIS	Various	UWA[1] Web	Characterization/Opportunities
Water GIS	SFPUC	UWA Web App	Characterization/Opportunities
Sewer GIS	SFDPW IDC - Hydraulic Section[2]	UWA Web App	Characterization
Stormwater/Wastewater Technical Reports			
CSS Reports	SFPUC WWE	SharePoint	Characterization/Challenges
Urban Watershed	SFPUC WWE	SharePoint	Characterization/Challenges
Modeling Reports	SFDPW IDC - Hydraulic Section	SharePoint	Characterization/Challenges
Water System	SFPUC WE	SharePoint	Characterization/Challenges
Planned Projects			
5 Year Plan	SFDPW BSM	BSM Login	Characterization/Opportunities
Planning Reports	Various	SharePoint	Characterization/Opportunities
CSS Operations Data			
DCS	SFPUC WWE	UWA Web App	Model Calibration
Rain Gages	SFPUC WWE	Telog Web App[3]	Model Calibration
CSS Asset Management Data			
CSAMP	SFDPW IDC - Hydraulic Section	UWA Web App	Challenges/Opportunities
Maximo®	SFPUC	SFPUC Login	Challenges
Storm Watch	SFDPW IDC - Hydraulic Section	UWA Web App	Challenges
CSS Modeling and Monitoring Data			
CCSF H&H Model	SFDPW IDC - Hydraulic Section	SFDPW Login	Challenges/Opportunities/Alt Analysis
CSS Flow Meters	SFDPW IDC - Hydraulic Section	Telog Web App[3]	Model Calibration/ Characterization/Challenges
CSS/LID Project Monitoring	SFDPW IDC - Hydraulic Section	Telog Web App[3]	Model Calibration/Opportunities/ Alt Analysis
CSD Water	SFPUC WWE	SharePoint	Challenges

Notes:

[1] UWA – Urban Watershed Assessment

[2] IDC – Hydraulic Section – Bureau of Engineering Hydraulics Section

[3] The Telog Web App is not long available; the access point is now via the Telog Server located at the NPF.

ESRI Server

The Urban Watershed Assessment team has created a web-based mapping application through use of Environmental System Research Institute (ESRI) Server technology. This application has been built using Microsoft Silverlight and contains relevant datasets as described in the sections above. This application is available to all Urban Watershed Assessment team members in order to share data, conduct quick desktop analysis, and ensure that team members are all using consistent data sets. The application is credentialed so that only authorized users can access it. Additionally, this system can be utilized as a web server within ArcGIS® desktop environments, allowing users to access data and perform analysis within their own mapping environment.

SharePoint

The SSIP Urban Watershed Assessment SharePoint site is a clearinghouse for project documentation. This includes project organizational information such as current action items, as well as background reports and working documents. The SharePoint site allows the team to quickly and easily share information while incorporating team member's comments in a manner that accounts for version control.

DATA IMPROVEMENTS

As part of identifying data needed to conduct the Urban Watershed Assessments, several data gaps and data management needs have been identified. It was determined that closing these gaps and improving select data management strategies would facilitate the implementation of the Urban Watershed Assessments and the SSIP as a whole. Below is a list of data needs identified and the steps that were taken to address those need.

- **Soil types** – citywide GIS coverages of soils data are available through the Natural Resource Conservation Service (NRCS) and the United States Geological Society (USGS). However, this data is only appropriate for high-level conceptual planning. The soils coverage for San Francisco could be improved by augmenting these sources with additional local information from borings, monitoring wells, and infiltration testing sites. Understanding local soil types is critical for estimating the expected runoff reduction performance and implementation feasibility of green infrastructure projects.

Status: In spring of 2012, the SFPUC and SFDPW initiated a joint effort to compile existing publically owned geotechnical reports and boring log information into a single database. The effort includes scanning hundreds of reports and entering key boring log information needed to understand subsurface conditions in that location. The borings from which this soils data is derived are spread throughout the City at various intervals, and the resulting data is therefore shown for planning purposes at the City or urban watershed level. This data should not be used for design, as further site investigations are required. These data are now stored in a database and the

Urban Watershed Assessment team in collaboration with SFDPW are post-processing these data to create an updated infiltration capacity map for the City.

- Soil contamination sites – The State Department of Toxics and Substance Control (DTSC), the RWQCB, the California DPH, and the San Francisco DPH collect data related to soil and groundwater contamination. A citywide layer of soil contamination sites could be improved by consolidating information from these existing sources. This information would improve knowledge about infiltration feasibility and potential construction constraints.

Status: Prior to consolidating information from the State or DPH, the SSIP team is consolidating information from SFPUC and SFDPW boring logs. After reviewing the results of that effort, it will be determined if consolidation of additional sources is needed.

- Groundwater – A citywide GIS layer of depth to groundwater exists; however, it is only appropriate for high-level conceptual planning. The coverage could be improved by augmenting it with data from local geotechnical reports, monitoring wells, and borings. Depth to groundwater impacts infiltration feasibility, constructability, and best management practice (BMP) selection. To improve local knowledge and mapping of San Francisco's groundwater resources, the layer could include additional hydrogeologic data, such as groundwater basin name, aquifer thickness, gradient, well locations, etc.

Status: Depth to groundwater is a data entry field included in the geotechnical database currently being compiled by the SFPUC and SFDPW. The Urban Watershed Assessment team is evaluating these data for suitability to develop a depth to groundwater coverage for the City.

- Bedrock – A citywide GIS layer of depth to bedrock exists; however, it is only appropriate for high-level conceptual planning. As with the soils and groundwater layers, the bedrock coverage could be improved by augmenting it with data from local geotechnical reports, monitoring wells, and borings. Depth to bedrock impacts infiltration feasibility, constructability, and BMP selection.

Status: Depth to bedrock is a data entry field included in the geotechnical database currently being compiled by the SFPUC and SFDPW and is being evaluated similar to the groundwater data.

- Monitoring data – Flow and water quality monitoring data for San Francisco LID projects is currently limited. Including monitoring as a component of near-term LID projects would improve the City's knowledge of expected LID performance and maintenance needs. Similarly, additional flow meters are needed at critical locations throughout the collection system to provide data points for calibration and validation of the citywide model.

Status: For the 2011-2012 rainy season, the SFPUC installed 71 flow meters within the collection system network and monitored the performance of five green infrastructure projects. In most cases, the monitoring equipment installed automatically uploads its data to a web server where it can be accessed remotely by staff. The flow meters are to be redistributed to new locations for the 2012-2013 *rainy season along with the installation of new meters. In addition, eight green infrastructure projects (one per urban watershed) are scheduled to be implemented and monitored during the first three years of the SSIP.*

- SFPUC DCS – Real-time information collected by the DCS (such as CSD occurrences and T/S box levels) is manually exported to Hydraulics or WWE staff upon request. A proposal is currently underway to improve and automate the data flow between the DCS and Hydraulics. When this is completed, Hydraulics could then provide an appropriate means of access to the SSIP/Urban Watershed Assessment team using existing data sharing pathways.

Status: Ongoing

- SFPUC Rain Gage Network – Real-time rainfall data collected by the rain gage network is manually exported to Hydraulics or WWE staff upon request. A proposal is already underway to improve the connection of the SFPUC's rain gage network to the DCS and ultimately to the Hydraulics staff. When these improvements are complete, Hydraulics could provide the relevant rainfall data as needed to the SSIP/Urban Watershed Assessment team using existing data sharing pathways.

Status: Rain gage data is currently uploaded to a web server hosted by the telemetry company. This information can be access remotely by staff. Future improvements may include uploading historical rainfall data on the web server to enable access and processing of all rainfall data in one location.

Lastly, field reconnaissance efforts were conducted to gather information not available from the sources described above or to verify existing information. For example, site visits were performed to investigate details of select challenges identified through Maximo® and interviews with City personnel. The main purpose of these site visits was to investigate more detailed characteristics of a challenge than had been recorded to date. In some instances, a site visit was performed to investigate discrepancies between reported and otherwise observed or modeled behavior.

Field reconnaissance was also conducted to address uncertainties or apparent anomalies discovered during modeling analyses. Despite the development and use of high quality data input within the CCSF H&H Model, anomalies in the collection system that affect system performance (e.g., pipe blockages) sometimes caused discrepancies between modeling results and observed behavior. Where those discrepancies were discovered, site visits were performed to document actual system performance at those locations via photo and written documentation.

STAKEHOLDER INPUT

Interviews

A key early goal for the Urban Watershed Assessment team was to articulate and tabulate known challenges facing the collection system, including both location-specific challenges within the eight urban watersheds and more pervasive challenges across the City. In order to gain the benefit of experience from City staff responsible for operating and maintaining the collection system, a "Known Challenges Forum" was conducted on January 20, 2012 with key personnel from the SFPUC and SFDPW. To gain further detailed knowledge of the challenges identified during the forum, a follow-up series of interviews was conducted with forum attendees and other key City staff with historical knowledge of the collection system who were not able to attend the forum. Nineteen individuals were interviewed over the course of four days in February 2012.

Ultimately, all of the relevant challenges identified during the forum and the follow-up interviews were organized and tabulated in a spreadsheet. An accompanying series of large-format maps were also developed to illustrate the challenges geographically and provide insight into their distribution density. Key information recorded in the table for each challenge includes location, extent, and general description; where known, specifics regarding cause and impacts were included in the description. The focus of the forum and interviews was intentionally restricted to include existing challenges but not potential solutions; solutions will be investigated during subsequent phases of the Urban Watershed Assessments.

All of the challenges that were identified through the forum and interviews have been grouped into eight categories, labeled A through H in the spreadsheet as shown below. More specific subcategories were created as appropriate to further group the challenges by common causes and impacts. All challenges were labeled sequentially by subcategory, and that nomenclature can be used to track each challenges between the table and the maps.

A. Excess Flows
    1. Capacity (C)
    2. Surge Pressure (SP)
B. Regulatory Compliance and CSDs
    1. CSDs (CSD)
    2. Sewage in Non-Normal Places (SNP)
    3. Threat of SSOs (SSO)
    4. Flow Release Methods (FRM)
C. Odor
    1. Odor (O)
D. Obstructions
    1. Grit Deposition (GD)
    2. Solids Deposition (SD)
    3. Debris Accumulation (DA)
    4. Fats, Oils, & Grease (FOG)
E. Reliability & Redundancy
    1. Redundancy (R)
    2. Seismic Reliability (SR)
    3. Aging Infrastructure (AI)

F. Maintenance
    1. Easement Sewers (ES)
    2. Maintenance “Hotspots” (MH)
G. Operations
    1. Sea Level Rise (SLR)
    2. Coastal Erosion (CE)
    3. Flow Equalization (FE)
    4. Operational Controls (OC)
H. Security
    1. Asset Security (AS)

Four themed maps were created by grouping challenge categories by common theme then layering those groups of challenges over a standard base map. The four themes were: 1) Wet Weather Challenges, including the Excess Flows and Regulatory & CSDs categories; 2) Odor and Solids Challenges, including the Odor and Obstructions categories; 3) Reliability and Redundancy; and 4) Operations and Maintenance, including the Maintenance, Operations, and Security categories.

The forum commenced with a quick overview of the Urban Watershed Assessment process and then a recap of the urban watershed and collection system challenges that had already been identified through due-diligence by the Urban Watershed Assessment team. Further input was solicited from the attendees through an open forum to confirm and refine those challenges, identify new existing challenges, and discuss the relative priority and significance of all challenges. Notes from the forum were consolidated into a spreadsheet that was then used as the basis for creating the initial version of the large-format maps.

Whereas the intent of the forum was to create a comprehensive list of known challenges throughout the eight urban watersheds the intent of the follow-up interviews was to garner more detailed information about each challenge, as well as to identify additional existing challenges that were not raised during the initial forum. The maps served as a medium during the interviews both to present previously identified challenges back to the interviewees, and to capture new information via manual mark-ups. The manual mark-ups were later digitally incorporated into the four themed maps. Descriptive information was added to the spreadsheet table in real time during the interviews then later refined.

Public Outreach

The Urban Watershed Assessment will be considering both traditional grey and green infrastructure technologies to better manage stormwater and surface drainage. Planning and implementing green infrastructure will create greater interaction with users and the general public than traditional grey solutions. As such, engaging stakeholders in the planning, design, and operations of stormwater management becomes even more critical.

Because it is based on a neighborhood level awareness of stormwater collection, the launch of the Urban Watershed Assessment is a way to capitalize on the SFPUC’s efforts to educate and engage the public. Since urban watersheds are defined by hydrology, they represent a new planning opportunity. The urban watershed approach can help the public to gain a more complete understanding of overall conditions in an area and the stressors which affect those conditions. Throughout the duration of the Urban Watershed Assessment process, the SFPUC will actively work with specific information from members of the public around sewer and stormwater related challenges, project opportunities, and Triple Bottom Line social criteria.

The approach for gathering Urban Watershed Characterization relevant information from the public involves first raising awareness about:

- San Francisco's eight urban watersheds and the concept of an Urban Watershed;
- The Urban Watershed Characterization process;
- Triple Bottom Line analysis;
- The SSIP;
- The function and design of the CSS;
- Sewer and stormwater challenges;
- Green and grey infrastructure project solutions; and
- Urban watershed stewardship.

Mechanisms for raising awareness and soliciting input include:

- Presentations at existing community meetings in each of the eight major urban watersheds;
- Sunday Streets citywide neighborhood events;
- iPad survey tool with a set target of 2,000 surveys citywide;
- Special urban watershed programs at San Francisco libraries citywide;
- On-line urban watershed questionnaire;
- SFPUC Citizen Advisory Committee (CAC) wastewater subcommittee bi-monthly meetings; and
- Workshops.

As more information from the Urban Watershed Characterization effort is made available, a workshop will be conducted with the purpose of reporting to the public on the findings of the characterization process and providing an opportunity for the public to weigh in on potential project opportunity selection.

The information obtained while implementing the above tactics is being tracked and documented using the SSIP SharePoint document control management system. Phase 1 public outreach feedback is displayed in Figure A.3. A Public Information Tracking Document template is used at each meeting and/or event that tracks the following information relevant to the Urban Watershed Characterization process:

- Tracking Category
    - Challenge, opportunity, question or comment
    - Urban Watershed Challenge Categories

- Excess flow (ponding, pooling or flooding), maintenance challenges (this would include clogged basins), odor, security

- Geographic Location by Urban Watershed
  - Richmond, North Shore, Channel, Islais Creek, Yosemite, Sunnydale, Lake Merced, and Sunset

In conducting public outreach during the Urban Watershed Characterization process, the Urban Watershed Assessment team has documented challenges at various venues and will continue to document challenges, project opportunities, Triple Bottom Line criteria ranking, questions, and comments from the public's perspective and incorporate the obtained input into the overall analysis for determining project alternatives throughout the two-year UWA process.

Interagency Coordination

The SFPUC is coordinating closely with key City and County of San Francisco departments and agencies to bring together the City's multifaceted and diverse interests in an open and cooperative process. Collection system projects will be comprised of both surface and sub surface improvements, which will require coordination with multiple City departments. The SFPUC recognizes that effective communication is critical to the successful implementation of the SSIP.

The goal of the Interagency Outreach effort is to improve the effectiveness of coordination and partnership between the SFPUC and other City departments and agencies. The SFPUC has organized an Interagency Working Group—comprised of the representatives from key City departments—that will meet throughout the planning process.

The objectives of the working group are to:

- Disseminate key project related information within their respective departments;
- Provide information on existing conditions, planned projects, Triple Bottom Line analysis and urban watershed challenges;
- Identify policy issues that need to be addressed for the efficient implementation of the SSIP; and
- Identify existing and possible future project synergies.

The working group will be a forum for open and ongoing communication specific to the Urban Watershed Assessment process. In addition, the SSIP team will be actively coordinating with all SFPUC divisions.

Peer Review

A main component of quality control throughout the Urban Watershed Assessment process is provided through peer review by the Technical Review Committee (Committee), which provides third-party technical review of select work products. Members were invited to participate in the Committee based on their exceptional professional experience and knowledge of issues affecting urban watershed management, drainage, and the collection system

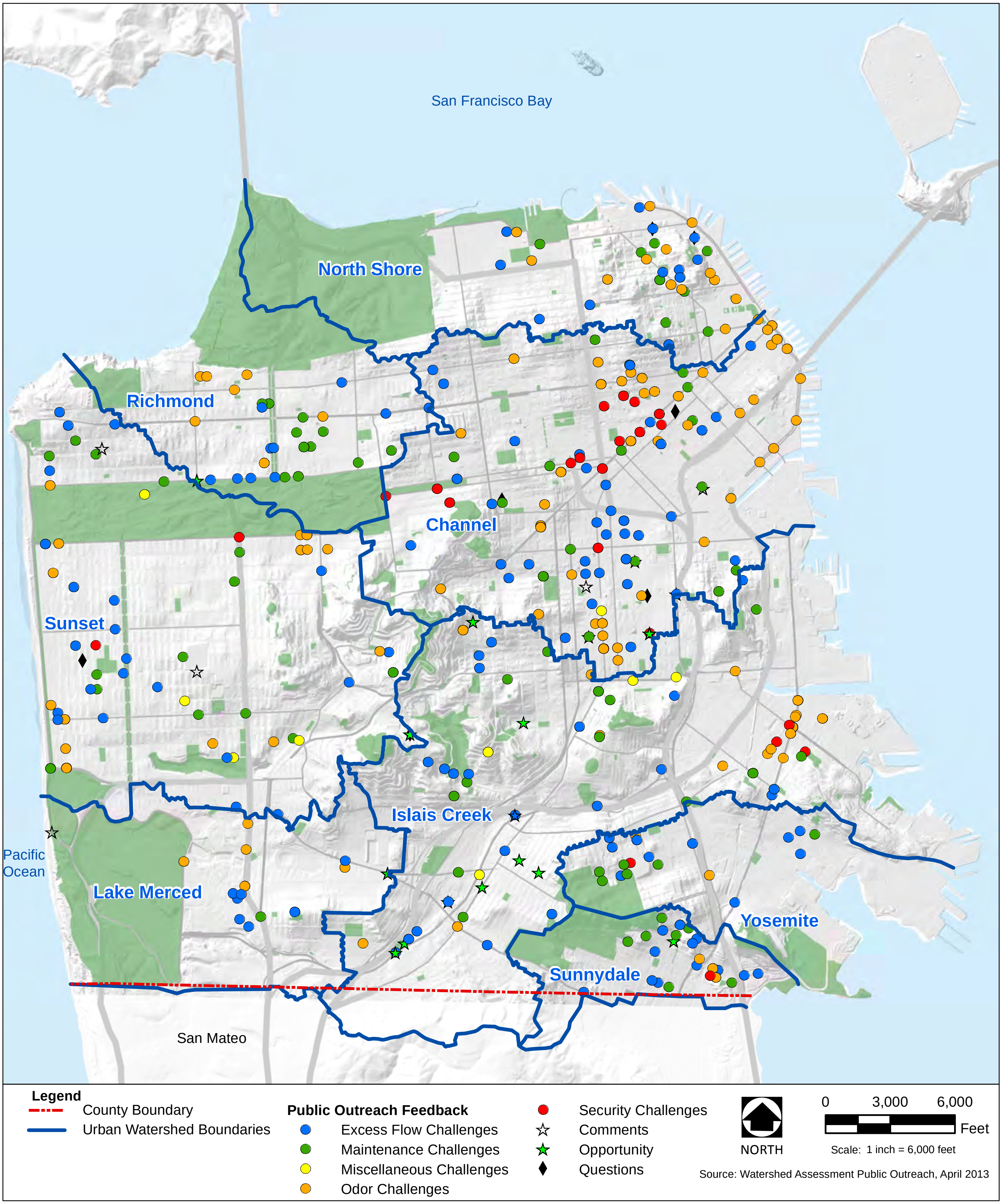

Figure A.3: Phase 1 Public Outreach Feedback

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in San Francisco. Positions on the Committee are voluntary, and members are considered "at-will" participants. The Committee is currently comprised of five professionals with San Francisco-specific knowledge and/or urban watershed-based infrastructure planning experience:

- Virgil Adderley, PE, Civil Engineer, Portland Bureau of Environmental Services
- Louise Mozingo, Landscape Architect, University of California at Berkeley
- Mary Cadenasso, PhD, Landscape Ecologist, University of California at Davis
- Meredith Williams, PhD, Environmental Data & Technology, San Francisco Estuary Institute
- Kay Cheng, LEED AP, City Planner, San Francisco Planning Department

One Committee activity is planned during the Urban Watershed Characterization phase. A kickoff meeting and presentation of characterization findings is scheduled to be held in November 2012 as an educational session for potential Committee members to learn about the SSIP Urban Watershed Assessment process along with the Committee's first chance to review team deliverables. The Committee will be engaged for review and comment throughout the remainder of the Urban Watershed Assessment process and their feedback will be documented in subsequent deliverables.

Citizens Advisory

The SFPUC CAC was formed (City Ordinance No. 58-04) to provide recommendations to the SFPUC General Manager, the SFPUC, and the Board of Supervisors regarding the SFPUC long-term strategic, financial, and capital improvement plans. The 17-member CAC has three subcommittees: water, wastewater, and power. The wastewater subcommittee monthly meetings serve as a forum to review and comment on the Urban Watershed Assessment process, as well as other wastewater collection and treatment activities and operations. The CAC consists of five members and are listed on the SFPUC website. . The Urban Watershed Assessment team will seek the advice and counsel of the WW CAC throughout the duration of the Urban Watershed Assessment process.

APPENDIX B

URBAN WATERSHED ASSESSMENT FLOODING ANALYSIS PROCESS

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Urban Watershed Assessment Flooding Analysis Process

Date: May 31, 2013

Subject: Recommendation for Implementing SFPUC Wastewater Enterprise (WWE) Level of Service (LOS) Relative to Flooding

Recommendation developed by:

Lewis Harrison, WWE Manager of the Collection System Division
Rosey Jencks, SFPUC Urban Watershed Management Program Planning
Iqbal Dhapa, SFDPW Hydraulic Engineering Section Manager
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In 2010 the SFPUC developed Wastewater Enterprise (WWE) Goals, Levels of Service (LOS), and Strategies to address flooding that were endorsed by the SFPUC Commission. Revisions were developed during the 2012 validation effort and endorsed by the SFPUC Commission on August 28, 2012. Both the 2010 and 2012 language is presented in the table below. The LOS remained the same, while the goal and strategies changed. Specifically, the LOS Goal was revised to more explicitly incorporate the City's commitment to green infrastructure (where appropriate) and the LOS Strategies were revised to promote an Urban Watershed Assessment approach that recognizes and incorporates other contributing objectives and benefits.

SFPUC WWE LOS Relative to Flooding, 2010 version and 2012 revisions

	2010	2012
Goal	Minimize Flooding	Integrate Green and Grey Infrastructure to Manage Stormwater and Minimize Flooding
Level of Service	Control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain	Control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain
Strategies	Develop projects to address identified collection system problems utilizing grey infrastructure and Low Impact Design (LID) criteria. Incorporate Interdepartmental coordination	Maximize protection of City in an LOS storm. Develop projects using an Urban Watershed Approach which employs the Triple Bottom Line Develop GI design standards that are informed by the performance of Early Implementation Projects Evaluate and develop projects to reduce CSDs on public beaches

This Memorandum documents the recommendations of the SSIP Urban Watershed Assessment Team, WWE Urban Watershed Management Program, the City Attorney's Office and SFDPW Hydraulic Engineering Section Staff who are responsible for collection system design and the SSIP Program Management Consultant regarding the implementation of WWE's Levels of Service (LOS) Relative to Flooding.

UWA Approach to Flooding Related LOS

The WWE's LOS to *control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain* does not require elimination of all water that is either standing/pooling or moving along the land surface during the LOS storm event. Some instances are acceptable because the presence of surface water presents no material risk to public safety or property. Furthermore, where such surface water may present a material risk to public safety and property, the LOS does not require elimination; rather, it requires *control* and *management* to *maximize protection of the City*.

The UWA approach follows six steps to determine what projects and programs will be recommended to achieve the LOS to control and manage flows from a storm of a three hour duration that delivers 1.3 inches of rain. The approach considers the likelihood and potential consequences of water that is anticipated to be standing/pooling or moving along the land surface during the LOS storm event which has been determined to represent potential material risk to public health and property and must be controlled and managed in order to properly protect public safety and property.

1. Using hydrologic and hydraulic modeling and recorded observations of known flooding events, identify areas of the City with high likelihood that water generated in the LOS storm event will pond or move on the surface at depths or with velocity great enough to potentially cause a risk to public safety or property. Such areas will be identified as susceptible to flooding during the LOS storm event. Areas with surface water in depths or with velocities that likely will not cause risk to public safety or property during the LOS storm event are defined as meeting the WWE LOS criteria.

2. Develop/refine a methodology for estimating the potential consequences in the areas potentially susceptible to flooding identified in Step (1) above. The flooding consequences evaluated are to include the following:
    - Public Safety impacts – based on industry standards related to flood hazards, quantified in the context of surface water ponding and velocity thresholds and recognizing that exposure to some water on the land surface of the City may constitute a public health risk.
    - Property damages –based on the number and type of roadways and property subject to flooding, and their relative importance.

3. Prioritize the list of flooding areas identified in Step (1) above, based on the potential risks and consequences defined in Step (2) above.

4. Develop Urban Watershed Assessment Alternative Recommendations for prioritized areas that include suites of management and regulatory controls, and capital projects that incorporate both grey and green infrastructure, that provide an appropriate level of protection in the LOS storm event, and that accommodate the best available information about potential future conditions related to climate change.

5. Compare and contrast project alternatives using triple bottom line analyses.

6. Present alternatives to SFPUC WWE management and, upon approval, to SFPUC Commission.

Integrating the UWA Approach to Flooding with Overall SFPUC Policy

The UWA process for identifying and recommending capital projects needs to move in tandem with management and regulatory program policy development in order to consistently manage surface water within the City. Neither the SFPUC nor any other entity can construct projects that will entirely eliminate flooding. SFPUC can, however, develop and promote City-wide management and regulatory programs that will improve surface water management throughout the City. The SFPUC is currently updating the WWE Utility Standards and the UWA approach to flooding will be consistent with what is prescribed therein.