



City of Sausalito

Gate 5 Area Drainage Management Study

Draft Concept Design and Implementation Report

2026-08-19





**City of Sausalito
Gate 5 Road Drainage Management Study**

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Prepared for

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Abbreviations and Glossary

Abbreviations

Abbreviation	Description
AAL	Average Annual Loss
BCDC	San Francisco Bay Conservation and Development Commission
DEM	Digital Elevation Model
FFE	First-Floor Elevation
MHHW	Mean Higher High Water
OPC	California Ocean Protection Council
RSAP	Regional Shoreline Adaptation Plan
SLR	Sea Level Rise

Glossary of terms

Term	Explanation
Average Annual Loss (AAL)	The average expected economic loss from flooding in a given year, accounting for the probability and damages of a wide range of flood events. It is the integral of the loss-probability function.
Annual Exceedance Probability (AEP)	The probability that a flood of a given size or greater will occur in any single year. A 1% AEP event has a 1-in-100 chance of occurring in any given year.
Blue Infrastructure	Strategically planned networks of natural and semi-natural structures, such as ponds, rivers, wetlands, and coastal areas, which manage water resources while promoting ecosystem health and human well-being.
Compound Flooding	Flooding caused by two or more drivers — such as storm surge and heavy rainfall — occurring simultaneously.
Depth-Damage Function	A curve that relates flood depth — measured from the top of the first finished floor — to damage expressed as a percentage of replacement cost. The output is a damage percentage that is then translated into a dollar loss estimate.
Discount Rate	A percentage used to convert future costs into their present-day value. A higher discount rate places less weight on future losses. This study uses 0% (undiscounted), 2%, and 7% discount rates. The 2% rate is generally used for long-term environmental, climate and sea level rise planning. The 7% rate is the historic default rate established by the Office of Management and Budget.
First-Floor Elevation (FFE)	The elevation of the lowest finished floor of a building. A building is considered exposed to flooding when water depth exceeds its first-floor elevation.
Flood Risk	The likelihood and adverse consequences of flooding. Flood risk for assets and people for any location in a floodplain is a function of flood hazard at that location and their exposure and vulnerability to the flood hazard (USACE, 2015).
Gray Infrastructure	Physical structures and systems that support urban development and water management, including traditional stormwater infrastructure such as gutters, drains, pipes and pump stations and engineered assets like roads, bridges, dams, and water treatment plants.
Green Infrastructure	A range of natural measures that use plant or soil systems, permeable surfaces or substrates, stormwater harvest and reuse, or landscaping for stormwater and habitat management. Such natural measures can provide storage, filtration, infiltration, and evapotranspiration to treat and soak up rainwater where it falls which can also deliver multiple environmental, social, and economic benefits.
Hazus	Hazus, short for Hazards United States, is a geographic information system (GIS)-based software tool created and distributed by the Federal Emergency Management Agency (FEMA) to help communities assess and manage risks from natural hazards

	(floods, earthquakes, hurricanes, tsunamis). It provides standardized depth-damage curves for buildings and content losses based on building type and occupancy.
Land Subsidence	The gradual sinking of the ground surface over time due to natural or human-caused processes. In coastal areas, subsidence lowers land relative to sea level, compounding flood risk.
LiDAR (Light Detection and Ranging)	A remote sensing technology that uses laser pulses to measure the distance to the Earth's surface.
Mean Higher High Water (MHHW)	The average of the daily higher-high tide.
Pluvial Flooding	Flooding that results from rainfall in which water accumulates faster than it can dissipate, either through infiltration or drainage methods.
Present Value	The current value of future costs, calculated by applying a discount rate. Used in this study to express flood losses in today's dollars.
Return Period	A statistical expression of how often a flood event of a given size is expected to occur on average. A 100-year return period event has a 1% chance of occurring in any given year. Return period and AEP express the same concept in different ways.
Sea Level Rise (SLR)	The long-term increase in average ocean water levels resulting from climate change, driven by the thermal expansion of warming ocean waters and melting of glaciers and ice sheets.
SLR Scenarios	Planning scenarios defined in the <i>State of California Sea Level Rise Guidance: 2024 Science and Policy Update</i> (OPC, 2024) to represent a range of plausible future sea level conditions.
Storm Surge (1-yr and 100-yr)	A sustained rise in sea level above the normal predicted tide as a result of a storm event. A 1- yr storm surge is expected to occur once per year while a 100-yr storm surge has a 1% chance of occurring in any given year.
Tidal Flooding or Inundation	Flooding that results from high tides encroaching along the shoreline or pushing water up a storm drain network.
XP-SWMM	XP-Stormwater Wastewater Management Model is an integrated 1D/2D modelling solution for stormwater and wastewater management supporting urban planning, growth, and flood mitigation efforts. It is a commercial software package building upon the open-source engine developed by the US Environmental Protection Agency.

Executive Summary

This report presents an implementable strategy to reduce flood risk in the Gate 5 Area while establishing a framework for future adaptation. The report evaluates existing and projected future flooding affecting Gate 5 Road, Coloma Street, Harbor Drive, Varda Landing, the Coloma Street Canal, and adjacent low-lying shoreline areas, and translates those findings into practical improvement strategies for the near-term (2025-2035), mid-term (2035-2050), and long-term (2050-2100). Based on a detailed assessment of storm surge, sea level rise, land subsidence, and stormwater runoff, the report is intended to support informed decision-making, prioritize future investment and provide a defensible basis for advancing the recommended improvements from concept through implementation.

The flooding analysis, which was completed utilizing XP Storm Water Management Model (XP-SWMM) and validated using real-world observations and measurements from the site, confirms that the Gate 5 area is currently affected by flooding driven primarily by tidal activity and storm surge and secondarily by stormwater flow impacts. Seawater flows up through the storm drain network and out the lowest elevation catch basins and drain inlets, resulting in recurring access, property, and operational impacts along Gate 5 Road and nearby properties. This report further concludes that sea level rise and land subsidence will significantly increase these risks in the future and will progressively shift the dominant flooding mechanism from drainage-system backflow to broader overland inundation from Richardson Bay (the Bay). These findings indicate that near-term improvements can reduce current flood impacts, but they should be advanced in a manner that is compatible with longer-term adaptation needs. This means that mid-term and long-term improvements would be additive to near-term solutions instead of simply replacing them, therefore maintaining the investment made into the near-term solutions.

The economic consequences of inaction are substantial. A “do-nothing” analysis of cumulative building losses over the 2025–2080 period estimated approximately \$2.37 billion in undiscounted damages, or roughly \$466 million in present value using a 7% discount rate. These figures underscore the long-term value of investing in the flood-reduction measures described below and provide a defensible economic basis for advancing the recommended improvements.

This report includes a comprehensive alternatives evaluation, including a review of over ten potential mitigation actions, such as the addition of permanent pump stations, tide gates to the two existing outfalls from the project area, and upstream and coastal storage, the implementation of vertical solutions, such as a seawall along the shoreline, raising Gate 5 Road, or raising individual properties, and the inclusion of green infrastructure. Based on this analysis, WSP recommends that the near-term solution include several key components:

- 1) adding a tide gate to each of the two existing stormwater outfalls to the Bay;
- 2) covering the Coloma Street Canal and installing a 38 cfs pump station on top of the Canal;
- 3) improving the storm drain network along Gate 5 Road;
- 4) constructing a seawall in a portion of the Varda Landing area; and
- 5) raising the elevation of Varda Landing (portion on private land, which would have to be coordinated with private landowners).

These solutions can be designed, permitted, funded, and constructed within a time frame estimated to be within 3 to 4 years. Specific aspects could be constructed faster, if desired and private owner collaboration is obtained. It is important to note that these five steps work together to increase the flood resiliency of the community and none of them on their own are sufficient. For example, raising Varda Landing alone would not address flooding issues of the properties on the seaward side of the road because the road would only act as a barrier to inland flow of water



for locations on the inland side of the road. Therefore, this solution must be partnered with the construction of a seawall around a portion of the Varda Landing area. This overall approach provides the strongest near-term balance of effectiveness, feasibility, and expandability because it addresses the principal flood mechanisms while preserving the ability to add future capacity, storage, roadway raising, shoreline protection, property adaptation, and green infrastructure. Table ES.1 summarizes the recommended near-term options.

Table ES.1 – Summary of Near-Term Mitigation Option

Near-Term Mitigation Option	Key Benefits	Key Limitations	Planning-Level Cost
• Add Tide Gates to Existing Outfalls • Pump Station on Coloma Street Canal (2-Year Rainfall Capacity) • Storm Drain Improvements	• Addresses Backflow of Coastal Water • Addresses Stormwater Flows While Tide Gates Are Closed • Relatively Fast Implementation (3 to 4 years) • Within City Right of Way	• Moderate O&M for Pump/Tide Gates • Potential Permitting Delays at Canal • Structural Assessment of Canal Must Be Done First	\$4.8 million
• Varda Landing Seawall (1-Year Storm Surge Elevation) • Raising Varda Landing to 1-Year Storm Surge Elevation (Portion on Private Property)	• Reduces Overland Flooding from the Bay • Initial Private Owner Approval	• Requires Private Owner Coordination	\$1.6 million

Together, the recommended near-term improvements carry a planning-level cost of approximately \$4.8 million for the Gate 5 Road drainage, pumping, and tide-gate work, plus about \$1.6 million for the Varda Landing shoreline protection. The near-term pump station is sized to convey roughly 38 cfs, which is equivalent to about a 2-year rainfall event when the tide gates are closed and is the maximum pump capacity that could be constructed on top of the canal. Capacity to pump the full 10-year design flow of 86 cfs would be reached incrementally through the mid- and long-term pump expansion. This reflects an accepted level of near-term residual risk in exchange for faster, lower-cost implementation.

To advance the recommended near-term solutions, the report also identifies a practical program of next steps including additional geotechnical investigation, closed-circuit television (CCTV) and drainage system verification, hydrologic model refinement, continued community engagement, phased design development, permitting, and a parallel funding strategy. These actions will allow the City to advance the project in an orderly and well-supported manner.

Funding for the recommended improvements is expected to draw primarily on FEMA's Building Resilient Infrastructure and Communities (BRIC) program for the core drainage and pump-station work, supplemented by California Department of Water Resources flood programs, San Francisco Bay Restoration Authority Measure AA, the Coastal Conservancy's Climate Ready Program, and the National Coastal Resilience Fund for shoreline and habitat features. Because work at the outfalls, the Coloma Street Canal, and along the shoreline touches waters of the Bay, permitting will require coordination with agencies including BCDP, the U.S. Army Corps of Engineers, and the Regional Water Quality Control Board, and should be initiated early to protect the project schedule.

Mid- and long-term improvements were also evaluated to provide phased implementation strategies intended to ensure future adaptability as flood potential intensifies between 2035 and 2100. The flood mitigation alternatives for the mid-term horizon (2035-2050) and long-term horizon (2050-2100) include adding additional stormwater pumping, adding upstream vaults for storing stormwater, implementing vertical solutions, such as a seawall along the shoreline, raising Gate 5 Road, or raising individual properties, and incorporating green infrastructure. These



solutions are viewed as additive and will build upon the flood resiliency provided by the near-term solutions. Mid-term options are summarized in Table ES.2 and long-term options are summarized in Table ES.3.

Table ES.2 – Summary of Mid-Term Mitigation Alternatives (Additive to Near-Term Alternatives)

Mid-Term Option	Key Benefit	Key Limitations	Planning-Level Cost
• Increase Pump Station (PS) Capacity (Incrementally Towards 10-year Rainfall Capacity)	• PS Can Handle Larger Rainfall Events • Moderate Cost	• Additional Space Needed for Pumps & Controls • Likely Requires Easements • Additional O&M	\$6.9 million
• Underground Storage at MLK Park	• Reduces Size of PS • Potential Irrigation Reuse	• High Cost • Park Impacts	\$28.8 million
• Green Infrastructure in Upstream Watershed	• Improves Water Quality, Sustainability, and Aesthetics • Sustainability • Reduces Size of PS • Community Approval • Moderate Cost	• Not a Stand-Alone Flood Protection Strategy	\$5.9 million
• Raise Gate 5 Road to 1-year Storm Surge Elevation	• Improved Access During Most Frequent Flood Events • Low Cost	• Does Not Protect Properties Waterward of Gate 5 Road • Requires Property and Utility Coordination • Only One-Way Traffic	\$0.6 million

Table ES.3 – Summary of Long-Term Mitigation Options (Additive to Near- and Mid-Term Alternatives)

Long-Term Option	Key Benefit	Key Limitation	Planning-Level Cost
• Raise Gate 5 Road to 100-year Storm Surge Elevation	• Improved Accessibility During High Flood Events • Low Cost	• Does Not Protect Properties Waterward of Gate 5 Road • Requires Property and Utility Coordination • Only One-Way Traffic	\$0.9 million
• Shoreline Seawall with Ecological and Recreational Improvements	• Addresses Broader Overland Flooding • Ecological and Recreational Benefits • Protects Entire Area	• Requires Property and Utility Coordination • Likely Requires Easements	\$34 million
• Raise Properties and Structures	• Reduces Long-Term Exposure for Individual Parcels	• High Cost • Piecemeal Solution • Requires Private Owner Participation	\$185 million

Based on this analysis and the feedback received during the community workshops, WSP recommends a phased hybrid approach combining the mid- and long-term mitigation alternatives. The recommended alternatives include:

- 1) Expansion of the pump station near the Coloma Street Canal;
- 2) Construction of a shoreline seawall with ecological and recreational enhancements; and
- 3) Incorporation of green infrastructure into all alternatives.



The goal of expanding the pump station and incorporating green infrastructure is to increase the capacity of the system to ultimately handle the runoff from the 10-year rainfall event storm occurring during a 100-year storm surge event. The 10-year rainfall event was used due to site constraints, such as available site size and storage capability required for large capacity pump stations, prohibitively high planning-level costs for larger pump stations, and design guidance used by Caltrans as a desirable design storm for urban roadways with speeds up to 45 mph. The construction of a seawall with ecological and recreational enhancements was selected because it provides protection for the entire area while pairing well with the pump station and green infrastructure improvements. It also provides full protection in a cohesive manner and at a fraction of the cost of raising properties and structures individually. The ecological and recreational enhancements for the seawall provide the City with the ability to maintain waterfront access for the public and improve ecological function along the shoreline. Green infrastructure is included because it improves the effectiveness and reduces the size and footprint of the proposed flood control facilities, resulting in net savings for the project. It also has benefits on water quality and creates a lasting environmental value while increasing agency acceptance to the project.

Once the near-term mitigation actions are underway, the City should establish a monitoring plan that tracks flood frequency, flood depths and duration, tide gate performance, pump station runtime and capacity utilization, nuisance flooding complaints, subsidence, sea level rise trends, and post-storm observations. These metrics can be used to define triggers for future upgrades, such as repeated exceedance of acceptable service levels, increasing flood duration, pump capacity exceedance, tide gate overtopping or backflow, accelerated subsidence, or updated sea level rise projections. Even though the mid- and long-term planning horizons provide a good framework for future capital planning and resilience investment, a monitoring plan can assist the city to adapt the mid- and long-term mitigation actions to fit the observed changes in site conditions.

1. Introduction

This document summarizes the conceptual design and implementation strategy for drainage improvements along Gate 5 Road and the surrounding low-lying shoreline area in the City of Sausalito. The purpose of the conceptual design is to evaluate a range of drainage improvement alternatives given near-term and future flooding conditions and then prepare and cost a preliminary design that is implementable and immediately applicable for the near-term along with strategic recommendations for future conditions. It is organized to provide a clear basis for planning decisions. Section 2 summarizes existing conditions and provides the overall scope of work for the project. Section 3 summarizes the findings from our vulnerability assessment which identifies immediate and future flooding concerns due to anticipated land subsidence, sea level rise and stormwater runoff changes. Section 4 provides the overall basis for design which will be used to develop and evaluate mitigation alternatives throughout the project area given the various flood scenarios provided from the vulnerability assessment. Section 5 provides the overall development of mitigation alternatives to address near-, mid-, and long-term flooding throughout the project area including such items as tide gates, pump stations, storage systems, grading and vertical element options, and green infrastructure. Section 6 describes the alternatives analysis including a prioritization of alternatives based on such items as cost effectiveness, permitting, funding, community and scheduling constraints. Based on this analysis, Section 7 discusses the mitigation actions that WSP recommends for the near-, mid-, and long-term time horizons. Section 8 then provides an overall implementation strategy for the near-term option and future strategy for selecting future flood control options. Section 9 provides a conclusion of the entire report. Appendices provide supporting technical information, assumptions, and reference material used to complete the assessment.

2. Background

2.1 Existing Conditions

The Gate 5 Area in the City of Sausalito faces chronic flooding and increasing flood risk due to the combined effects of sea level rise, storm surge, storm water runoff from rainfall events, and land subsidence estimated between 0.2 to 0.6 inches per year (See Section 3.2). Flooding is primarily caused by high tides and storm surge, with rainfall having a minimal effect, regardless of whether it occurs during a storm surge or low tide event. The project area focuses on locations currently affected by storm events, coastal flooding, and aging drainage infrastructure and is displayed in Figure 2.1.

Portions of Coloma Street, Heath Way, Harbor Drive and Varda Landing also experience chronic flooding. Topography of these low-lying areas is shown in the maps in Appendix C. A topographic survey (Towill, 2026) was completed at Gate 5 Road from Coloma Street to Harbor Drive and along the Coloma Street canal. The work effort included road and utility surveying for drainage and flood mitigation improvements along Gate 5 Road with the survey area encompassing approximately 1.35 acres. Project control and survey support was provided throughout the project including tying into the project control network to support survey and design activities. Project control uses NAD83 CCS83 Zone 3, 2011 (2025.00) epoch for the horizontal datum and NAVD88 for the vertical datum. The survey documented elevations and coordinates for drainage inlets and manholes of over 15 structures including top of canal and bottom of canal elevations along the Coloma outfall canal and other drainage features within the roadway right-of-way.



Figure 2.1 – Gate 5 Project Area in City of Sausalito

2.2 Scope of Work

The scope of work included development and evaluation of three conceptual alternatives as part of the Gate 5 Area Drainage Management Study conceptual design. Each alternative would:

- Incorporate a combination of blue (e.g. ponds, coastal areas, etc.), green (e.g. infiltration, bioretention, and nature-based solutions), and gray (e.g. stormwater pipes and pump stations) infrastructure
- Include a range of improvements throughout the project area
- Be evaluated by technical feasibility, cost-effectiveness, community priorities, regulatory and permitting requirements, funding, right-of-way and site constraints, and schedule constraints
- Be refined through stakeholder and City workshops, incorporating feedback to assist in building consensus on conceptual approaches.



Based on the vulnerability assessment presented in Section 3, which describes the extent and progression of flooding over time, different conceptual solutions are most appropriate at different planning horizons: near-term (2025-2035), mid-term (2035-2050), and long-term (2050-2100). This, combined with the varying geographic extent of potential improvements, resulted in the evaluation of more than three conceptual alternatives as originally specified in the scope of work. For each planning horizon, flood control improvements were evaluated and combined to form various mitigation alternatives. The following are mitigation actions that were assessed in this study:

- Covering the Coloma Street canal and adding a pump station on top of the canal;
- Adding tide gates to the existing stormwater outfalls to the Bay;
- Raising the elevation of Gate 5 Road, Coloma Street, and Harbor Drive;
- Raising the elevation of Varda Landing,
- Adding additional drainage connections along Gate 5 and Harbor Drive;
- Connecting the Harbor Drive drainage system with the Coloma Street and Gate 5 Road drainage system;
- Adding underground storage at MLK Park;
- Adding a pump station near Coloma Street and Gate 5 Road intersection coupled with underground storage;
- Adding a pump station near Harbor Drive and Gate 5 Road intersection;
- Installing a seawall along portions of Varda Landing;
- Installing a seawall along the shoreline of the project area and incorporating recreational and ecological improvements;
- Adding green infrastructure throughout the project area; and
- Raising the elevation of individual properties and structures.
- Evaluation of these various improvements along with City and stakeholder staff discussions yielded the following recommendation for near-term solutions to flooding in the Gate 5 Road area:
 - Cover Coloma Street canal, adding a tide gate, and placing a pump station on top of the canal;
 - Connecting the Harbor Drive drainage system with the Coloma Street and Gate 5 drainage system; and
 - Construction of a seawall along portions of Varda Landing.

This report presents the analysis and evaluation of these mitigation alternatives that incorporate findings from the vulnerability assessment and from stakeholder and City feedback. It presents feasibility level analysis for a near-term solution and provides a planning-level evaluation of potential mid-term and long-term solutions, incorporating a range of improvements (rather than only three). Accordingly, the conceptual design alternatives are organized by planning horizons, where near-term improvements focus on feasible, constructible solutions, while mid- and long-term options are presented at a planning level and will require additional community input, City coordination, and funding evaluation for further implementation.

3. Vulnerability Study Applicability

As part of this project, a vulnerability assessment for the Gate 5 Road area was conducted to evaluate existing and future flood risks driven by rainfall, tidal conditions, sea level rise (SLR), and land subsidence. Flood conditions were assessed for existing conditions (2025) and three future planning horizons (2050, 2080, and 2100) using an XP-SWMM model which combines both 1D and 2D inputs. Thirty-six scenarios that incorporated various combinations of these factors across the four-time horizons were evaluated and are shown in Table 3.1. This was done to see how current and future flooding will affect the area in the absence of any mitigation efforts. Results from the model were then used to inform the conceptual design development and identify key areas for both near-term mitigation opportunities and long-term adaptation strategies.

The vulnerability assessment flood modeling component integrated a hydrologic analysis that included rainfall inputs. The NRCS (SCS) 24-hour Design Storm Type IA, typical for this region of California (USDA/NRCS, 1986), was used to develop rainfall distributions for the model. These distributions were applied at 6-minute intervals and scaled using multipliers derived from NOAA Atlas 14 24-hour precipitation frequency data for the project area (USDC/NOAA, 2014). For future conditions (2050, 2080, and 2100), the multipliers were further adjusted based on projected percentage increases in precipitation intensity relative to existing conditions according to the California Energy Commission Cal-Adapt Analytics Engine. SLR values were selected from the State of California Sea Level Rise Guidance (OPC, 2024). Location-specific median SLR projections for San Francisco Bay were applied to represent relative sea level change at the project site. Four model versions were created to represent the 2025, 2050, 2080 and 2100 subsidence scenarios as discussed in Section 3.3.

Table 3.1 – Model Simulation Scenarios

Scenario #	Climate Scenario	Year	Sea Level Rise (ft)	Extreme Storm Surge	Still Water Level (ft) NAVD88	Pluvial
1	N/A	2025	0	1-Year	7.2	N/A
2	N/A	2025	0	100-Year	9.6	N/A
3	N/A	2025	0	N/A	6.0	10-Year
4	N/A	2025	0	N/A	6.0	25-Year
5	N/A	2025	0	N/A	6.0	50-Year
6	N/A	2025	0	N/A	6.0	100-Year
7	N/A	2025	0	1-Year	7.2	10-Year
8	N/A	2025	0	1-Year	7.2	25-Year
9	N/A	2025	0	1-Year	7.2	50-Year
10	N/A	2025	0	1-Year	7.2	100-Year
11	N/A	2025	0	100-Year	9.6	10-Year
12	N/A	2025	0	100-Year	9.6	100-Year
13	Intermediate	2050	0.8	1-Year	8.0	N/A
14	Intermediate	2050	0.8	100-Year	10.4	N/A
15	Intermediate	2050	0.8	N/A	6.8	10-Year
16	Intermediate	2050	0.8	N/A	6.8	25-Year
17	Intermediate	2050	0.8	N/A	6.8	50-Year
18	Intermediate	2050	0.8	N/A	6.8	100-Year
19	Intermediate	2050	0.8	1-Year	8.0	10-Year

Scenario #	Climate Scenario	Year	Sea Level Rise (ft)	Extreme Storm Surge	Still Water Level (ft) NAVD88	Pluvial
20	Intermediate	2050	0.8	1-Year	8.0	100-Year
21	Intermediate	2050	0.8	100-Year	10.4	10-Year
22	Intermediate	2050	0.8	100-Year	10.4	100-Year
23	Intermediate	2080	1.8	1-year	9.0	N/A
24	Intermediate	2080	1.8	100-Year	11.4	N/A
25	Intermediate	2080	1.8	N/A	7.8	10-Year
26	Intermediate	2080	1.8	N/A	7.8	100-Year
27	Intermediate	2080	1.8	1-Year	9.0	10-Year
28	Intermediate	2080	1.8	1-Year	9.0	100-Year
29	Intermediate	2080	1.8	100-Year	11.4	10-Year
30	Intermediate	2080	1.8	100-Year	11.4	100-Year
31	Intermediate	2100	3.1	N/A	9.1	N/A
32	Intermediate	2100	3.1	1-year	10.3	N/A
33	Intermediate	2100	3.1	100-Year	12.7	N/A
34	High	2100	6.5	N/A	12.5	N/A
35	High	2100	6.5	1-year	13.7	N/A
36	High	2100	6.5	100-Year	16.1	N/A

3.1 Existing Conditions

Under existing conditions, flooding along Gate 5 Road is primarily caused by high tides and storm surge. The most vulnerable location is the area around Heath Ceramics. Figure 3.1 shows existing conditions with a 100-yr pluvial event occurring during MHHW and Figure 3.2 shows existing conditions with a 100-yr pluvial event coupled with 100-yr storm surge conditions. This illustrates the minimal influence that rainfall has on flooding when compared to flooding driven by storm surge, which causes the seawater to flow through the storm drain system into the project area and via overland flow into the project area.

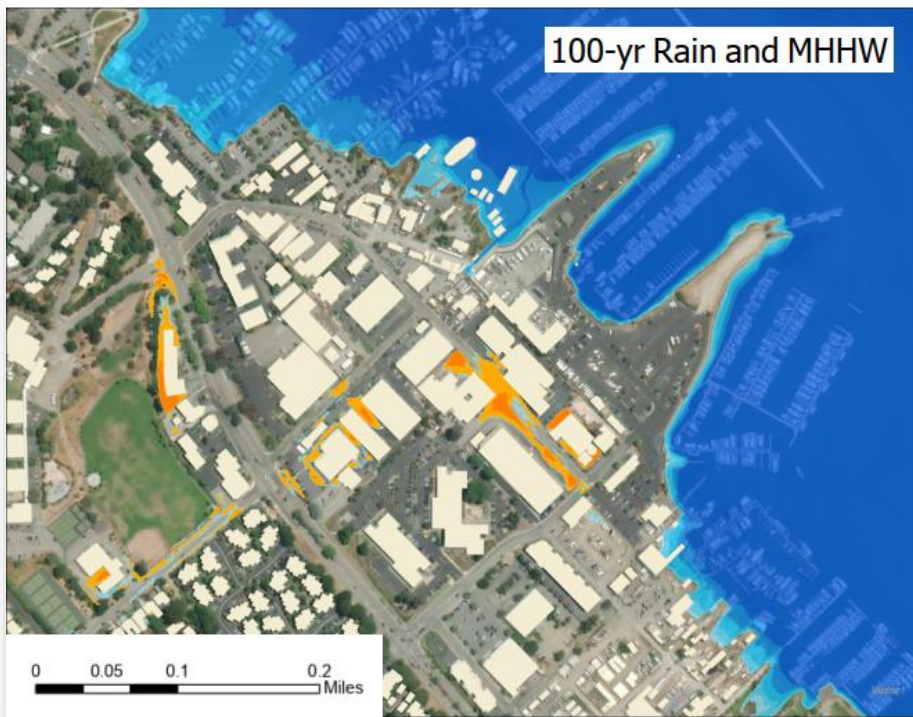


Figure 3.1 – Rainfall Driven Flooding in the 2025 Time Horizon.

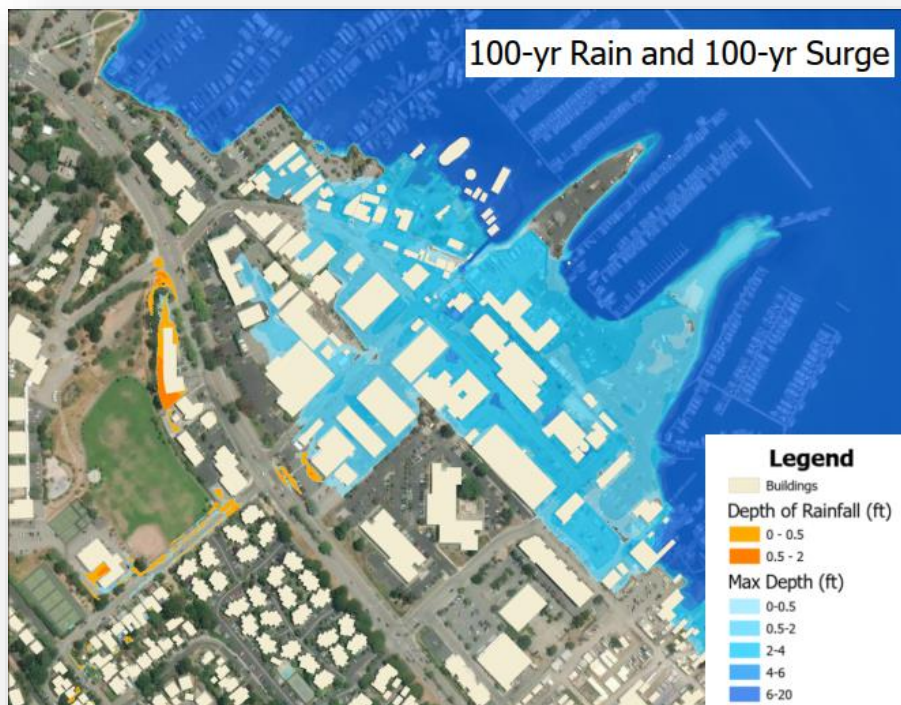


Figure 3.2 – Storm Surge Driven Flooding in the 2025 Time Horizon.

3.2 Future Conditions

In future conditions (2050 and beyond), rising sea levels and land subsidence significantly worsen the effects of the flooding. By 2050 and onward, overland flooding from the Bay becomes the dominant driver of inundation across the Gate 5 Road project area. This is shown in Figure 3.3 which illustrates the MHHW conditions across all time horizons. The most vulnerable areas to overland flooding include the area west of Varda Landing Road towards the Bay, the area along Gate 5 Road, and the western portions of the Clipper Yacht Harbor, where proximity to the shoreline and lower ground elevations result in deeper, longer-lasting inundation. By 2080 and 2100, extensive portions of the project area—including all of Gate 5 Road—experience extensive flooding during typical tidal cycles. Overall, the modeling indicates that while stormwater system improvements may provide near-term benefits, future flood risk is fundamentally caused by overland flow from the Bay. These risks necessitate the development of vertical solutions to address progressively increasing flood risk across the project area.

In addition, the Vulnerability Assessment describes expected property damage associated with existing and future conditions. Building exposure and risk increase markedly across all future scenarios. A “do-nothing” risk analysis, which quantified cumulative flood damages over the 2025–2080 period for buildings alone, estimated total undiscounted losses of approximately \$2.37 billion. Even when discounted to present value, projected damage remains substantial (approximately \$466 million with 7% discount rate), underscoring the long-term economic consequences of inaction.

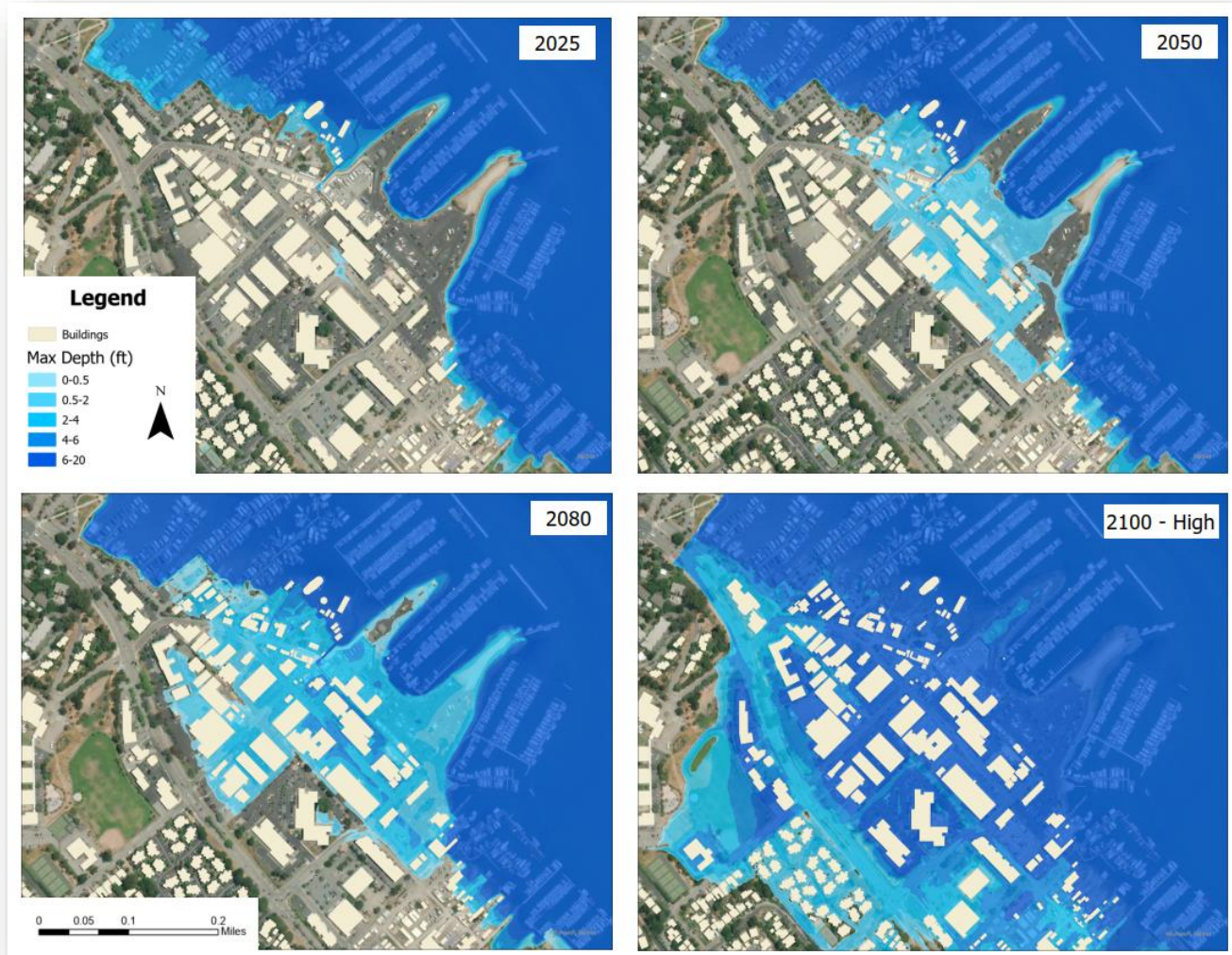


Figure 3.3 – MHHW with No Rainfall for All Time Horizons.

3.3 Subsidence

The Vulnerability Assessment also evaluated potential subsidence within the study area. Subsidence is the gradual downward movement of the Earth's surface, typically expressed as a rate over time, such as inches or feet per year. While the specific mechanisms were not analyzed, both local (e.g., soil settlement, groundwater effects) and regional tectonic processes are likely contributing factors in the project area. Analysis of USGS and NORCE datasets showed a generally consistent range of rates for subsidence, yielding the following results:

- 0.42 ft to 1.25 ft of subsidence in 25 years (2050)
- 0.83 ft to 2.5 ft of subsidence in 50 years (2075)
- 1.25 ft to 3.75 ft of subsidence in 75 years (2100)

While there is a range in the subsidence values, there is not a clear spatial pattern to this range along any of the seven profiles of interest in the project area. These include profiles along Varda Landing Road, Gate 5 Road, Northern Clipper Point, Southern Clipper Point, Coloma Street, Harbor Drive and Bridgeway, so this study has assumed a single rate of subsidence through time across the entire site. Subsidence values used as a basis of design are provided in Section 4.3.

3.4 Overview of Flooding

The Vulnerability Assessment shows the overall mechanics of flooding in the area throughout time. It identifies how flooding along Gate 5 Road is primarily caused by high tides and storm surge and that rainfall has minimal effect on flooding, regardless of whether it occurs during a storm surge or low tide event. Figure 3.4 illustrates how the storm drain system interacts with the seawater and how seawater can back up through the storm drain system, causing inland flooding under existing conditions. It also shows the minimal influence that rainfall has on flooding when compared to flooding driven by storm surge. This information was used as a basis for developing conceptual design criteria provided in Section 4. It shows that to protect inland areas from flooding, even under existing conditions, the storm drain system must include: 1) a barrier such as a tide gate to prevent backup of coastal waters inland during storm surges, and 2) an alternate system to discharge stormwater to the Bay when the tide gates are closed.

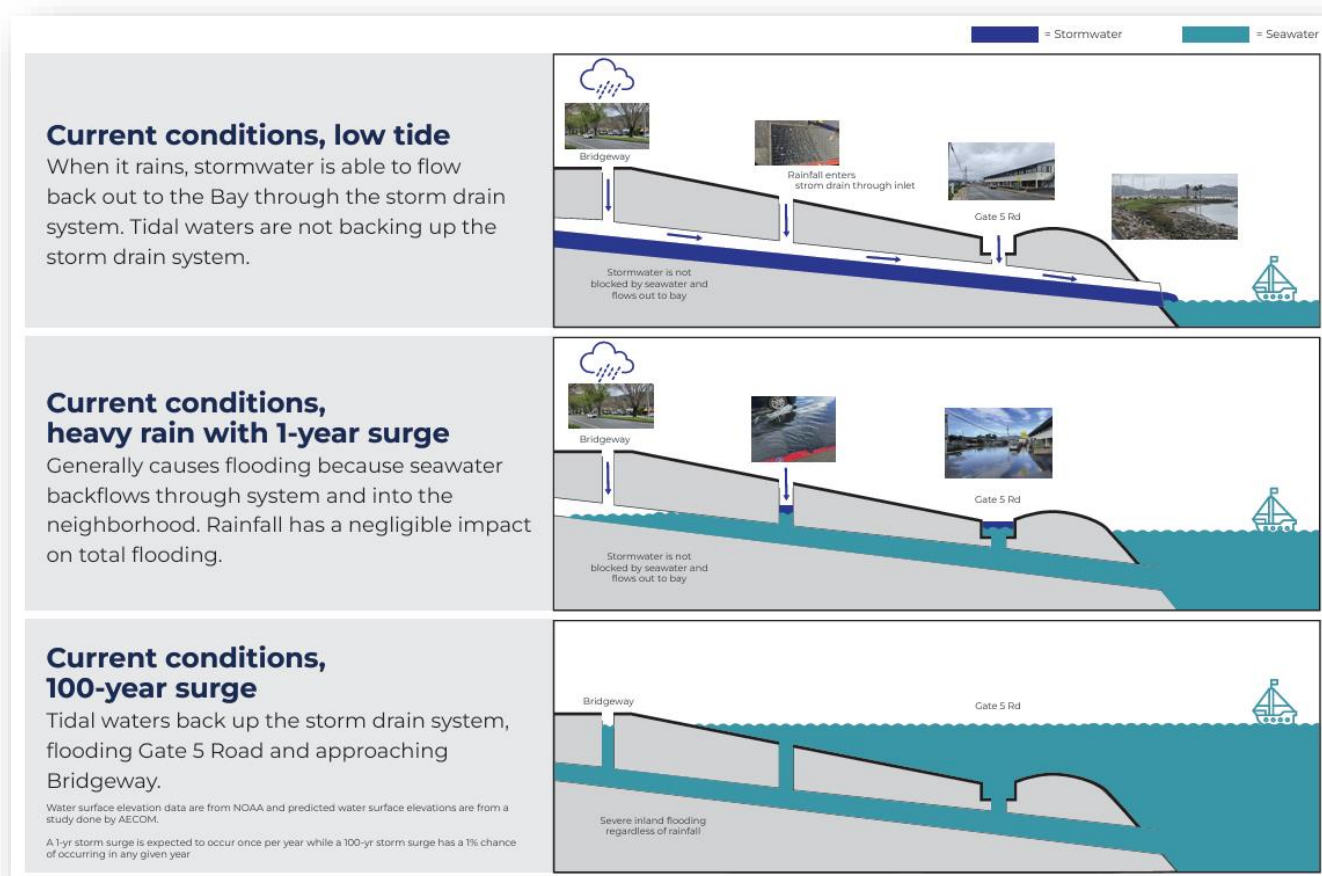


Figure 3.4 – Flooding Primarily Caused by Seawater Backflow in the Gate 5 Road Area.

4. Basis of Conceptual Design

Based on the vulnerability assessment, protecting inland areas from flooding will require a tide gate placed at the end of the storm drain system to prevent backflow of coastal waters inland and a pumped drainage system to convey stormwater out to the coast when the tide gates are closed (see Figure 4.1).

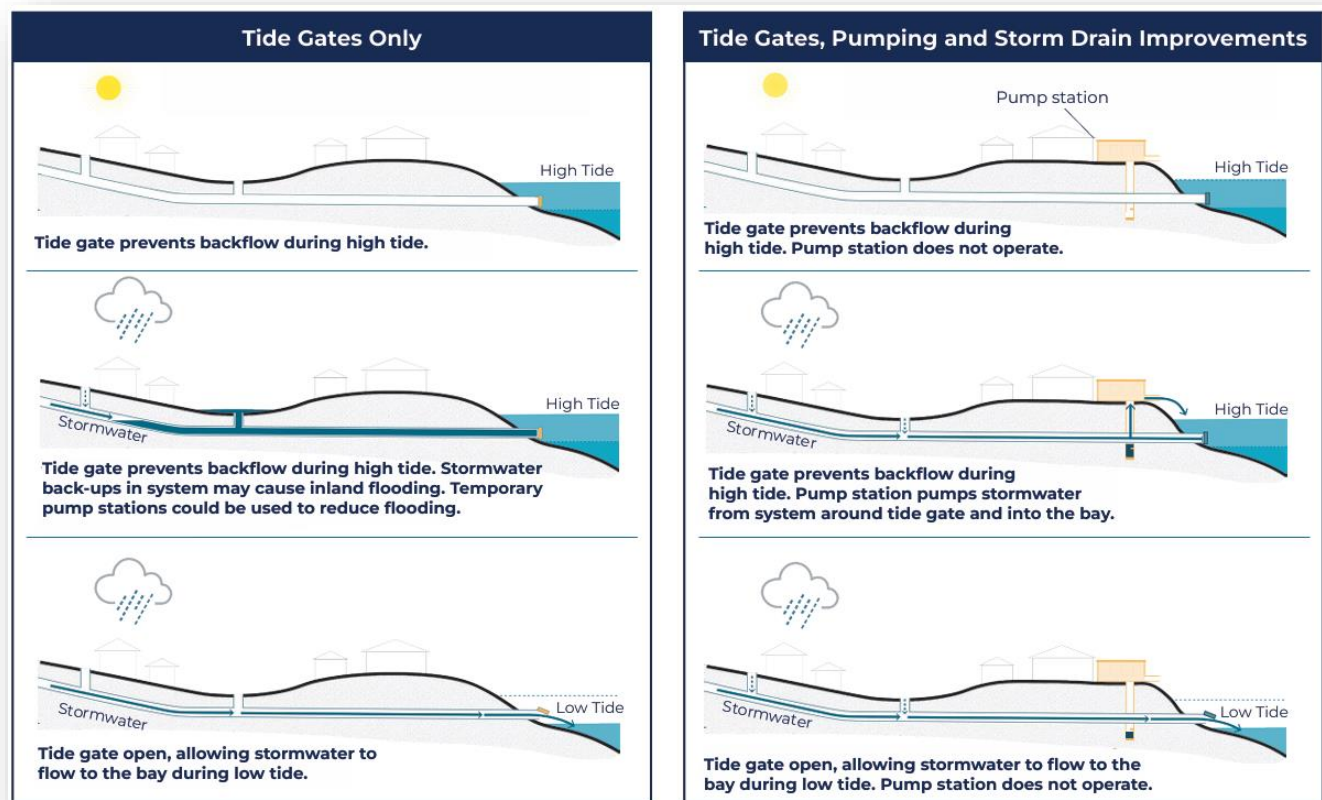


Figure 4.1 – Tide Gate Pump Station Interaction

The following basis of conceptual design describes the criteria for sizing a tide gate / pump station system. It also provides information for future conditions given the compounded effect of storm water flows combined with sea level rise, subsidence, storm surge and storm water runoff.

4.1 Design Criteria – Stormwater Runoff

Although current flood risk is driven primarily by tidal and surge-related backflow, stormwater runoff remains a necessary design criterion because pump and conveyance infrastructure must operate during tide-gate closure. Stormwater runoff was estimated using XP-SWMM modelling described in Appendix A. Based on the XP-SWMM model, runoff at the Coloma Street and Gate 5 Road drainage area (node CB388, shown in Appendix C, Figure 3) was identified as the critical location for preliminary pump station sizing when tide gates are closed (see Section 5 for more information). Due to site constraints (such as available site size and storage capability required for large capacity pump stations) and prohibitively high planning-level costs, the 10-year rainfall event was used for initial

sizing. This is also used by Caltrans as a desirable design storm for urban roadways with speeds of 45 mph and under per their Highway Design Manual. To determine the flow rate for the pump, WSP assumed that the rainfall event occurred at the same time as a storm surge event (i.e. the tide gates are closed). WSP investigated the still water elevations in the Bay during the 100-year storm surge event and found that there is an approximately 10-hour window of time where the tide gates would be closed to prevent seawater from backflowing up the stormwater system. WSP assumed the worst-case scenario for sizing the pump, which is that the 10-hour time-period is centered around the peak runoff of the storm event. Based on this overlay, WSP determined the design flow rate for the pump station to be 86 cfs.

Because pump operation would only be required during overlapping rainfall and storm surge events, the likelihood of these events (i.e. 10-yr rainfall event and 100-yr storm surge) occurring simultaneously is lower than the 10-year return period alone. The 100-year storm surge was used for estimating the time for which the tide gate would be closed (which was the 10-hr duration described above) for the calculation of overall rainfall volume to be stored. In comparison, a 2-year event would require a design flow rate of approximately 38 cfs. Accordingly, the selected design approach provides a practical near-term solution, with the understanding that additional capacity could be added in the future to address more severe rainfall events. Further evaluation and model calibration following implementation could be used to refine these long-term capacity needs.

4.2 Design Criteria – Flood Elevation

Selected scenarios were used as a basis of design for conceptual solution alternatives and are presented and evaluated for near-term, mid-term, and long-term options. These flood scenario elevations along with subsidence were used to determine recommended vertical solution elevations. While lower levels of protection could be provided based on available funding and the City's risk tolerance, the following provides a recommended design level that was used for general concept design and cost estimates. These scenarios are summarized in Table 4.1. The design elevation is one foot higher than the still water elevation to account for wave action.

Table 4.1 – Basis of Design – Design Flood Elevation

Condition	Time Period	Climate Scenario	Sea Level Rise Condition (ft)	Extreme Tide Condition	Still Water Elevation (ft)	Design Elevation (ft)
Near-Term	2025-2035	N/A	0	1-yr	7.2	8.2
Mid-Term	2035-2050	Intermediate	0.8	100-yr	10.4	11.4
Long-Term	2050-2100	Intermediate	3.1	100-yr	12.7	13.7

4.3 Design Criteria – Subsidence

Based on the results of the subsidence analysis in the Vulnerability Assessment, the following subsidence values were combined with flood elevations in the evaluation of vertical design solutions. By mid-century, the ground could sink by 0.42 to 1.25 feet and by end of century, it could sink between 1.25 and 3.75 feet. The values are summarized below in Table 4.2. These generally fall within the high range of rates predicted from the analysis described earlier in the report. Note that a positive subsidence correlates to the ground elevation lowering. Subsidence lowers land relative to sea level while SLR is the long-term increase in average ocean water levels



resulting from climate change. Together, these two processes can significantly increase flood risk for the area in the future as displayed in Figures 4.2 and 4.3. In Figure 4.3, the ground surface (tan) lowers while the seawater surface (blue) rises. It illustrates how the shoreline (where tan and blue colors intersect) moves significantly inland due to the effects of SLR and subsidence.

Table 4.2 – Basis of Design – Subsidence

Condition	Year	Subsidence (ft)
Existing	2025	0
Near-Term	2035	0.5
Mid-Term	2050	1.3
Long-Term	2100	3.75

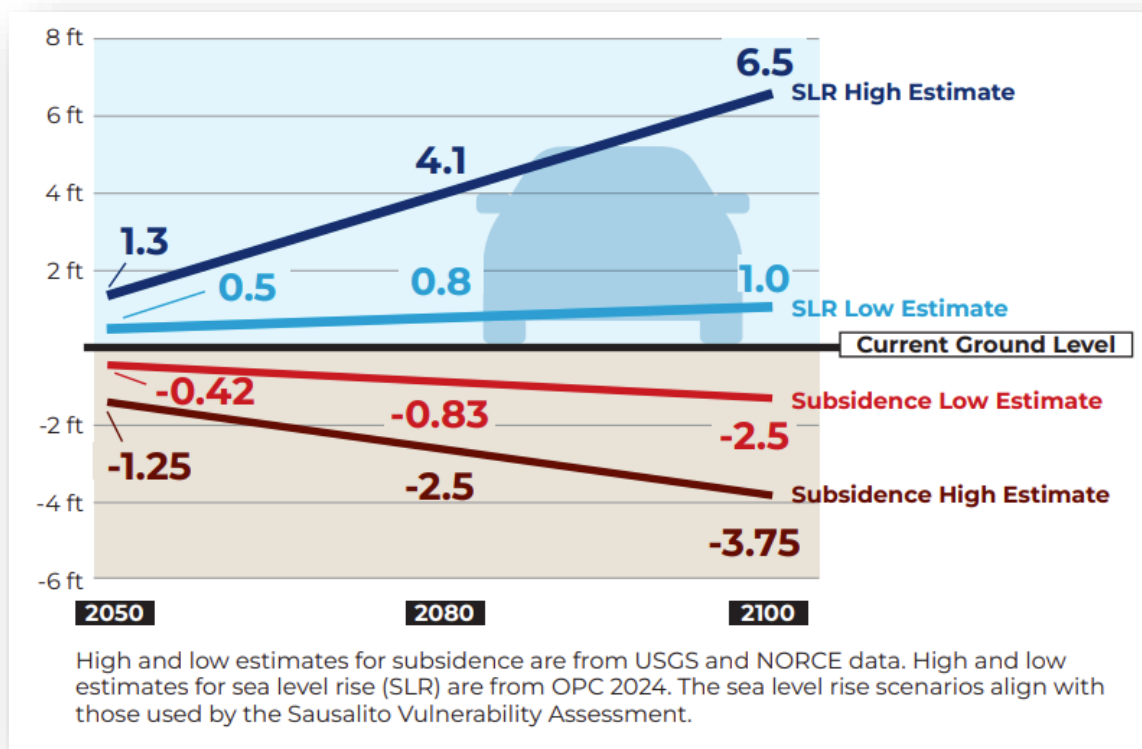


Figure 4.2 – Subsidence and SLR Estimates in the Gate 5 Road Area

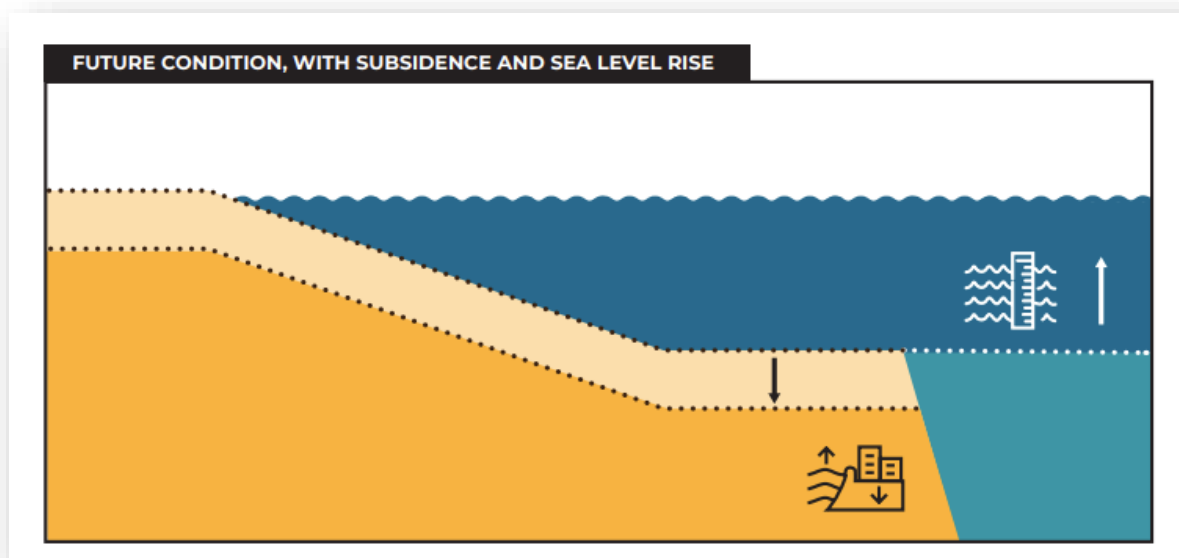


Figure 4.3 – Change in Shoreline Location Due to SLR and Land Subsidence

5. Concept Design Solutions Alternatives

5.1 Overview

Based on findings from the vulnerability assessment and input from local citizens, members of the business community, and the City, WSP decided to organize the conceptual design alternatives by planning horizons: near-term (2025–2035), mid-term (2035–2050), and long-term (2050–2100). Near-term improvements focus on feasible (with respect to cost effectiveness, right of way, timeliness of implementation), constructible solutions, while mid- and long-term options are presented at a planning level and will require additional community input, City coordination, and funding.

5.2 Near-Term

The project area is a low-lying coastal community which is already experiencing flooding due to seawater backflowing through the stormwater pipeline network. Near-term improvements evaluated for this type of flooding include tide gates and pump stations. Tide gates allow natural stormwater runoff to drain into the sea at low tide but seal the storm drain network during high tide or storm surge situations. The pump stations mechanically pump stormwater from the upstream side of the tide gate to the Bay if there is a rainfall event that occurs while the tide gates are closed (see Figure 5.1). These two measures need to be implemented together for a workable solution.

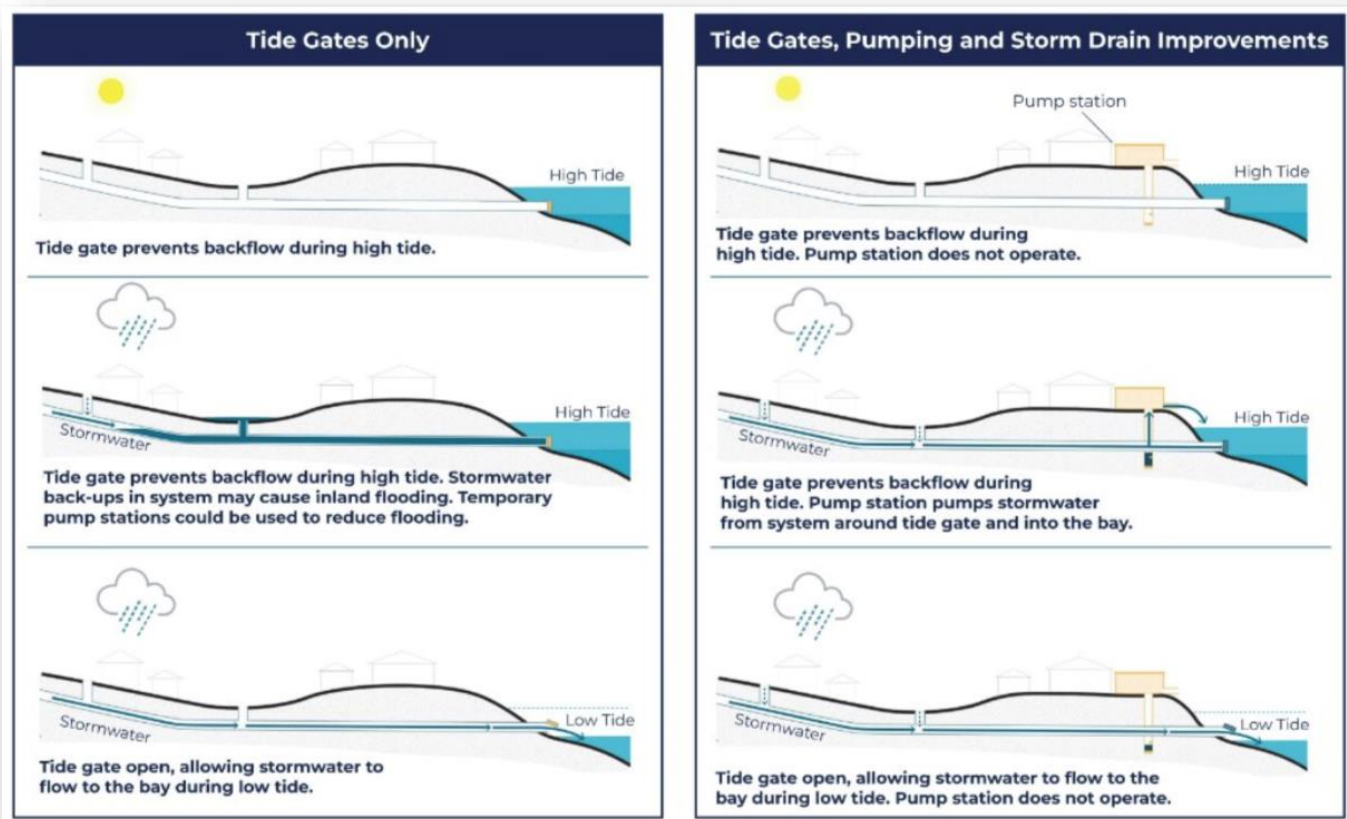


Figure 5.1 – How Tide Gates and Pump Stations Work Together

Neither one alone is sufficient as discussed later in this section. An overview of the improvements assessed for near-term solutions are shown in Figure 5.2. These technologies are discussed in more detail in this section.

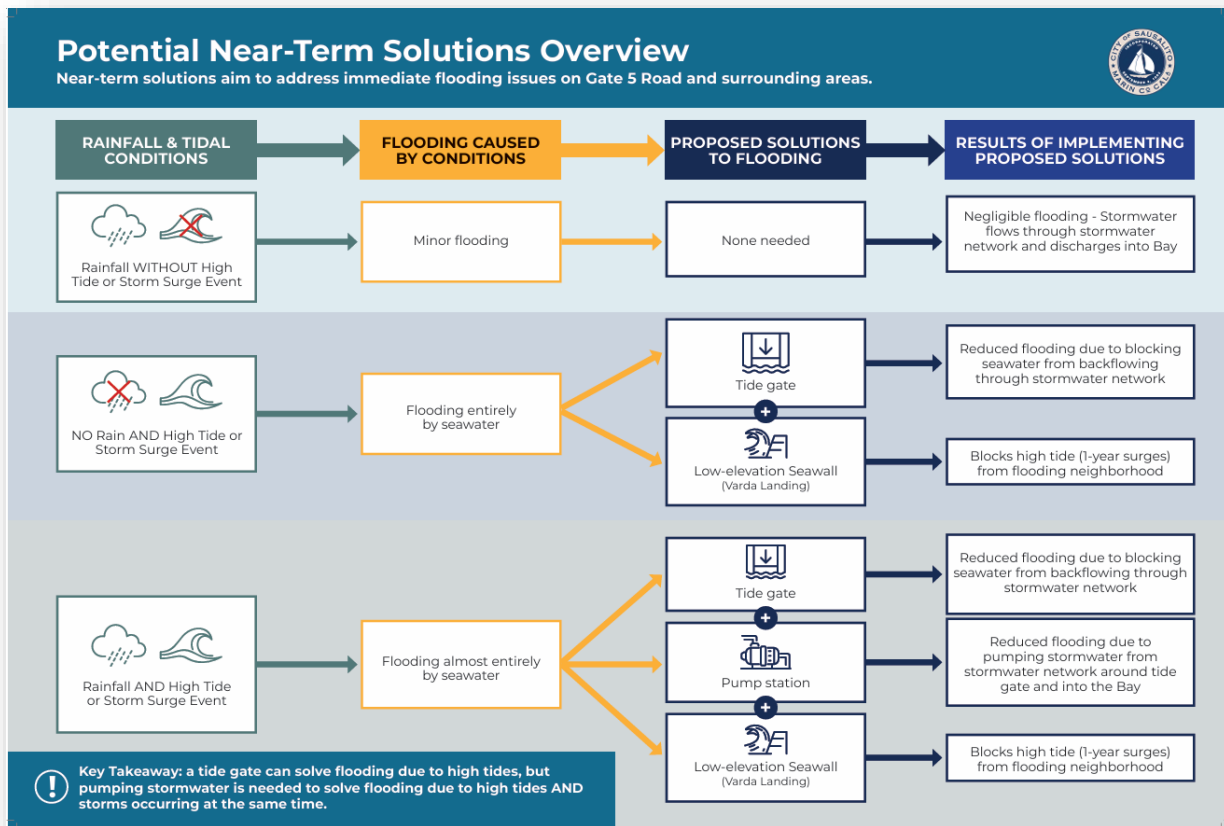


Figure 5.2 – Overview Infographic of Potential Near-Term Solutions

One other area that is directly influenced by coastal inundation is the area along Varda Landing. The flooding mechanisms affecting Varda Landing differ from those in the Gate 5 Road area since flooding primarily occurs when seawater flows across the ground into low-lying areas. As a result, measures such as tide gates and pump stations, which are designed to manage flooding within drainage networks, would not be effective in this location. Instead, WSP investigated the potential of constructing a seawall along the shoreline that would be built to maximum height of three feet (Alignment shown on Figure 5.3).

This seawall would reach the design elevation for the 1-year storm surge under existing conditions (Elevation 8.2' as shown in Table 4.1).

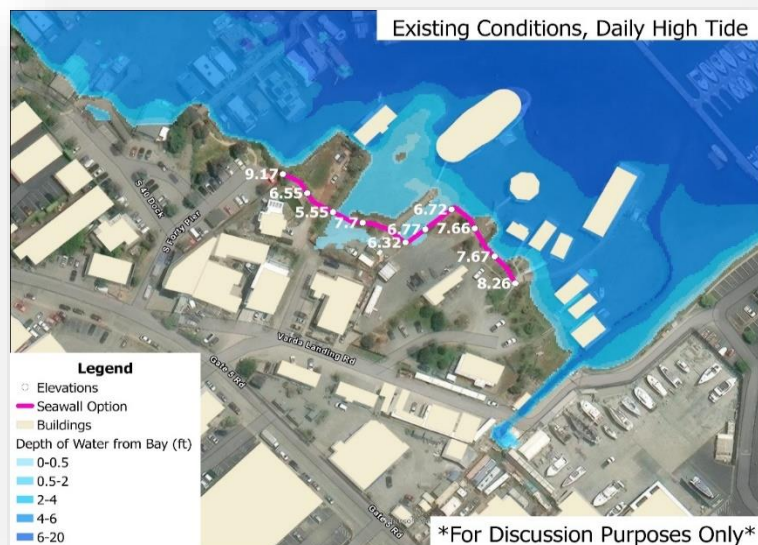


Figure 5.3 – Varda Landing Seawall Alignment

5.2.1 Tide Gate and Stormwater Pumping Options

5.2.1.1 Continue Current Approach

Flooding in the area is currently managed by private owners using pumps on their property to drain water onto Gate 5 Road while using sandbags to prevent flooding from the road into their homes and businesses (See Figure 5.4). The City has tested the use of temporary pumps at catch basins along Gate 5 Road to pump water out to the Bay while placing sandbags around targeted catch basins. This system has yielded positive results. According to the City, this temporary solution costs about \$20k per flood event. Assuming eight instances per year, this costs the City about \$160k per year. Additionally, this solution would only benefit specific problem areas in the district and would not provide protection when storm surge is high enough to flow overland into the project area.

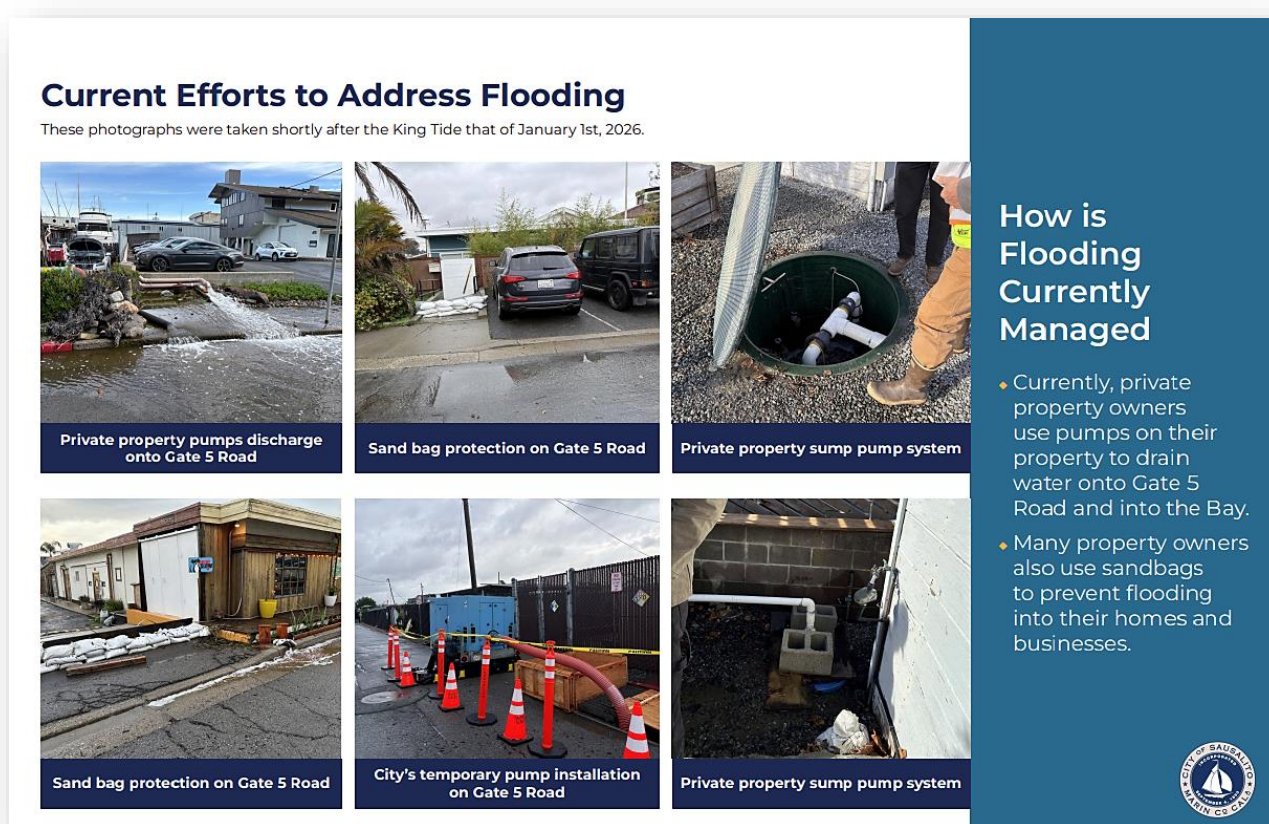


Figure 5.4 – Overview of Current Flood Management

5.2.1.2 Tide Gates Only

Tide gates incorporated into the storm drainage system without the use of pump stations would only be useful during high tide or storm surge events when precipitation events do not occur simultaneously (i.e. while the tide gates are closed). Without a pump station, the City would have to decide whether to keep the tide gate closed, which would cause stormwater to back-up in the stormwater system and potentially flood the project area, or open the tide gate, which would cause seawater to flow through the stormwater network and potentially flood the project area. In either case, this system may end up providing little to no protection. The likelihood of a rainfall event coinciding with a high tide or storm surface event is high, as evidenced by the events of early January 2026. Tide

gates coupled with additional storage in the pipeline system could add a small amount of protection if much smaller precipitation events occurred, though this would likely be protection from events that would be smaller than a 1-year rainfall event.

5.2.1.3 Tide Gates, Pumping and Storm Drain Improvement

The use of tide gates coupled with pump stations is the recommended option for this area since the drainage system intercepts flows from a relatively large watershed with little opportunity to store runoff. The improvements would allow natural stormwater runoff to drain into the sea at low tide and seal the storm drainage system shut during high tide or storm surge while mechanically pumping the stormwater out to the Bay. The incorporation of both of these elements into the overall storm drain network will also necessitate storm drain improvements which depend on the type of tide gate, the location of the pumping station, the location of a wet well for the pump station and any upstream improvements needed to convey the flow efficiently to the pump station and from the pump station to the Bay.

To achieve relatively quick implementation, WSP proposes to cover the canal and construct the pump station on the canal. Based on the limited space available on top of the canal, it is not possible to handle the design flow rate of 86 cfs. WSP assumes that a pump station on top of the canal can accommodate 4 pumps, each with a capacity of 12.7 cfs and each operating under relatively low hydraulic head (on the order of 50-feet or less). A maximum of three pumps would operate at one time, meaning the maximum capacity of the pumphouse is about 38 cfs. A pressurized pipeline leading from the pump station to the bay (downstream of the tide gate) would be required.

A second option was brought up during a walkthrough of the site with the Sausalito Sustainable Waterfront Association (SSWA, See Section 5.2.3 for more detail). This option would place a culvert used to channelize the flow to a tide gate at an existing crossing of the canal (at Varda Landing). Here, temporary pumps could be used to pump water out from the canal upstream of the tide gate (after tide gate closure) for alleviation of upstream stormwater flooding. This option, however, would not be able to support the pump capacities noted in the prior alternative. More specifically, the pump capacity would be significantly less than the prior alternative and would be less than the 1-year rainfall event. Additionally, this alternative would require raising the downstream canal walls by 1.5 - 3.0 feet and is likely to require more permitting requirements to the recommended near-term option. It is for these reasons that a larger pump station placed downstream of the Varda Landing crossing of the canal is recommended.

There are currently two main locations along Gate 5 Road experiencing flooding during storm surge events. One location is along Gate 5 Road from Coloma Street to Heath Ceramics and the other is at Gate 5 Road and Harbor Drive (see Figures 5.5 and 5.6). The survey for this project (Towill, 2026) showed that these two systems are not connected to each other. The stormwater system from Gate 5 Road and Harbor Drive conveys stormwater northeast to Clipper Yacht Harbor (discharging into the Bay through a duck billed flap gate. Based on flooding experienced in this portion of the stormwater network, the duck billed flap gate is not functioning correctly and is not preventing Bay water from flowing into the stormwater system during high tides and storm surge events.

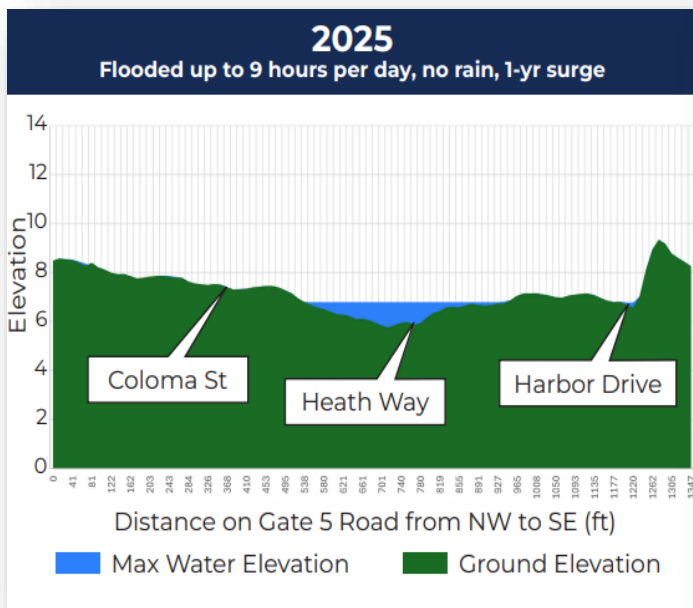


Figure 5.5 – Overview of Potential Near-Term Solutions Gate 5 Road Flooding, 2025

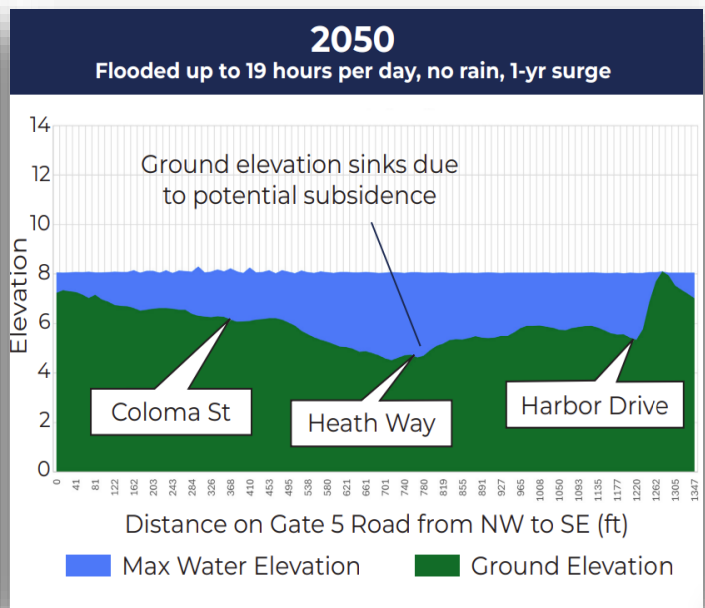


Figure 5.6 – Overview of Potential Near-Term Solutions Gate 5 Road Flooding, 2050

The stormwater system along Gate 5 Road northwest from Heath Ceramics conveys water to the northwest to combine with flow coming northeast down Coloma Street before ultimately flowing into the Coloma Street Canal. To reduce the number of pump stations required to convey stormwater while the tide gates are closed, WSP recommends that the Harbor Drive system be connected to the Coloma Street system via an 18" storm drain along Gate 5 Road. Based on the survey, this connection would be made between

the systems along Gate 5 Road in front of the Industrial Center Building. This storm drain improvement is included in the cost estimates for this overall improvement scenario in Appendix C and is shown in Table 5.1 and Figure 5.7.

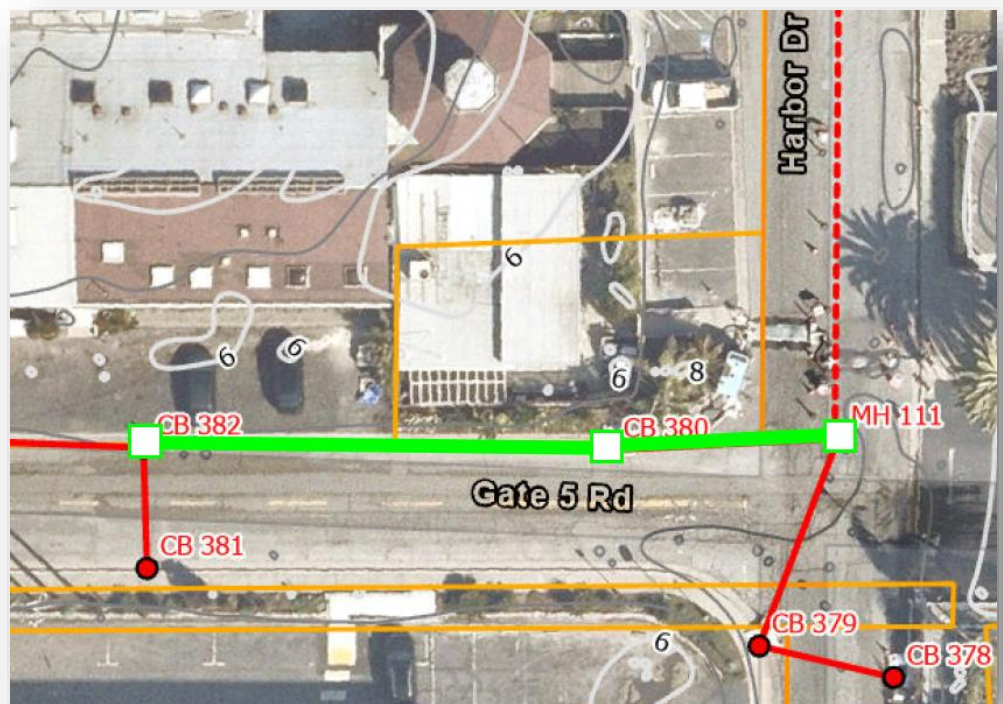


Figure 5.7 – Overview of Potential Near-Term Solutions Gate 5 Road Flooding, 2050

5.2.1.4 Cost Summary and Alternatives Summary, Near Term

To assist the City with securing funding and planning for near-term improvements, WSP cost the alternatives discussed above. The cost summary is included in Table 5.1.

Table 5.1 – Near-Term Alternatives Cost Summary

Design Element	Cost
Covering the Coloma Street Canal	\$ 460,000
Pump Station on Top of Covered Canal	\$ 1,800,000
Tide Gate Installations on Coloma Street Canal and at the end of Harbor Drive	\$ 420,000
Connection of Harbor Drive and Gate 5 Road Stormwater Networks	\$ 80,000
Subtotal	\$ 2,800,000
Engineering and Design (Assume 15% of Construction)	\$ 400,000
50% Contingency	\$ 1,600,000
Total	\$ 4,800,000

The summary of these alternatives along with the pros and cons are shown in Table 5.2.

Table 5.2 – Near-Term Mitigation Option Summary

Near-Term Mitigation Option	Key Benefits	Key Limitations	Planning-Level Cost
• Add Tide Gates to Existing Outfalls • Pump Station on Coloma Street Canal (2-Year Rainfall Capacity) • Storm Drain Improvements	• Addresses Backflow of Coastal Water • Addresses Stormwater Flows While Tide Gates Are Closed • Relatively Fast Implementation (3 to 4 years) • Within City Right of Way	• Moderate O&M for Pump/Tide Gates • Potential Permitting Delays at Canal • Structural Assessment of Canal Must Be Done First	\$4.8 million

5.2.2 Vertical Solution Options

5.2.2.1 Raising Varda Landing Road

Varda Landing Road is a private unpaved road that allows access from Gate 5 Road to private homeowners located on the seaward (north) side of the road and to some businesses located on the east side of the road. The lowest elevation of the road is approximately 6 ft which is below the elevation of the 1-year storm surge by 1.2 ft. One near-term option is to raise Varda Landing Road. The most constructable target elevation for the road is 8.2' NAVD88, which is one foot above the existing 1-year storm surge elevation (see Table 4.1). If funding and private property permissions allow, then the road should target a higher elevation. However, such an option alone would not address flooding issues of the properties on the seaward side of the road because the road would only act as a barrier to inland flow of water for locations on the inland side of the road.

Raising the road would be coordinated with the private owner. On the morning of May 12, 2026, WSP spoke with the private owner during a walkthrough with the Sausalito Sustainable Waterfront Association and confirmed their interest and conditional acceptance of this approach (See Section 5.2.3). The road raising would assume a 20-ft wide road surface with side slopes of 4H:1V to the existing ground. The road currently crosses the canal at the end of the Coloma Street drainage system. Here, the road is elevated to approximately 8.5 ft NAVD88, though the

adjacent canal walls are lower. Depending on the target elevation for the road, it may or may not have to be raised at this location, though raising it has been included in the cost estimate in Table 5.3.

5.2.2.2 Seawall for Varda Landing

A second, more effective, solution for this area is to construct a vertical element along the shoreline that acts as a seawall to prevent high tides and storm surge from inundating low-lying land along the coast. The seawall could be vertical (See Figure 5.8), stepped or mounded with revetments (the latter generally used in cases where low energy erosional processes operate such as in protected bays). The exact material depends on the target elevation and the allowable footprint. WSP recommends that at a minimum, the seawall be designed to an elevation of 8.2' NAVD88. This would address the existing 1-year storm surge plus 1-foot of freeboard. An approximate footprint for this seawall is shown in Figure 5.9. It has been placed in a way that follows the shoreline, is far from existing structures, and minimizes the required height (less than 3-ft) and length of the wall. This would reduce the amount of coordination among private property owners and aid in its ease of construction. This option would address immediate concerns of overland flow issues for the most common storms, although more severe storms would still overtop the seawall.



Figure 5.8 – Overview of Potential Near-Term Solutions Vertical Seawall with Sloped Embankment

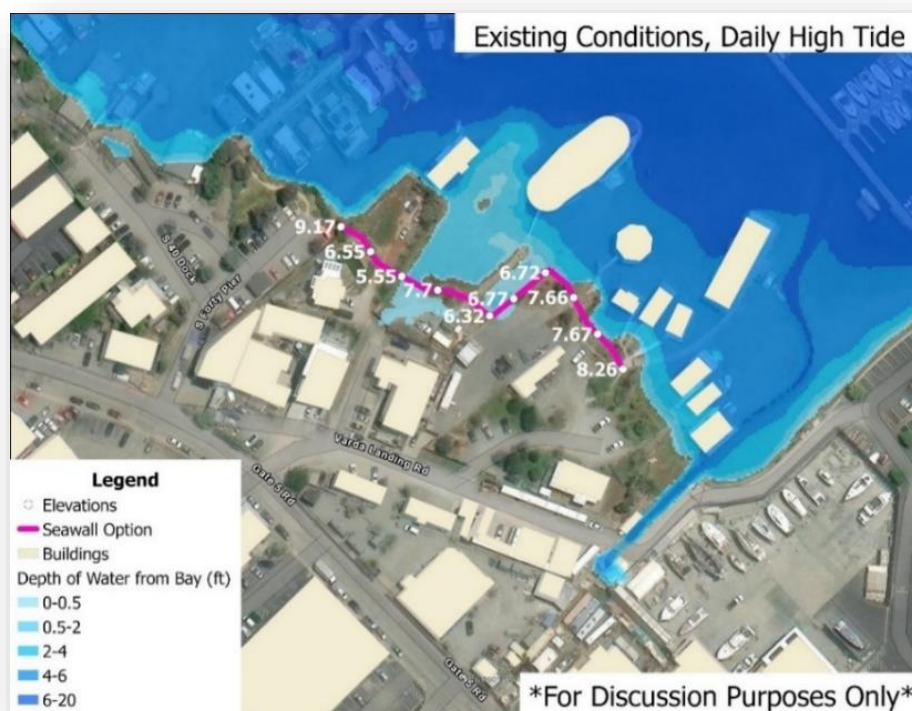


Figure 5.9 – Overview of Potential Near-Term Solutions - Varda Landing Seawall Alignment

5.2.2.3 Cost Summary and Alternatives Summary, Varda Landing

To assist the City and private property owners with planning to implement these solutions, WSP has put together high-level costs for each of them. This cost summary is shown in Table 5.3.

Table 5.3 – Varda Landing Near-Term Cost Summary

Design Element	Cost
Installation of Seawall (No Easements)	\$ 330,000
Road Raise (2025 1-Year Storm Surge [8.2' NAVD88])	\$ 20,000
Subtotal	\$ 350,000
Engineering and Design (Assume 15% of Construction)	\$ 50,000
50% Contingency	\$ 200,000
Total (Without Easements)	\$ 600,000
Easements	\$ 1,000,000
Total (With Easements)	\$ 1,600,000

The pros and cons of the near-term alternatives for Varda Landing are shown in Table 5.4.

Table 5.4 – Varda Landing Near-Term Alternatives Summary

Near-Term Mitigation Option	Key Benefits	Key Limitations	Planning-Level Cost
• Varda Landing Seawall (1-Year Storm Surge Elevation) • Raising Varda Landing to 1-Year Storm Surge Elevation (Portion on Private Property)	• Reduces Overland Flooding from the Bay • Initial Private Owner Approval	• Requires Private Owner Coordination	• \$1.6 million

5.2.3 Input from Site Walk with SSWA

On May 12, 2026, the City, WSP, and members of the Sausalito Sustainable Waterfront Association (SSWA) completed a site walk of the areas specifically targeted by the near-term solutions discussed above. SSWA discussed their preferred solutions with the City and WSP. The first proposed solution from SSWA was to raise Varda Landing Road by 18 to 30 inches (see Figure 5.10 for location of Varda Landing Road). As noted in Section 5.2.2.1, WSP agrees that raising the road would provide access to Clipper Yacht Harbor, however raising the road would not provide flood relief to the properties on the seaward side of the road. Based on past discussions between WSP and the City, WSP understands this road to be a private road that is not owned by the City. Therefore, the raising of the road would be the responsibility of the property owners or be done through a collaborative process between the property owners and the City. WSP believes that raising Varda Landing Road would be a productive step in addressing the flooding in the project area.

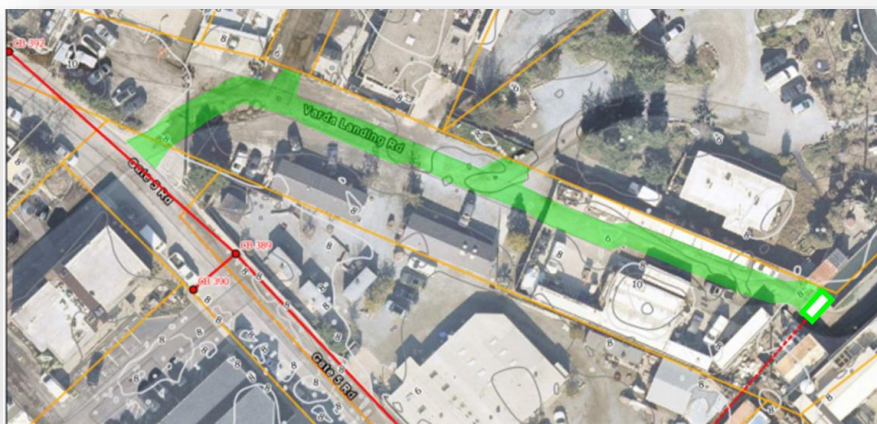


Figure 5.10 – Alignment of Varda Landing Seawall Varda Landing Road and Culvert Location at Canal

The second solution that SSWA proposed during this walkthrough was to install a new 60" diameter culvert from Gate 5 Road and Coloma Street to the existing open-air part of the canal (see Figure 5.10 for location of culvert). A tide gate would then be installed on the culvert at the outfall location into the existing open-air part of the canal and small pump station would be installed near this location. This option would prevent baywater from backflowing through the stormwater system to Gate 5 Road during storm surge events (overland flow would still occur though). WSP views this solution as similar in nature to the tide gate and pump station alternative discussed in Section

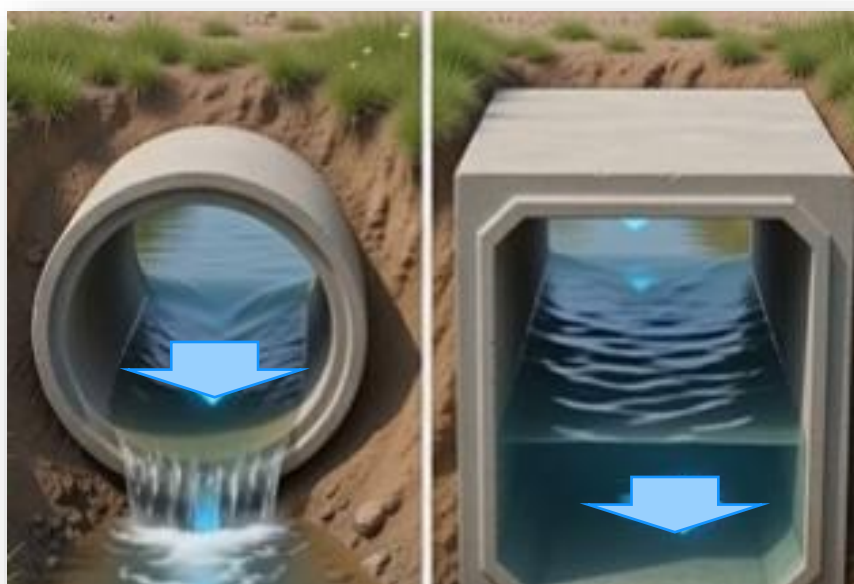


Figure 5.11 – Alignment of Varda Landing Seawall Pipe

5.2.1.3, however WSP does have some concerns with some key differences between the alternatives. The first concern is related to the permitting to place a circular culvert in the canal that is connected to the Bay. While this canal is manmade and provides limited ecological value, placement of a circular culvert in the canal would potentially restrict flow when the tide gates are open and produce negative biological and water quality impacts, making it subject to a lengthy permitting process. In lieu of placing a circular culvert, WSP would therefore recommend installing a box culvert (see Figure 5.11 for difference between pipe and box culvert installation) with less flow restriction. Tide gates are frequently installed on box culverts, so this would provide the advantage of being a typical tide gate application scenario, which would reduce design and construction costs. WSP's second

concern is related to the size of the pump station that SSWA is proposing. Based on these conversations, SSWA is proposing to use a pump station that is similar to the current pump capacity that has been used by the City during their temporary corrective measures in Winter and Spring 2026. WSP believes this pump capacity to be less than 5 cfs, which is far less than a 1-year rainfall storm frequency and less than the 38 cfs pump capacity proposed in Section 5.2.1.3. Therefore, the likelihood that the pumps cannot keep up with a rainfall event (while the tide gate is closed) is much higher than in the alternative that WSP proposed. Ultimately, this risk is up to the City and its residents to discuss so that they can come to a determination of the level of risk that they are willing to tolerate, especially when weighed against the capital investment required to implement the mitigation action.

5.3 Mid-Term and Long-Term

As previously discussed, several flood hazard sources exist in the study area that can cause significant flooding. Key hazard sources include SLR, tidal inundation, storm surge, pluvial flooding and land subsidence. Since these processes change through time, flooding conditions have been modelled throughout the project area for what is considered a mid-term time scenario (2035-2050) and long-term scenarios (2050-2100). Discussion of these predictive models are presented in the Vulnerability Assessment Excerpts in Appendix A. Due to the various extents of flooding and the site-specific conditions of the Gate 5 Area, a variety of solutions have been evaluated for these timelines. These solutions are additive to the near-term solutions discussed in Section 5.2 and should be used as a planning tool for the future implementation strategies discussed in Section 7. It is assumed that a tide gate has already been installed as part of the near-term condition. The solutions provided for these future time periods include:

- Additional pumping and storage,
- Vertical solutions such as:
 - Sea walls,
 - Raising Gate 5 Road at varying levels (depending on future flood tolerance),
 - Raising properties and structures, and
- Green infrastructure.

An infographic of the mid-term and long-term solutions is shown in Figure 5.12. These solutions are discussed in more detail in this section.

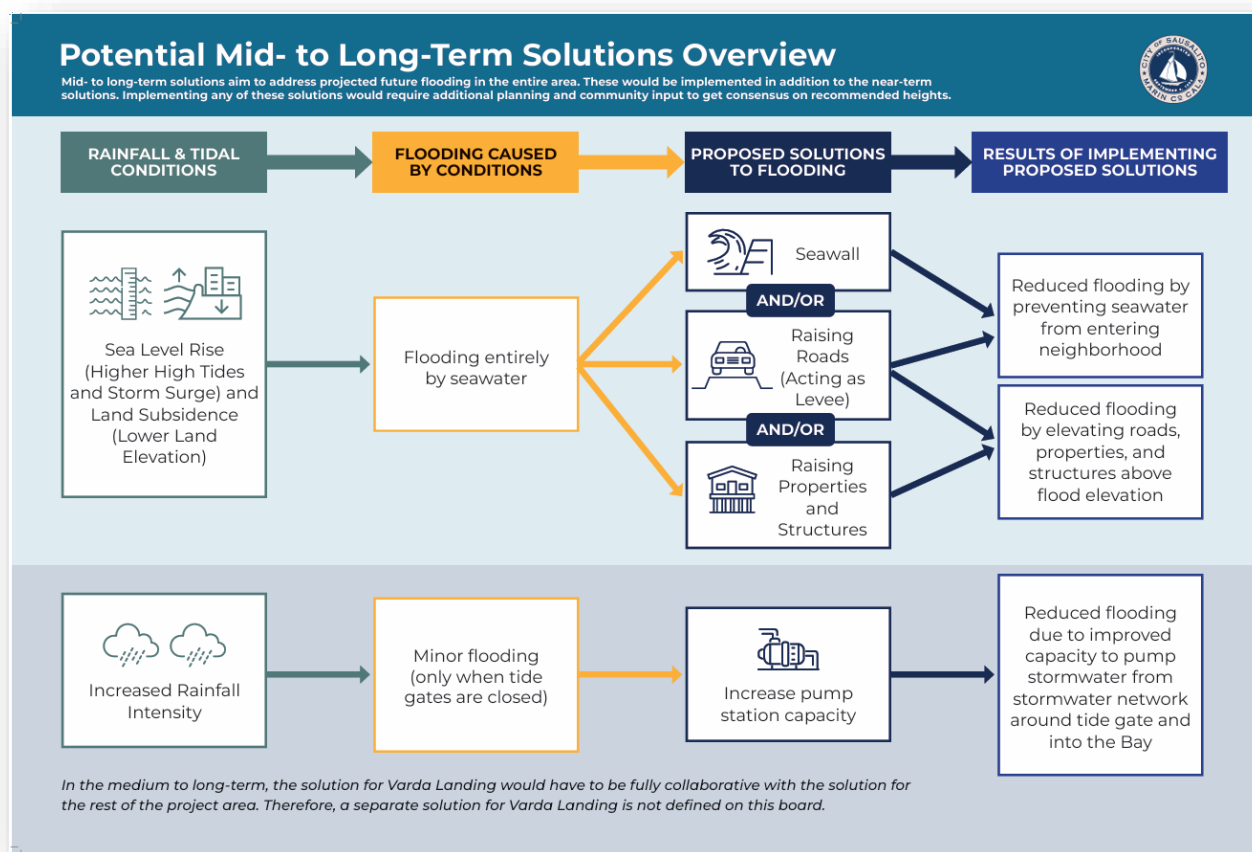


Figure 5.12 – Overview Infographic of Mid- to Long-Term Solutions

5.3.1 Additional Pumping and Storage Options

5.3.1.1 Additional Pump Capacity at Coloma Street and Gate 5

As noted in section 5.2.1.3, the pump station proposed for near-term conditions has a capacity of about 38 cfs, which is approximately enough capacity to handle a 2-year rainfall event. As a mid-term and long-term solution, an additional pump station would be added near Coloma Street and Gate 5 Road. WSP recommends designing this pump station to add at least an additional 49 cfs of capacity so that the combined capacity between the proposed near-term pump station and this additional pump station is 86 cfs (the peak flow rate for the 10-year rainfall event).

Another option is to relocate the near-term pump station and combine it with the second pump station at a new location in close proximity to Coloma Street and Gate 5 Road. This would simplify maintenance because it would combine all pump activity into one building instead of dividing it amongst two locations which would require additional maintenance, additional space for pump motors and controls and the need for property acquisition. The existing canal could still be used for a wet well which would significantly reduce the overall cost for the pump station, though the same environmental and permitting concerns would apply.

5.3.1.2 Upstream Stormwater Storage

A second option for future upgrades to the near-term solution improvements includes the addition of storage upstream in the watershed which will reduce the peak runoff flow entering the pump station by the Coloma Street canal. By reducing the peak runoff flow rate entering the pump station, it means that the pump station could be smaller, saving on capital cost, operation and maintenance cost, and property acquisition cost. It would also increase the potential locations where the pump station could be located because the footprint would be smaller.

The most suitable area for stormwater storage is at MLK Park. Underground stormwater storage in parks is a space-efficient solution for managing runoff while preserving valuable surface area for recreational, aesthetic, or functional uses. The stored water can be detained, retained, infiltrated, or treated depending on the design and desired end use of the water. Here, the area could be used to siphon runoff from the adjacent Coloma Street Storm Drain during peak flow events and discharge it back into the Coloma Street storm drain using a small pumping system at the outlet of the storage basin. The water could also be used as a potential reuse source for irrigation in the park.

5.3.2 Vertical Solution Options

Vertical solutions evaluated include road raising, seawalls (in various forms) and property raising. Improvements for raising Gate 5 Road from Coloma to Harbor to various heights were quantified and estimated assuming a multi-use street cross-section (See Figure 5.14). Seawalls of various heights and lengths were evaluated for an alignment along the shoreline. Seawall costs were estimated given specific ground and flood elevations (estimated by the vulnerability assessment) for the alignment and respective profile along with mechanical gates placed at access points and incorporation of ecological and recreational elements. The cost for raising properties was also evaluated, although it should be noted that this would not be a quick solution because existing structures and properties would have to be voluntarily raised by existing property owners. Due to the large number of private property owners in the area and the relatively infrequent rate that properties change ownership, it would take several decades to make the necessary improvements. The estimate includes costs for raising properties affected by long-term flooding, including demolition, utility relocation, recontouring, fill material placement, compaction, repaving, and reconstruction of structures.

5.3.2.1 Raise Gate 5 Road (1-year Storm Surge)

Road raising consists of increasing finished roadway grades above projected flood elevations to reduce the frequency and extent of tidal and storm-surge inundation. Two potential elevation scenarios were evaluated, with feasibility dependent on funding availability, acceptable flood-risk tolerance, allowable traffic-control constraints, and the applicable sea level rise planning horizon. The more constructable alternative consists of raising Gate 5 Road to a lower target elevation that improves access reliability and flood resilience while reducing capital cost, construction complexity, traffic disruption, and other implementation impacts. The proposed design elevation corresponds to the 2025 1-year storm-surge water surface elevation and could be incorporated in the mid-term planning horizon. Under this alternative, Gate 5 Road between Coloma Street and Harbor Drive would be raised to a target elevation of approximately 8.2 feet NAVD88. This would require a maximum of approximately 2.5 feet of fill in the lowest-lying segments. The improvement would also require grade adjustments along portions of Harbor Drive and Coloma Street to provide appropriate roadway tie-ins at their intersections with Gate 5 Road. To accommodate the proposed improvements within the existing City right-of-way, Gate 5 Road would likely need to be converted into one-way operation. This configuration would require a traffic circulation analysis of parallel roadways and an evaluation of potential effects on daily mobility, access, and transportation network connectivity within the surrounding area.

5.3.2.2 Raise Gate 5 Road (2050, 100-year Storm Surge)

To provide more flood protection, the raising of Gate 5 Road was evaluated to accommodate the 100-year storm surge anticipated for the year 2050. The 2050 100-year storm surge elevation was selected due to space constraints within the existing right-of-way. The space constraints mean that there would not be sufficient space to raise the road any higher than the target elevation of about 11.4' NAVD88, which is a maximum of about 5.5 feet in the lowest lying areas. This option would enable Gate 5 Road to operate as a levee and therefore would have to be incorporated into a broader infrastructure plan or redevelopment plan for the area. An illustration of how the road would function as a levee is shown in Figure 5.13.

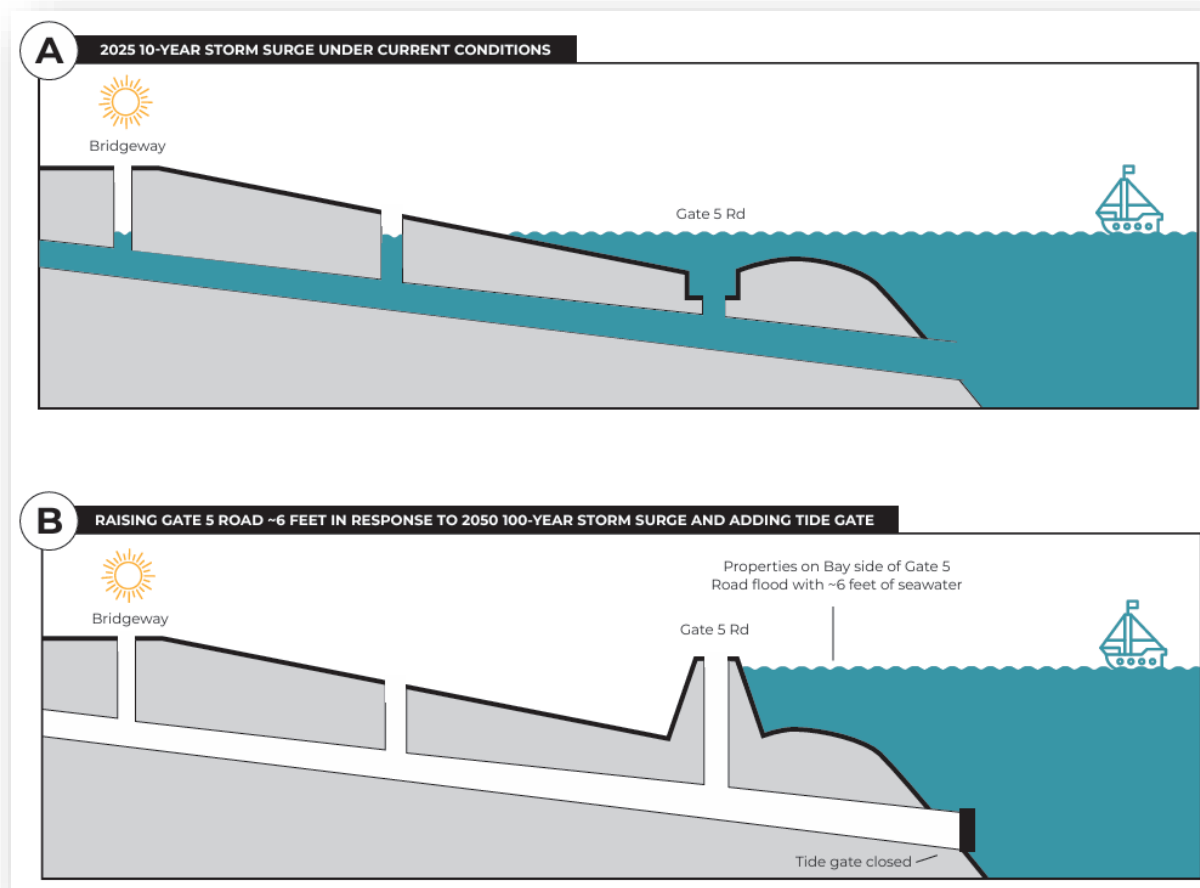


Figure 5.13 – Gate 5 Road with Tide Gate Acting as Levee

To implement this solution, it would likely require retaining walls where space is limited while other areas could include sloped embankments down to the existing ground. Tie-in points along portions of Harbor Drive, Coloma Street, and Varda Landing would also require raising. Similar to the lower-elevation road raising alternative, this type of improvement would likely require Gate 5 Road to become one-way. Traffic patterns would require evaluation along with the effects of daily mobility and transportation networking. A generic potential cross-section for the raised road is shown in Figure 5.14.

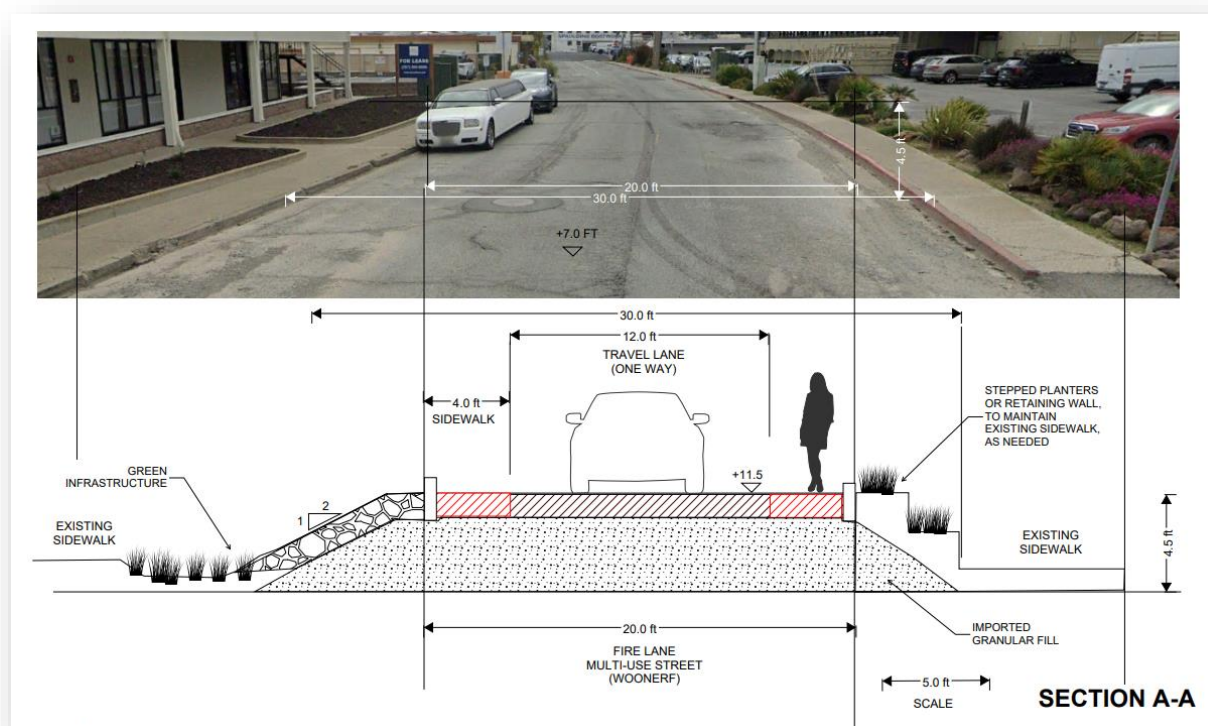


Figure 5.14 – Raising Gate 5 Road (2050, 100-year Storm Surge)

5.3.2.3 Seawall – Shoreline Alignment with Ecological and Recreational Elements

Seawalls are physical barriers built along shorelines to minimize coastal erosion and prevent coastal inundation. A simple characterization of the benefits that seawalls provide is shown in Figure 5.15.

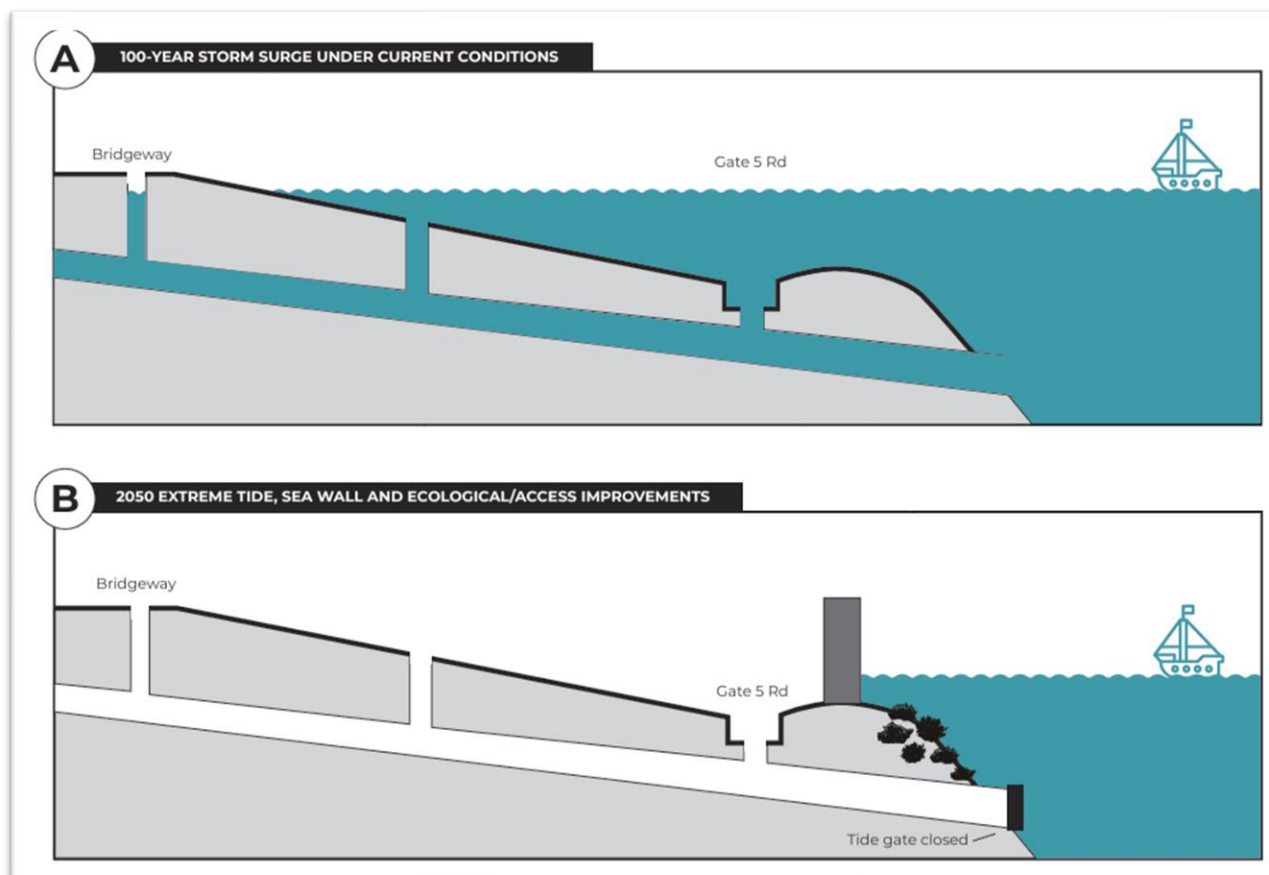


Figure 5.15 – Comparison of Flooding with and without a Seawall and Tide Gate

Seawalls can be traditional concrete or steel structures, or more innovative designs like *living seawalls* that incorporate habitat features such as sea tiles, habitat-friendly concrete admixtures, and/or nearshore plantings to support marine biodiversity. Seatiles are specialized, textured panels retrofitted onto flat, concrete seawalls. They mimic natural rocky shorelines, transforming static, sterile coastal barriers into thriving, ecologically productive ecosystems while simultaneously improving structural longevity and resilience. An example of a seatile for a sheet pile seawall is shown in the following Figure 5.16 (Kind Designs 2026).

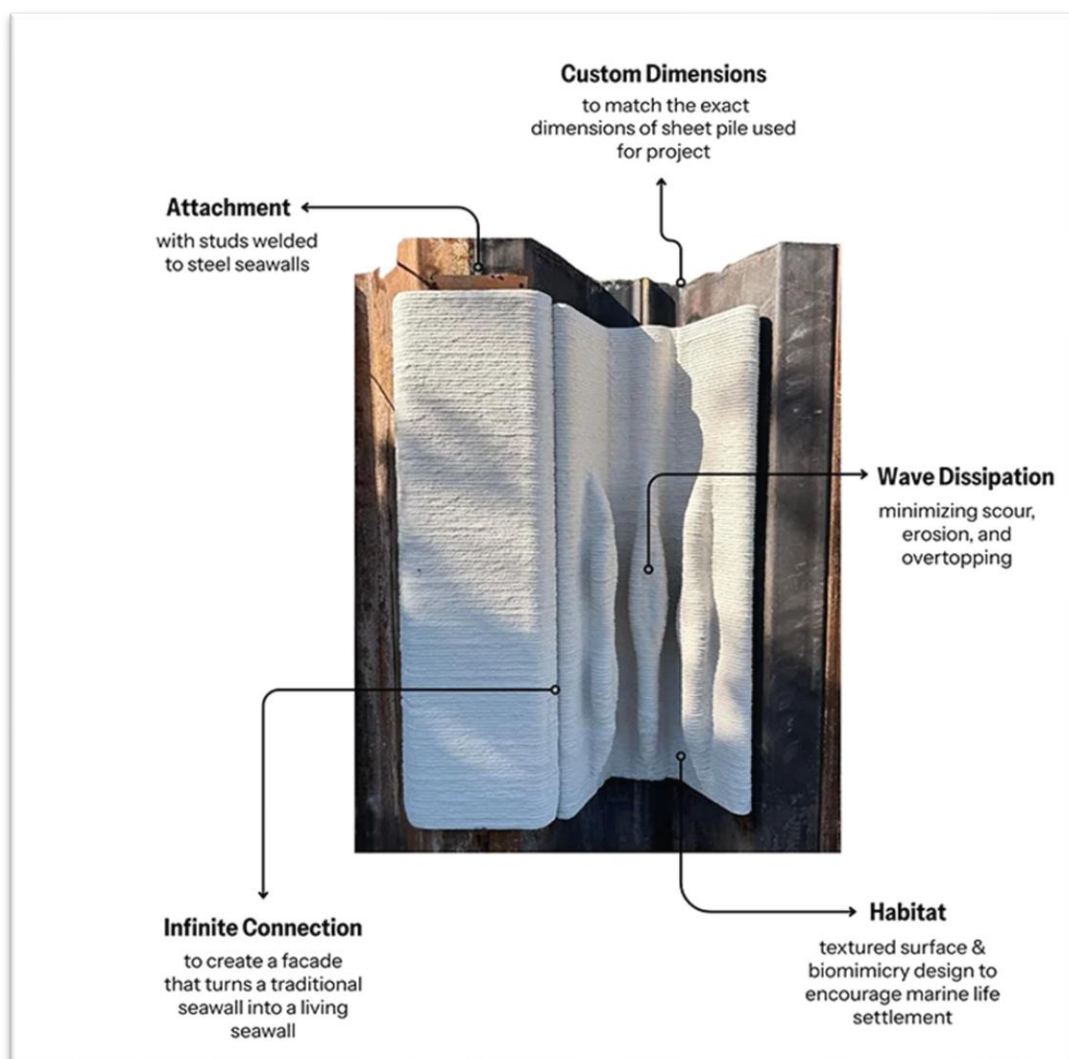


Figure 5.16 – Example of Seattles on Sheet Pile Seawall (Kind Designs, 2026)

To provide recreational benefit, seawalls can be integrated into public spaces with walking paths located adjacent to the top of the seawalls assuming adequate right of way space and community desire to maintain waterfront access. This type of solution is extremely common in urban environments where waterfront promenades are developed in conjunction with a seawall.

In Sausalito, a seawall alignment along the shoreline would require approximately 3900 linear feet of structure of varying heights with a maximum height of 8-foot so that the seawall would reach a target elevation of 11.4' NAVD88, which is the 100-year storm surge elevation for 2050 plus 1-foot of freeboard. The exact design height could be determined based on the funding availability and the flood risk tolerance. It should be noted that Clipper Yacht Harbor has already been elevated by their own private funding along the shoreline for much of their parking lot, exhibiting elevations up to approximately 9.5' NAVD88. In these locations, the seawall height would be significantly less than 8 feet to reach the target elevation. Due to the effects of future subsidence, WSP assumes that this area would also benefit from some form of vertical barrier.

While a near-term seawall was proposed for Varda Landing, the seawall alternatives for mid-term and long-term would be the same for Varda Landing as it is for the rest of the project area. The shoreline alignment would continue from the northwest side of Clipper Yacht Harbor into Varda Landing. The exact materials and height

constructed as part of the near-term solution for the seawall at Varda Landing would dictate the approach for upgrading it to address the 2050 100-year storm surge. The height of the seawall could potentially be increased, or a new seawall could be constructed following a similar alignment as the near-term seawall.

Figure 5.17 shows what can be accomplished when incorporating ecological and recreational elements into a seawall. This figure illustrates the seawall being combined with a pedestrian pathway, steps for waterfront access, salt marsh at the bottom.

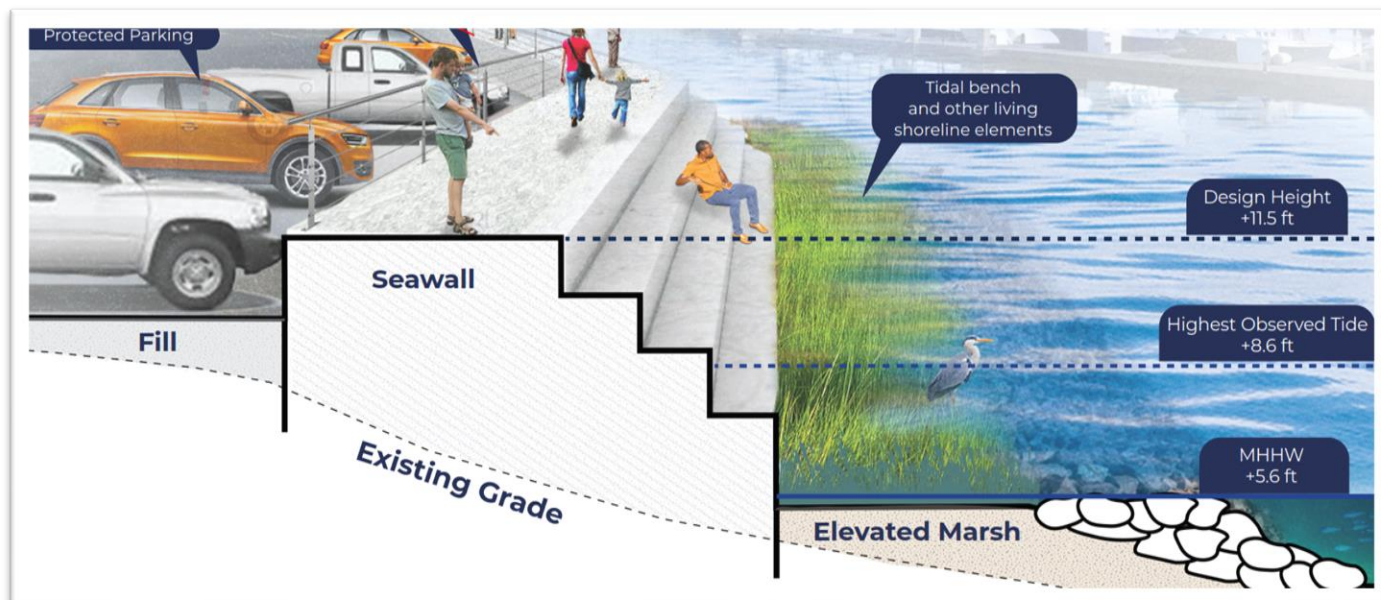


Figure 5.17 – Seawall with Recreational and Ecological Benefits

5.3.2.4 Raise Properties and Structures

Raising properties would provide improved access to raised roads and would allow the area to meet long-term flooding challenges. Clipper Yacht Harbor has raised their parking lot to the current 100-year Base Flood Elevation of approximately 10' NAVD88 as evidenced in the No Rise Certification Letter dated March 13, 2020. Most other areas throughout the area range from 6' – 9' NAVD88 without accounting for long-term subsidence.

The most likely solution for implementing this approach is for the City to pass regulations requiring all new structures and properties to be raised to one foot above the 2050 100-year storm surge elevation. Unfortunately, this does not appear to be a quick solution because existing structures and properties would have to be voluntarily raised by existing property owners. Due to the large number of private property owners in the area and the relatively infrequent rate that properties change ownership in the area, it would take several decades to make the necessary improvements. Even then, this would amount to a piecemeal solution where each property owner is addressing the problem on their own. Additionally, raising properties and/or structures up to this design elevation could come at a relatively high cost since fill placement, retaining walls, and equipment access can significantly increase project costs. Additionally, costs would be increased because each property would be completing the process on their own, requiring additional contractor designs and mobilizations. This option will also require further analysis in the future, given potential redevelopment plans and future community and landowner feedback. Preliminary cost estimates have been provided for raising properties and structures for the long-term planning horizon. Key drivers for the cost associated with this alternative are:

- Paved Area Removal and Reconstruction,
- Excavation, Backfill and Compaction,
- Utility Removal and Reconstruction,
- Structure Removal and Reconstruction,
- Demolition Debris Volumes, and
- Temporary Traffic and Storm Water Pollution Control.

5.3.3 Other Improvements

5.3.3.1 Green Infrastructure

Green infrastructure can be installed with grey infrastructure (e.g., along sea walls, along City streets, or within parking lots) in hybrid approaches, creating a layered defense against flooding that maximizes protection while minimizing environmental impact. The infrastructure offers a sustainable, multi-benefit strategy to combat long-term flooding problems. For the project area, multiple green infrastructure options are available including:

- Placement of biofiltration and retention facilities within the upstream watershed to reduce stormwater peak flows required for pumping (when tide gates are closed),
- Placement of biofiltration facilities along Gate 5 Road and within parking lots along Gate 5 Road to reduce stormwater peak flows required for pumping (when tide gates are closed); and

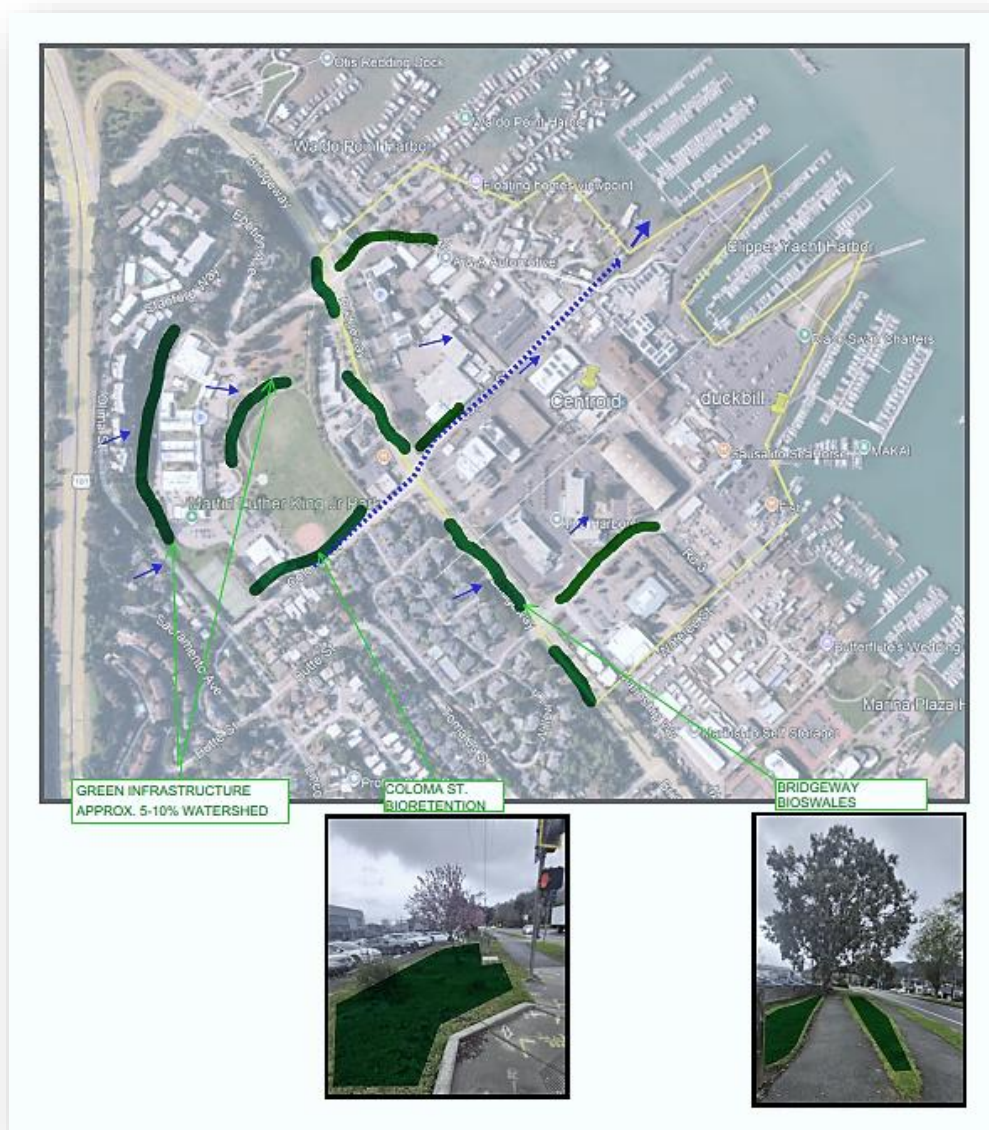


Figure 5.18 – Potential Green Infrastructure in Upstream Watershed

- Creation of living shorelines combined with seawalls to create a shoreline that reduces erosion potential while restoring natural processes along the seawall.

Figure 5.18 shows where green infrastructure could be added throughout the project area. Green infrastructure alone would not be enough to combat the flooding issues. However, it can be used to improve the effectiveness and reduce the size and footprint of the proposed flood control facilities. For example, implementation of bioretention facilities throughout the project area could result in a 10% reduction in the volume of stormwater storage required or peak flow rate to the stormwater pumps. The savings gained by reducing the volume of stormwater storage required or size of the stormwater pumps would be greater than the cost to implement these green infrastructure facilities. It also has benefits on water quality and creates a lasting environmental value while increasing agency acceptance to the project.

5.3.4 Cost Summary and Alternatives Summary, Mid to Long Term

To assist the City with prioritizing and future planning for the mid- and long-term solutions, WSP has costed the various alternatives discussed in Section 5.3. The cost summary is included in Table 5.5. The summary of the mid-term alternatives and long-term alternatives are shown in Table 5.6.



Table 5.5 – Mid- and Long-Term Alternatives Cost Summary

Design Element	Total Item Cost	Engineering and Design (Assume 15% of Construction)	50% Contingency	Total
Additional Pump Station Capacity	\$ 4,000,000	\$ 600,000	\$ 2,300,000	\$ 6,900,000
Green Infrastructure throughout Project Area	\$ 3,400,000	\$ 510,000	\$ 2,000,000	\$ 5,910,000
Raise Gate 5 Road (2025 1-Year Storm Surge [8.2' NAVD88])	\$ 330,000	\$ 50,000	\$ 190,000	\$ 570,000
Raise Gate 5 Road (2050 100-Year Storm Surge [12.4' NAVD88])	\$ 500,000	\$ 80,000	\$ 290,000	\$ 870,000
Seawall with Ecological and Recreational Improvements (No Easements)	\$ 12,300,000	\$ 1,850,000	\$ 7,100,000	\$ 21,250,000
Seawall with Ecological and Recreational Improvements (With Easements)	\$ 19,600,000	\$ 2,940,000	\$ 11,300,000	\$ 33,840,000
Raising Properties and Structures	\$107,000,000	\$ 16,050,000	\$ 62,000,000	\$185,050,000
Underground Storage and Small Pump Station at MLK Park	\$ 16,700,000	\$ 2,510,000	\$ 9,600,000	\$ 28,810,000



Table 5.6 – Mid- and Long-Term Alternatives Summary

Planning Horizon	Option	Key Benefit	Key Limitations	Planning-Level Cost
Mid-Term	Increase Pump Station (PS) Capacity (Incrementally Towards 10-year Rainfall Capacity)	• PS Can Handle Larger Rainfall Events • Moderate Cost	• Additional Space Needed for Pumps & Controls • Likely Requires Easements • Additional O&M	\$6.9M
Mid-Term	Underground Storage at MLK Park	• Reduces pump station sizing needs • Potential irrigation reuse	• High cost • Park impacts during construction	\$28.8M
Mid-Term	Green Infrastructure in Upstream Watershed	• Improves water quality, sustainability, and aesthetics • Reduces pump station sizing needs • Likely community support • Moderate cost	• Not a stand-alone flood protection strategy	\$5.9M
Mid-Term	Raise Gate 5 Road to 1-Year Storm Surge Elevation	• Improves access during frequent flood events • Low cost	• Does not protect properties waterward of Gate 5 Road • Requires property and utility coordination • Only one-way traffic	\$0.6M
Long-Term	Raise Gate 5 Road to 100-Year Storm Surge Elevation	• Improves access during high flood events • Low cost	• Does not protect properties waterward of Gate 5 Road • Requires property and utility coordination • Only one-way traffic	\$0.9M
Long-Term	Shoreline Seawall with Ecological and Recreational Improvements	• Addresses broader overland flooding • Provides ecological and recreational benefits • Protects the broader project area	• Requires property and utility coordination • Likely requires easements	\$34.0M
Long-Term	Raise Properties and Structures	• Reduces long-term exposure for individual parcels	• High cost • Piecemeal solution • Requires private owner participation	\$185.0M

6. Performance Evaluation Framework

6.1 Evaluation Criteria

A qualitative approach was taken for evaluation of the concept design solutions of flood improvements in the Gate 5 Road Area for the near-term, mid-term and long-term planning horizons. This included a combined assessment, evaluating both potential tradeoffs associated with the following criteria along with positive benefits:

- Short-term effectiveness,
- Long-term effectiveness,
- Ease of implementation,
- Cost effectiveness,
- Agency acceptance,
- Community feedback,
- Sustainable and ecological benefits, and
- Recreational and aesthetic benefits.

The parameters for the assessment are discussed in more detail below.

6.1.1 Short Term Effectiveness

Short term effectiveness is the ability of a solution to address immediate flooding problems as described in Section 3.1. It is a measure of how effective the solution would be in solving current flooding issues which mainly occur along Gate 5 Road and at Varda Landing during high tide or storm surge events.

6.1.2 Future Effectiveness

Future effectiveness is the ability of a solution to address future flooding problems as described in Section 3.2, within the future mid-term and long-term planning horizons. It is a measure of how effective the solution would be in solving issues related to rising sea levels, increasing rainfall intensity, and land subsidence. Without any preventative measures, flooding in the area becomes largely independent of rainfall intensity and the storm drain system and becomes more a result of overland flooding from the Bay.

6.1.3 Ease of Implementation

This is a measure of how straightforward the solution is to construct, the impact construction might have on the surrounding areas and the community, the maintenance of the solution, the duration of construction, and site constraints, such as proximity to buildings, right of ways and groundwater levels

6.1.4 Cost Effectiveness

Cost effectiveness includes the overall cost to construct, operate, and maintain the facilities over time, along with easement costs and funding potential for the proposed facilities. It emphasizes achieving the goals while maximizing the value of resources spent.

6.1.5 Agency Acceptance

Agency acceptance is a measure of how acceptable a solution might be to agencies involved in approvals and permitting. It includes the overall length of time such approvals may take to obtain. These include environmental agencies such as the California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Control Board, California Coastal Commission, Nation Oceanic and Atmospheric Administration – National Marine Fisheries, San Francisco Bay Conservation and Development Commission, and others described in Section 7 of this report.

6.1.6 Community Feedback

The community was engaged in this process during a field visit that coincided with a King Tide event on December 3rd, 2025, a workshop held on April 29, 2026, on-line surveys, a site walkthrough with SSWA on May 12th, 2026, and various meetings with property owners and/or owner representatives at other times. This process provided valuable insight into community concerns, desires, and existing flood control practices. Feedback was also obtained from the Shoreline Adaptation Plan and from City Department of Public Works meetings with the community. This community feedback was used as part of the selection criteria for the recommended concepts to move forward into final design as discussed in Section 7. Appendix B provides a Community Meeting Recap that describes the Community workshop on April 29, 2026, and addresses overall results of Community feedback.

6.1.7 Sustainability and Ecological Benefits

Sustainability and ecological benefits refer to the extent by which a solution could provide benefits through ecological restoration that supports biodiversity (coastal and inland), addition of green infrastructure that improves urban biodiversity while assisting in flood protection and improving water quality, or sustainable design and construction that reduces environmental disruption, promotes water conservation and reduces overall carbon footprint. This could also come with additional impacts such as increasing project footprints, which was also considered during the evaluation process. This criterion focused on the benefits for sustainability and ecology and did not look at the drawbacks.

6.1.8 Recreational and Aesthetic Benefits

Recreational and aesthetic benefits refer to the extent to which a solution could enhance the aesthetic character of an area and provide recreational benefits, such as access to the shoreline and to environmental habitat overall. When recreational and aesthetic goals are combined, multi-functional spaces can be produced, such as walking paths and landscaped areas along the shoreline that promote health and well-being along with flood protection and access to the shoreline. This could also come with additional impacts such as increasing project footprints, which was also considered during the evaluation process. This criterion focused on the benefits for recreation and aesthetics and did not look at the drawbacks.

6.2 Near-Term Results

Table 6.1 below shows the overall performance assessment used for evaluation of the improvements discussed for the Near-Term options in Section 5.2. Attendees at the Community Workshop (see Appendix B) overwhelmingly voted for: 1) the tide gate, pumping and storm drain improvement option for minimizing flood impacts over the short term along Gate 5 Road, and 2) the seawall for Varda Landing option that would minimize flood impacts along Varda Landing for the short term. The tide gate, pumping and storm drain improvement option addresses immediate flooding problems along Gate 5 Road which was very important to the public and the City. Even with a slightly higher cost basis, this option will satisfy flooding concerns for the near-term condition and can be expanded upon for improving future flood issues as subsidence and sea level rise worsen future flooding potential. The

importance of Varda Landa was also apparent in the voting, which suggests that this option should also be pursued, though with coordination of the landowners.

Table 6.1 – Near-Term Options Performance Evaluation

NEAR-TERM (PRESENT TO 2035)	Short Term Effectiveness	Long Term Effectiveness	Implement- ability	Agency Acceptance	Ecology and Sustainability Opportunities	Recreational Opportunity	Capital Cost	O&M Cost
TIDE GATE AND PUMP OPTIONS								
Continue Current Approach	●	●	■	○	●	●	\$	\$
Tide Gates Only	▲	●	■	▲	●	●	\$	\$
Tide Gates, Pumping, and Storm Drain Improvements	■	▲	▲	▲	●	●	\$\$	\$\$
VERTICAL SOLUTION OPTION								
Seawall for Varda Landing, Recommendation only – to be completed by Private Landowners	▲	●	■	○	●	●	\$	\$

O&M Cost = Operation and Maintenance Costs

■ = Most closely satisfies criterion ▲ = Satisfies some aspects of criterion
● = Least closely satisfies criterion ○ = Not applicable

6.3 Mid/Long-Term Results

Table 6.2 shows the overall performance assessment used for evaluation of the mid- and long-term flood improvement options as discussed in Section 5.3. These options should be used as a planning tool for future implementation strategies discussed in Section 7. The solutions provided for these future time periods include: 1) tide gates, additional pumping, and storage, 2) vertical solutions ranging from sea walls, to raising Gate 5 road, to raising properties and structures, and 3) green infrastructure. These alternatives were discussed at the Community Workshop held on April 29th, 2026. The attendees at the workshop provided the feedback of the various options (see Appendix B) and were most positive regarding the following options: 1) expanding the pump station near the Coloma Street Canal, 2) raising Gate 5 Road (above the 2050 100-year storm surge), 3) placing a seawall along the shoreline, and 4) incorporating green infrastructure into all alternatives. Note that a hybrid of these options will likely be the best solution for phased planning in the future at the mid- and long-term time periods. Table 6.2 can be used as a basis for such an evaluation.

Table 6.2 – Mid- to Long-Term Options Performance Evaluation

MID- TO LONG-TERM (2035-2100)	Short Term Effectiveness	Long Term Effectiveness	Implement- ability	Agency Acceptance	Ecology and Sustainability Opportunities	Recreational Opportunity	Capital Cost	O&M Cost
TIDE GATE AND PUMP OPTIONS								
Additional Large Capacity Pumping	■	■	▲	■	▲	●	\$\$\$	\$\$\$
Upstream Stormwater Storage (Requires Additional Small Pump Station)	■	■	▲	■	▲	●	\$\$\$\$\$	\$
VERTICAL SOLUTION OPTIONS								
Raise Gate 5 Road (1-year Storm Surge)	▲	●	●	▲	▲	●	\$\$\$	\$
Raise Gate 5 Road (2080 100-year Storm Surge)	■	●	●	▲	▲	▲	\$\$\$\$\$	\$
Seawall – Shoreline Alignment	■	■	■	●	●	●	\$\$\$	\$
Seawall – Shoreline Alignment with Ecological and Recreational Enhancements	■	■	▲	▲	■	■	\$\$\$	\$
Raise Properties and Structures	■	▲	●	■	●	●	\$\$\$\$\$	\$
OTHER IMPROVEMENTS								
Green Infrastructure	▲	●	▲	■	■	▲	\$	\$

■ = Most closely satisfies criterion ▲ = Satisfies some aspects of criterion
 ● = Least closely satisfies criterion ○ = Not applicable

7. Recommended Conceptual Alternative for Implementation

As discussed previously, the conceptual design alternatives have been organized by planning horizons. Near-term improvements focus on feasible, constructible solutions, while mid- and long-term options are presented at a planning level and will require additional community input, City coordination, and funding evaluation. Near-term improvements are intended for implementation during the planning horizon between 2025 and 2035, to be initiated immediately. Mid-term strategies should be refined and sequenced in advance of 2035 for the planning horizon between 2035 and 2050. Long-term strategies should be refined and sequenced in advance of 2050 for the planning horizon between 2050 and 2100.

Focusing on the near-term solution, the tide gate, pumping and storm drain improvement option is the recommended solution for further design and implementation. This solution is: 1) important to the public and the City, 2) will satisfy the most-prevalent flooding events for the near-term condition, and 3) can be expanded upon for addressing future flooding issues. A seawall along the shoreline of Varda Landing is also recommended in partnership with the private landowners in the area.

7.1 Pump Station

The recommended option incorporates a pump station located on the Coloma Street Canal. The pumps may be placed on a deck located above the canal (or the canal may be converted into a box culvert with the pump station placed above or to its side). For purposes of this conceptual design, it is assumed that a deck will be placed across the top of the canal. The canal is a concrete lined rectangular channel with a concrete bottom, sloped at ~0.25% toward the bay over its 132-ft length. Height varies along its length, averaging approximately 7-ft deep from the top of the sheet pile wall to the sediment below.

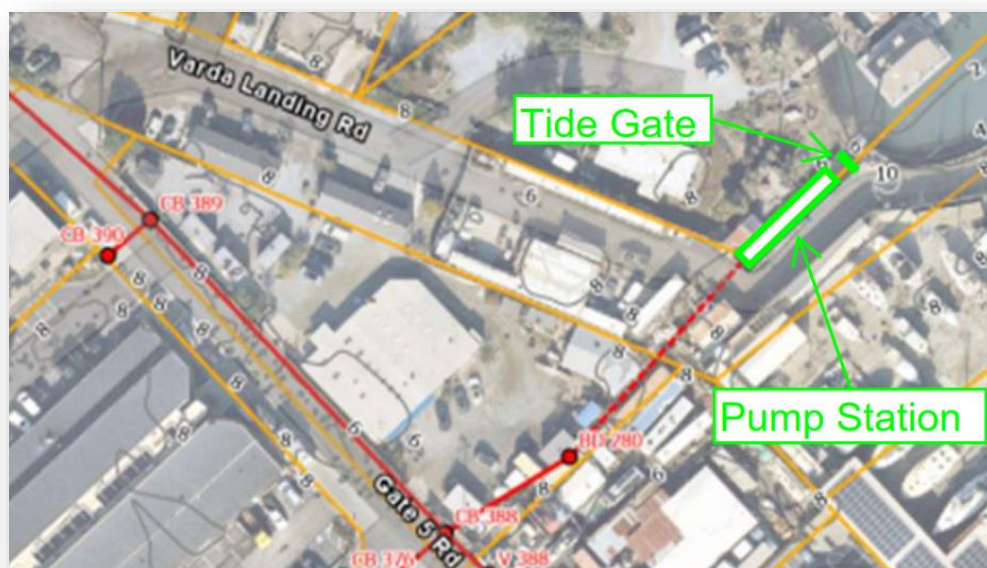


Figure 7.1 – Recommended Conceptual Design - Proposed Pump Station Location

The pump station should be placed at a minimum elevation of 8.2' NAVD88, which is 1' above the 1-year 2025 storm surge elevation. To accommodate decking, the floor elevation of the station is set at 8.5' NAVD88. The top of the canal is around 6' NAVD88, so this means the pump would have to be elevated about 2.5 feet above the top of

the canal. While a portion of the canal currently has decking, the approximate 108-foot portion without decking is the proposed section for the near-term pump station as shown in Figure 7.1.

An existing 66" stormwater pipe from Gate 5 Road connects to the canal via a headwall at the existing decked portion. Because of its size and its placement within an easement for City maintenance, the undecked portion of the canal would be an optimal location for the pump station wet well (assuming a tide gate is located downstream at the end of the canal). Preliminary calculations show that a wet well approximately 10-ft wide, 100-ft long and 4-ft deep would suffice for the proposed 38 cfs pump station. A total of four vertical turbine suction pumps would be placed on the proposed deck above the canal in a configuration displayed in Figure 7.2. Note that the pump station can be fully enclosed in any style structure depending on community input, sound attenuation requirements, and cost effectiveness. The wet well, for purposes of this analysis, has been assumed to be below the pump motors, in the canal.

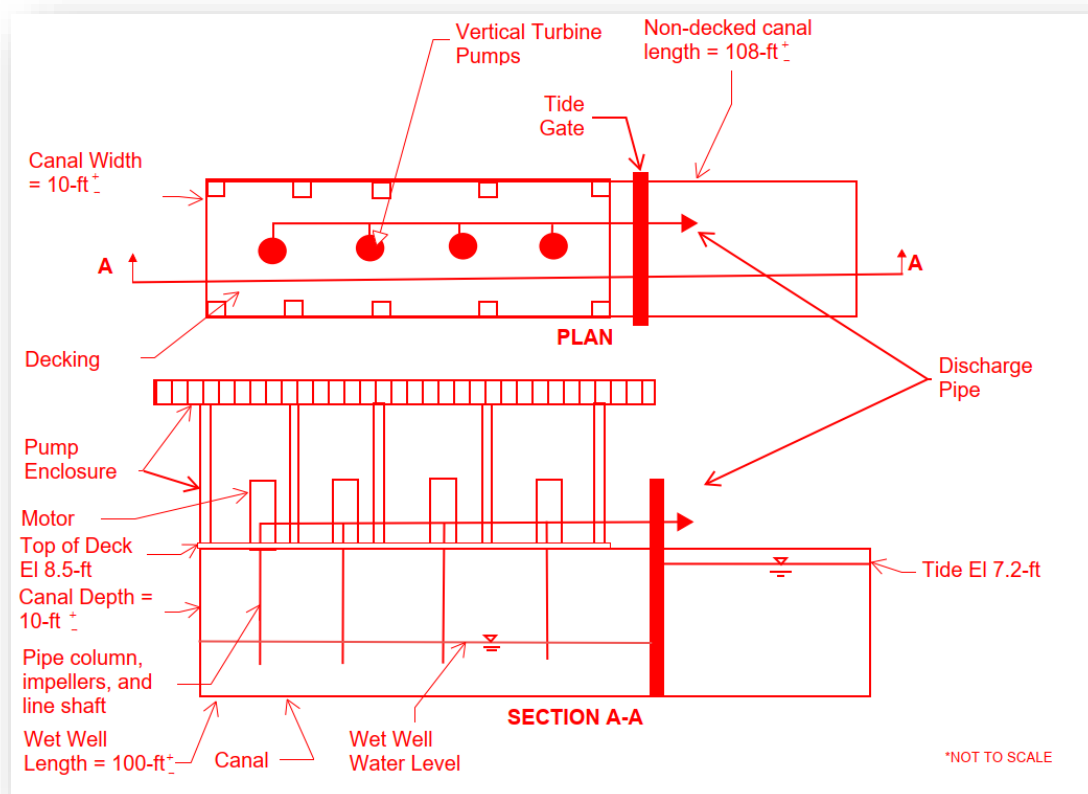


Figure 7.2 – Recommended Conceptual Design - Pump Station Schematic

Note that future improvements to the canal are proposed by the City under a separate contract, so the decking may need to be replaced/improved in coordination with that project. The scope of that project includes a structural inspection of the existing canal, which would be a requirement prior to constructing the decking and pump on top of the canal. The loading capabilities of the existing canal need to be factored into the design of any infrastructure that would be placed on top of the canal. Depending on the findings of that assessment, structural improvements to the canal may be needed prior to the placement of infrastructure on top of it.

7.2 Tide Gate

Several tide gate options were evaluated for use at the outfalls within the project area. These include duck-billed check valves, WaStop inline check valves, flap gates, sluice gates, and self-regulating tide gates. The check valves allow water to move in only one direction and are the least expensive and simplest tide-gate options to install, requiring minimal structural work and offering high reliability. They are generally installed at the outfall of circular culverts, meaning they are not highly feasible for the rectangular shaped Coloma Street Canal. These check valves (see Figure 7.3 and 7.4) are the

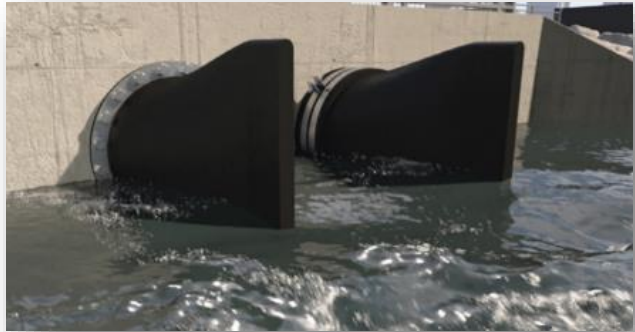


Figure 7.3 – Tide Gate – Duck-Billed Check Valve

recommended choice, however, for the outfall pipe from Gate 5 Road and Harbor Drive. While that outfall currently has a duckbill tide gate, it is not functioning correctly. Therefore, WSP recommends replacing the tide gate on this outfall with another Duck Billed check valve.



Figure 7.4: Tide Gate - WaStop Check Valve

A flap gate is a simple mechanically operated tide gate, typically top-hinged or side hinged, that remains closed to block flow until water pressure is great enough to push it open. It is susceptible to debris blockages which may prevent closure. Considering the geometry of the canal, a top-hinged flap gate could be constructed near the downstream end of the Coloma Street Canal, but that is not a typical application for a flap gate and may therefore increase its cost and decrease its effectiveness.



Figure 7.5: Recommended Tide Gate - Vertically Operated Sluice Gate with Automated Level-Based Actuator

Therefore, WSP believes a better alternative is a sluice gate. A sluice gate is a vertically operated water-control gate that is often automated with timed or level-based actuators that provide more precise regulation than a flap gate. It is very well suited for placement at the end of a rectangular channel and for use with large capacity pumps and can be fitted with tide, level and rainfall-based controls. Gate logic can be adjusted over time, making this option for a tide gate well suited for sea level rise adaptability. The motorized sluice gate can stay closed during peak tide, open during favorable tide windows and be overridden during emergencies. Figure 7.5 shows a typical vertically operated sluice gate that is best for large box culverts or pipes, straightforward outfalls and for new construction or major retrofits, making it the recommended alternative for placement at the end of the canal.

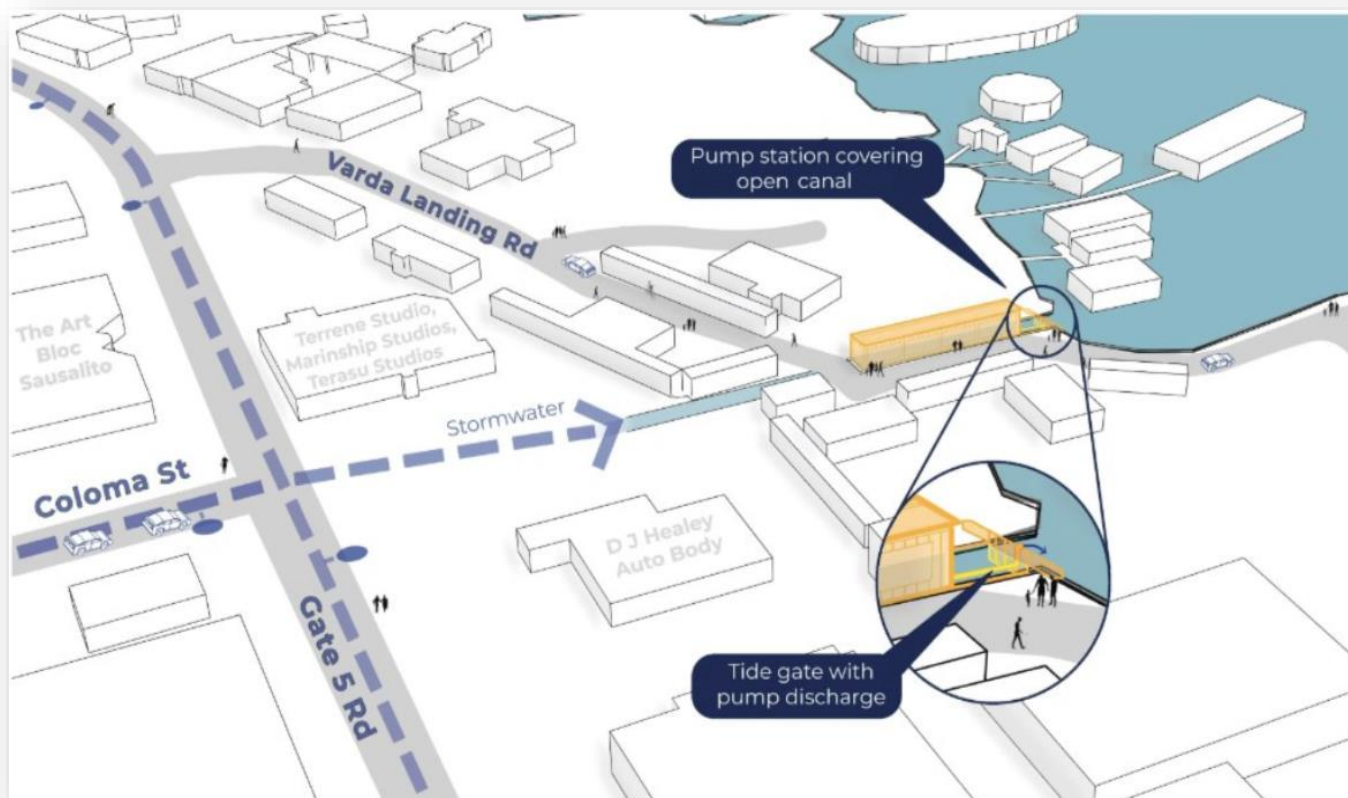


Figure 7.6 – Recommended Conceptual Design -Tide Gate, Pumping and Storm Drain

7.3 Storm Drain Improvements

To eliminate the need for a second pump station located at Harbor Drive and Gate 5 Road, the recommended alternative includes a pipe connection between the stormwater system at Harbor Drive with the stormwater system conveying flow to Coloma Street. From survey data and information from the recent Storm Drain Assessment performed by the City, it is apparent that this connection would require a new pipeline to be placed along the northeast shoulder of Gate 5 Road from a storm drain manhole at Harbor Drive to an existing catch basin approximately 150-ft northwest along Gate 5 Road. This would involve reconstruction of approximately 3 structures and the addition of 150-ft of 18-inch storm drain (See Figure 7.7).

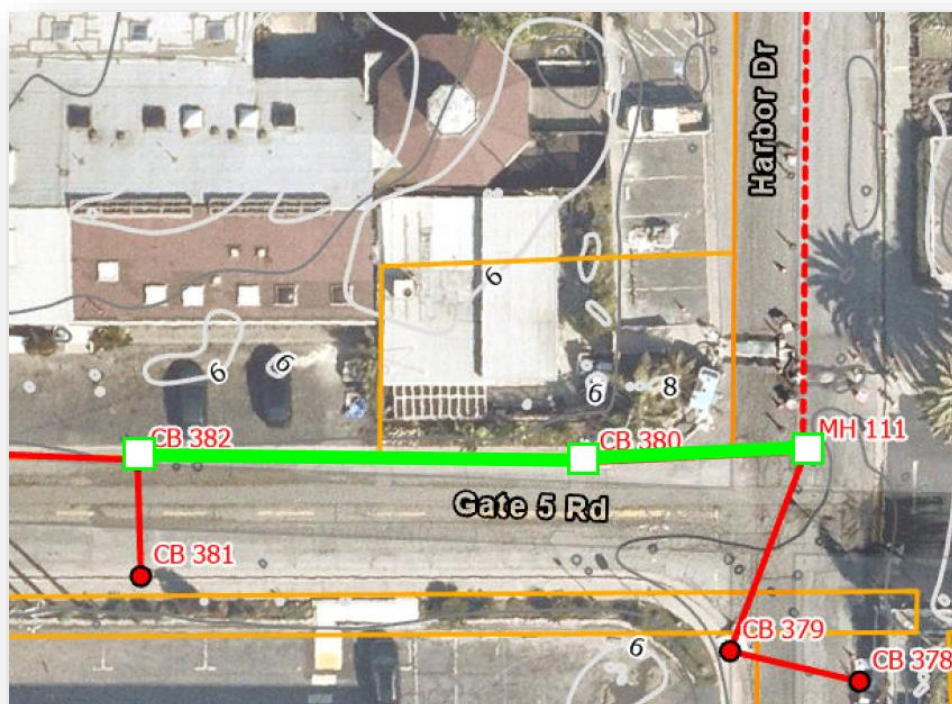


Figure 7.7 – Proposed Gate 5 Road Storm Drain Improvements

7.4 Varda Landing Improvements

The recommended solution for Varda Landing is to construct a seawall along the shoreline to prevent high tides and storm surge from inundating low-lying land along the coast. The seawall could be vertical, stepped or mounded with revetments. WSP recommends that at a minimum, the seawall be designed to an elevation of 8.2' NAVD88. This would address the existing 1-year storm surge plus 1-foot of freeboard. This option would address immediate concerns of overland flow issues for the most common storms although more severe storms would still overtop the seawall.

An additional improvement that can be considered is the raising of Varda Landing Road, which is a private unpaved road that allows access from Gate 5 Road to private homeowners located on the seaward (north) side of the road and to some businesses located on the east side of the road. This Road could be a good maintenance access road for the Pump Station discussed in Section 7.1. The lowest elevation of the road is approximately 6 ft which is below the elevation of the 1-year storm surge by 1.2 ft. Raising the road would require coordination with the private owner. As discussed previously, WSP spoke with the private owner during a walkthrough with the Sausalito Sustainable Waterfront Association and confirmed his interest and condition acceptance in raising the road, though its use for maintenance access would need further discussion. The road raising would assume a 20-ft wide road surface with side slopes of 4:1 to the existing ground. The road currently crosses the canal at the end of the Coloma Street drainage system. Here, the road is elevated to approximately 8.5 ft NAVD88.

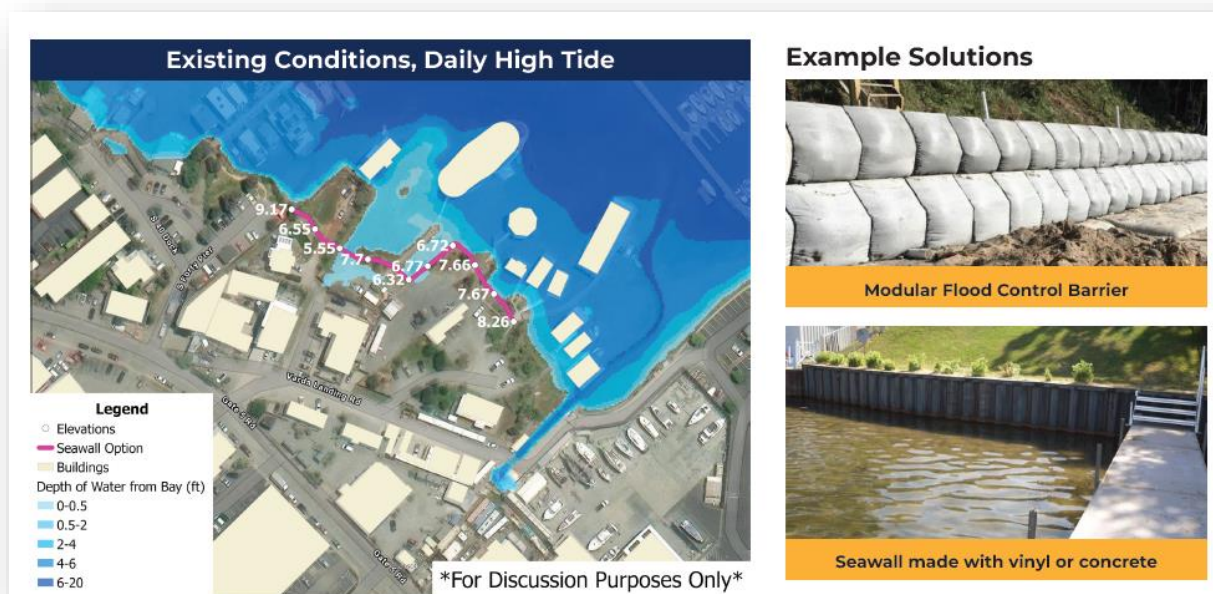


Figure 7.8 – Varda Landing Seawall Alignment with Example Solutions

7.5 Recommendations for Future Solutions

Although the recommended conceptual design presented in this report focuses on the near-term solution, discussion of future improvements is warranted. Feedback received during the community workshops indicates strong support for several strategies, including: 1) expansion of the pump station near the Coloma Street Canal, 2) construction of a shoreline seawall with ecological and recreation enhancements, and 3) incorporation of green infrastructure into all alternatives. Based on this feedback, a phased hybrid approach combining these strategies is likely to provide the most effective path forward for the mid- and long-term planning horizons.

Using Table 6.2 as a framework for future decision-making, the recommended hybrid strategy for the mid- and long-term planning periods should include the following components:

- Expanding or adding a new pump station (depending on ROW availability at the Canal)
 - Moderate cost
 - Effective in both the mid- and long-term
 - Satisfies agency criteria for funding and permitting (e.g. RWQCB and
 - Supported by the community
- Shoreline seawall with ecological and recreational enhancements
 - Moderate cost
 - Effective in both the mid- and long-term
 - Provides ecological, sustainability, and recreational benefits
 - Can be phased between the mid- and long-term depending on sea level rise and subsidence conditions
 - Supported by the community
- Green infrastructure
 - Low cost

- Satisfies agency criteria for permitting and funding (e.g. Water Quality Control Board, California Coastal Conservancy),
- Provides ecological and sustainability benefits
- Supported by the community

The goal of expanding the pump station and incorporating green infrastructure is to increase the capacity of the system to ultimately handle the runoff from the 100-year, 24-hour storm (storm with 1% chance of occurring in a given year). The exact size and design flow rate for the pump station is unknown at this time because it will be affected by climate change projections, reduction of stormwater flow due to green infrastructure, and changes to land use within the watershed. The construction of a seawall with ecological and recreational enhancements was selected because it provides protection for the entire area while pairing well with the pump station and green infrastructure improvements. It also provides full protection in a cohesive manner and a fraction of the cost of raising properties and structures individually. The ecological and recreational enhancements for the seawall provide the City with the ability to maintain waterfront access for the public and ecological function along the shoreline.

In the long term, the City should also monitor the performance of the near- and mid-term improvements to inform future implementation decisions. This process should include community engagement and periodic evaluation of the level of flood protection achieved, helping determine when more substantial long-term measures are warranted. These reviews should assess whether sea level rise, subsidence, and more severe combinations of storm surge and storm events are resulting in flood depths, durations, or access constraints that are no longer acceptable to the City and its residents. If so, the City should transition toward the larger-scale strategies identified in this report, such as raising Gate 5 Road to serve as a protective corridor or levee, constructing a continuous shoreline-aligned seawall with ecological and public access features, and/or supporting the incremental elevation of properties and structures through redevelopment, regulatory changes, and private investment.

8. Project Implementation

8.1 Additional Data and Analyses Required

To continue with the design of the recommended alternative, additional investigations would be required and should be conducted during the 30% design phase of the project.

8.1.1 Groundwater and Geotechnical Investigations

WSP recommends additional groundwater and geotechnical investigations with the incorporation of exploratory drilling at strategic locations of the proposed project. The purpose of these investigations would be to determine subsurface soil and groundwater conditions at the precise locations where improvements are proposed. This helps predict soil behavior and failure mechanisms under varying loads and water pressures to optimize the design and construction of foundations, slabs, and underground structures.

The drilling can also provide additional data to be used to refine subsidence evaluation. Due to a lack of subsurface geotechnical data, this report calculated one subsidence rate throughout the project area. By completing a more refined subsidence analysis, then the design could be adjusted to account for varying subsidence rates throughout the project area, resulting in a more accurate and cost-effective design.

8.1.2 CCTV of Existing Storm Drains

While the existing storm drain information has been partially delineated through the City's recent Storm Drain Assessment and our recent survey along Gate 5 Road, critical data is still needed to identify private connections to the City storm drains and to the canal at the end of Coloma Street. CCTV would be a good tool for identifying the locations of these connections as well as providing the conditions of the existing storm drains (including both private and public storm drain systems). Our investigation indicates that there are some storm drain systems and structures connecting to unmapped storm drains within the Varda Landing Area and along both sides of Gate 5 Road, which could be identified through this process.

8.1.3 Modelling Updates

Once the private storm drain systems have been identified, WSP recommends that the SWMM model be updated accordingly to assess how the private connections affect flow patterns and flooding within the project area. After updating the model for existing conditions, WSP recommends incorporating the proposed improvements into the model to assess their impact on flooding. For example, the model could be used to evaluate the overall pump station inflows and outflows during extreme tide events. This would allow the designer to optimize the overall sizing of the pumps and wet well storage.

8.1.4 Community Feedback

Community feedback is instrumental throughout the entire planning and design phase. As right of way, permitting requirements, and overall project schedule become more solidified, community feedback in the form of meetings or on-line messaging is highly recommended. Items important to the public, including the incorporation of green infrastructure, the pump station design coupled with its enclosure, and discussions of the Varda Landing site improvements, should be considered for feedback from community members in the future. The implementation

schedule will be a very important item to discuss, especially regarding construction schedule and any schedule changes resulting from permitting, unforeseen design issues, and delays during construction.

8.2 Design Phase

Section 7 of this report provides a recommended conceptual design for the Gate 5 Road Project. To implement the recommended Gate 5 improvements, the City should advance the project through a staged design process focused on the selected near-term solution: the tide gate, pump station, and storm drain improvements option, with separate coordination for Varda Landing improvements.

8.2.1 30 Percent

At 30 percent design, the City should convert the recommended concept into a workable preliminary layout and confirm the basis of design. This stage should include:

- Completing the additional investigations and analyses identified in Section 8.1, including geotechnical investigations, CCTV, hydrologic model updates, and community engagement.
- Confirming the preferred pump station and tide gate configuration at the Coloma Street Canal.
- Developing preliminary layouts for the pump station, wet well, discharge line, tide gate, and Gate 5 to Harbor Drive storm drain connection.
- Identifying permitting, right-of-way, utility, access, and environmental constraints that could affect project delivery.
- Preparing a preliminary cost estimate and confirming whether Varda Landing improvements will proceed separately or in parallel.

8.2.2 60 Percent

At 60 percent design, the City should refine the preferred improvements into a coordinated draft design suitable for agency, owner, and constructability review. This stage should include:

- Advancing hydraulic, geotechnical, and civil design for the pump station, tide gate, storm drain improvements, and discharge system.
- Refining grading, site access, structural support, electrical service, controls, and maintenance requirements.
- Coordinating utility conflicts, temporary construction access, traffic control, and sequencing along Gate 5 Road and at Harbor Drive.
- Advancing permit strategy and right-of-way coordination, including any easement, property access, or environmental mitigation needs.
- Updating the cost estimate and preparing a preliminary construction schedule.

8.2.3 90 Percent

At 90 percent design, the City should complete the near-final design package and close out remaining review comments. This stage should include:

- Finalizing coordinated drawings and specifications for civil, structural, hydraulic, mechanical, and electrical elements.
- Completing QA/QC review of pump sizing, tide gate operation, wet well configuration, drainage connectivity, and constructability.
- Addressing agency comments, permit conditions, and owner coordination issues.
- Refining bid quantities, opinion of probable construction cost, and construction phasing.

8.2.4 Final

At final design, the City should issue the project for construction. This stage should include:

- Incorporating final review comments, permit requirements, and stakeholder commitments.
- Completing signed and sealed construction drawings, specifications, details, schedules, and bid documents.
- Confirming final construction access, sequencing, temporary protection measures, and operational requirements for the completed system.
- Separately finalizing any partner-led Varda Landing improvements, if they are advanced in parallel with the near-term project.

The result should be a complete, permitted, and buildable package that allows the City to move directly into procurement and construction. A timeline between phases is discussed in Section 8.6.

8.3 Funding Mechanisms

The City would benefit by pursuing a phased funding strategy that aligns each project component with the most suitable grant or financing source and advances the project from feasibility through construction.

The project is well positioned for next-phase funding because it already benefits from U.S. Economic Development Administration support for vulnerability and feasibility work, matched with local funds. This report can further support funding requests by defining project components, documenting benefits and costs, and supporting environmental clearance and construction applications.

Primary funding should focus on core roadway, drainage, pump station, and tidal improvements. FEMA's Building Resilient Infrastructure and Communities (BRIC) program, or similar state flood programs, should serve as the main capital source, with current BRIC timing confirmed through California OES.

Supplemental funding should support shoreline, habitat, and public-access features that align with broader coastal resilience goals. The San Francisco Bay Area Measure AA may support habitat-linked flood management elements, while the Coastal Conservancy's Climate Ready Program is well suited to shoreline and sea level rise adaptation features. For living shoreline and other natural infrastructure improvements, the National Coastal Resilience Fund should also be pursued.

Financing for pump stations, drainage conveyance, and related water-quality infrastructure may include low-interest revolving fund loans so grant funding can be concentrated on the most competitive project elements.

Overall, the project should be packaged into fundable phases: complete feasibility, environmental review, and preliminary design; pursue primary applications for core flood protection improvements; then seek supplemental funding for shoreline adaptation and habitat features. This approach improves eligibility, reduces overlap, and supports phased delivery as funding is secured. Details of each funding mechanism are provided below.

- **FEMA Building Resilient Infrastructure and Communities (BRIC).** FEMA BRIC should be treated as the primary funding source since it is designed to fund pre-disaster hazard mitigation projects that reduce future risk to life, property, infrastructure, and community function. This project includes roadway improvements, pump stations, tide gates, drainage upgrades, and related flood-protection features that preserve access and reduce recurring flood damage. The application should demonstrate such items as risk reduction, consistency with the City's FEMA-approved Local Hazard Mitigation Plan, and readiness to advance into design and construction.

- **California Department of Water Resources Flood Funding.** DWR flood programs can be a primary or backup capital source for stormwater and flood-risk-reduction components as well, including drainage conveyance, pump station upgrades, detention or storage improvements, road-drainage interface improvements, and related flood-risk-reduction measures. The City should maintain a grant-ready package that includes vulnerability assessment, alternatives evaluation, cost estimates, flood documentation, and a clear explanation of how the project reduces risk while supporting public access and community resilience.
- **San Francisco Bay Restoration Authority Measure AA.** Measure AA should be used for shoreline and habitat-linked components. The program is for tidal wetland restoration, managed pond or shoreline habitat enhancement, natural shoreline features, public access improvements tied to habitat projects, and flood management features for a habitat project. The City should separate living shoreline, marsh edge enhancement, habitat restoration, and shoreline public-access elements into a distinct Measure AA scope.
- **California Coastal Conservancy Climate Ready Program.** The Coastal Conservancy's Climate Ready Program is well suited for sea level rise solutions, coastal resilience planning, nature-based shoreline solutions, public access, and multi-benefit shoreline improvements. This program should be used to advance design, permitting, environmental review, community-facing resilience benefits, and selected green-gray shoreline features. Emphasis on sea level rise, storm surge, public access, vulnerable shoreline infrastructure, and the use of natural infrastructure is recommended.
- **National Coastal Resilience Fund.** The National Coastal Resilience Fund, administered by NFWF with federal and partner support, is best suited for nature-based or hybrid coastal resilience projects that protect communities while improving habitat. This would include living shoreline features, marsh or wetland enhancement and monitoring of natural infrastructure performance. NCRF should not be relied on to fund the primary roadway or pump station package, but it can strengthen the overall funding stack by supporting shoreline resilience elements that reduce exposure to coastal flooding and improve ecological outcomes.
- **Clean Water State Revolving Fund financing.** CWSRF is a financing tool for water-quality and stormwater-related infrastructure. Eligible components may include stormwater conveyance, pump stations, runoff treatment, green infrastructure or other facilities that improve water quality or manage runoff. Because CWSRF is generally repaid as a low-interest loan, it is best used to reduce local cash-flow pressure, support match requirements, or finance eligible stormwater improvements while grant funds are directed to the most competitive flood and shoreline resilience elements.
- **U.S. Army Corps of Engineers Planning Assistance to States and Section 205.** USACE should be considered for technical and project-development rather than for a near-term grant substitute. Planning Assistance can support planning-level analysis, flood-risk evaluation, regional water resources planning, and assessment of nature-based or hybrid alternatives. The City should coordinate with USACE early on to determine whether the project is better suited for technical planning support, for a flood-risk-management project, or for longer-term regional coordination.
- **U.S. Economic Development Administration follow-on funding.** EDA should be used where the project can clearly demonstrate economic resilience, business continuity, job protection, access to employment areas, and infrastructure benefits tied to economic recovery or growth. The vulnerability and feasibility analyses can be used to show project progression and readiness.

8.4 Permitting Requirements

For the recommended near-term alternative, which is largely limited to improvements within the City right-of-way (ROW), the permitting strategy will be narrower and more targeted than for a broader shoreline adaptation program. Most of the roadway drainage improvements and the pump station are likely to be addressed through local design review, utility coordination, and CEQA compliance, while the tide gate and any work affecting the canal

outlet to the Bay will likely drive the principal state and federal permit requirements. Therefore, the recommended permitting strategy is to advance the ROW storm drain improvements, pump station, and canal outlet modifications primarily as a City-controlled drainage project in cooperation with private citizens where improvements are recommended on their properties, while separately confirming the tide gate and related construction triggers state and federal review at the Bay interface. The most efficient approach will be to define a single integrated project description to be used for preparing all permitting applications, we recognize that external permitting may be limited if the work remains within the City's existing jurisdictional footprint and avoids impacts that independently trigger BCDC, USACE, Regional Water Board, or CDFW review. Given the reason for the improvements pertain to climate adaptation, the project may be able to accelerate permit approvals for improvements through BCDC, and this should be confirmed at the same time as the other state and federal permitting triggers.

Table 8.1 provides likely permits, approvals and right of way considerations for this work which need further confirmation at the 30 percent design phase. Note, low cost represents a cost under \$100,000, while moderate represents one that exceeds this cost, but would not exceed \$500,000. While several agencies are listed separately, multi-agency reviews can be streamlined through organizations like the Bay Restoration Regulatory Integration Team (BRRIT) once the development is complete, so if several agencies within BRRIT would be involved the consultation and permitting efforts would likely be combined.

Table 8.1 – Likely Permits, Approvals and Right of Way Considerations for Near-Term Recommended Solution

Agency	Likely Permit or Approval	Principal Trigger	Likelihood	Timeline	Cost Magnitude	ROW / Easement Considerations
City of Sausalito	Public works, engineering, & local approvals	Roadway storm drain improvements, pump station siting, canal outlet modifications within City jurisdiction, utility coordination, and construction sequencing	High	Concurrent with design	Low to moderate; primarily staff, engineering, and coordination costs based on a percentage of the total project cost	Confirm work remains within City ROW, identify temporary access or staging needs.
City of Sausalito	CEQA lead agency review	Overall project approval and environmental review	High	Shorter if exempt, several months if Initial Study/MND is required	Low to moderate, increases if technical studies are required	ROW boundaries should be confirmed before CEQA project description is finalized.
BCDC	Permit only if Bay or shoreline jurisdiction is triggered	Tide gate or outlet work extending into the Bay or within the 100-foot shoreline band in a manner subject to BCDC jurisdiction; seawalls	Possible	Several months, longer if major permit review is required, acceleration of timeline may be available at time of project execution	Low to moderate; may require application support, exhibits, and agency coordination, based on a percentage of the total project cost	Confirm shoreline band limits, construction access, and whether work extends beyond City-controlled areas.
USACE	Section 10 permit; Section 404 permit if fill is involved	Tide gate or outlet modifications affecting navigable waters or waters of the United States; seawalls	Possible	Several months, longer if individual permit or consultation is required	Moderate, could increase with jurisdictional delineation, alternatives analysis, or mitigation	Confirm federal jurisdiction and whether permanent or temporary work occurs outside City ROW.
Regional Water Board	Section 401 Water Quality Certification & related construction water quality approvals	Federal permit linkage, dewatering, turbidity control, or temporary discharge management that triggers Water Board review	Possible	Several months, typically coordinated with USACE review	Low to moderate, may include water quality plans, BMPs, and monitoring	Temporary construction easements may be needed for dewatering, bypass pumping, or treatment areas.

Agency	Likely Permit or Approval	Principal Trigger	Likelihood	Timeline	Cost Magnitude	ROW / Easement Considerations
CDFW	Lake and Streambed Alteration Agreement	Potential effects on a jurisdictional channel, aquatic resource, or adjacent tidal area beyond the City-controlled outlet	Possible	Several months after complete application package	Low to moderate, could increase with habitat mitigation or monitoring requirements	Confirm maintenance access and whether channel work requires temporary or permanent access rights.
NOAA Fisheries	ESA consultation and Essential Fish Habitat review, if triggered through USACE	Potential effects on fish passage, tidal hydraulics, or aquatic habitat at the channel mouth	Possible if USACE consultation is triggered	Several months, may extend federal permitting schedule	Low to moderate, higher if design revisions, surveys, or mitigation are required	Access and easement needs depend on final tide gate footprint and maintenance requirements.
USFWS	ESA consultation or biological review	Potential effects on protected species, nesting birds, or adjacent marsh-edge habitat	Possible depending on site conditions	Several months if consultation or focused biological review is required	Low to moderate, higher if surveys, work windows, or mitigation are required	May affect temporary access, staging, and construction work windows near habitat areas.

8.5 Mitigation of Construction Impacts

Mitigating construction impacts at the Coloma Street Canal requires environmental controls, construction constraints, and engineering protocols. Since the project discharges into the Bay, mitigation may require isolating the construction site to prevent contamination through the use of: A) Cofferdams and/or other flow diversion best management practices coupled with a dewatering system, B) Silt Curtains installed downstream in the bay to catch any loose sediment, and C) In-Water Work Windows to protect migrating fish in the Bay.

8.6 Implementation Schedule

8.6.1 Immediate Needs for Near-Term Option

Until the near-term option is implemented, the City should continue operating the temporary pumping system during extreme tide events while advancing the permanent near-term solution: storm drain improvements, a pump station, and a tide gate tied to the Coloma Street Canal. Implementation should be managed as a combined technical, environmental, permitting, funding, procurement, and construction effort, with funding pursued in parallel so the project can move forward as each phase becomes ready. Based on the anticipated activities, with many that can be done concurrently, implementation of the permanent solution will likely require approximately three to four years.

A proposed implementation schedule and roadmap for the near-term alternative is outlined below.



1. Pre-Permitting and Engineering Studies (6 to 12 months, overlapping with environmental review)

The first priority is to conduct technical work needed to support permitting, final design and funding applications. This includes the Coloma Street Drainage Canal structural investigation that the City is currently conducting, and CCTV of existing storm drains along Gate 5 Road between Coloma Street and Harbor Drive. During this phase, the City should also confirm the funding strategy and package the project into fundable components.

2. Environmental Review (CEQA) (3 to 18 months, overlapping with early design and funding)

The City should initiate CEQA review early so it can proceed in parallel with design development where feasible. The level of review will depend on the final project description and environmental setting, but it will likely include preparation of the appropriate CEQA document such as an exemption, MND or EIR, agency consultation, technical studies, public review, and incorporation of mitigation measures into the design and construction approach.

3. Funding Strategy and Applications (6 to 12 months, overlapping with early design and CEQA)

Funding should be advanced as an active workstream rather than deferred until design is complete. For the core flood protection improvements, the City should pursue FEMA BRIC or comparable state hazard mitigation funding, with current BRIC timing and eligibility confirmed through Cal OES. In parallel, the City should position shoreline, habitat, or public-access elements for supplemental sources such as the Coastal Conservancy's Climate Ready Program, Measure AA where applicable, and nature-based resilience programs such as the National Coastal Resilience Fund. The City should also evaluate low-interest revolving fund financing for eligible pump station, drainage, and water-quality-related infrastructure so grant funding can be concentrated on the most competitive project elements.

4. Agency Permitting and Approvals (12 months, overlapping with design development)

As the project definition is refined during the 30 percent design, the City should advance the permitting strategy identified in this report. Depending on final jurisdictional determinations, approvals may include City implementation approvals and coordination with agencies such as BCDC, USACE, the Regional Water Board, and CDFW for canal outlet and tide gate work affecting the Bay interface. This phase should include confirming jurisdictional boundaries, preparing permit application packages, coordinating early agency meetings, addressing agency comments, and incorporating permit conditions into the final design, construction sequencing, and environmental protection measures. Funding applications and agency coordination should be kept aligned so grant scopes, cost estimates, and permit assumptions remain consistent.

5. Design Development (9 to 12 months)

Design should advance through the 30, 60, 90, and final design stages described previously. Portions of design can proceed concurrently with CEQA, permitting, and funding applications, but final documents should incorporate permit conditions, utility coordination, construction access requirements and related right of way, stakeholder commitments, and any conditions tied to grant or financing awards. Maintenance right of way should also be included with the design documents to enable right of way procurement such as maintenance access easements to be started at the 30- to 60- percent design phase.

6. Procurement and Construction (12 to 18 months)

Once the design package is complete and approvals are secured, the City should proceed with procurement, bid, award, and construction. This phase should include advertisement of the project, response to bidder questions, evaluating bids, and issuing notice to proceed. Construction should then be sequenced to maintain flood protection during implementation, including temporary bypass pumping, traffic control, utility coordination, environmental compliance. The City should also plan for construction management, inspection, start-up and testing of pumps and controls, operation and maintenance for the completed system.

Implementation Roadmap for Near-Term Option:

1. Pre-Permitting and Engineering Studies: January 2027 – December 2027
2. Environmental Review (CEQA), Funding Strategy and Applications, and Agency Permitting and Approvals: June 2027 – January 2029
3. Design Development: January 2028 – January 2029
 - a. 30% Design: March 2028
 - b. 60% Design: August 2028
 - c. 90% Design: November 2028
 - d. 100% Design: January 2029
4. Procurement and Construction: January 2029 – June 2030

8.6.2 Future Needs for Mid- and Long-Term Options

In the future, implementation planning should be guided by a recurring review of flood risk associated with sea level rise, land subsidence, storm surge, and watershed storm events, so that the City can adjust adaptation measures to meet the needs of the community. The review process should use updated topographic and bathymetric information, observed subsidence data, revised sea level rise guidance, storm surge and rainfall modelling, and update stormwater pipe network information. The purpose of this effort should be to assess the functionality of the near-term solution, determine the design objectives for the mid-and long-term options, and support funding, permitting, and property-owner coordination for mid-term and long-term adaptation actions.

Mid-Term Strategy (2035 to 2050). During the mid-term period, the City should reassess flooding conditions at regular intervals and after major storm seasons to determine whether the recommended solutions within this report need to be adjusted. The review should focus on how combined sea level rise, subsidence, and storm-driven water levels affect the performance of the Coloma Street and Gate 5 drainage systems, roadway access, canal outfalls, and the frequency and duration of closure of tide-influenced discharge points. The review should also include engagement with the community to assess their view on how the near-term solution has affected flood prevention and whether their preferred solutions have changed. Considering the near-term solution will not be designed to standard design storm severities, the City should be prepared to advance the mid-term options described in this section, including an additional pump station or combined pump facility, upstream stormwater storage, raising Gate 5 Road to improve access during lower-level surge conditions, and/or hybrid shoreline improvements that can be integrated with ecological and recreational features. Mid-term reviews should include the completion of the remaining engineering analyses that are recommended in this report, such as groundwater and geotechnical studies. At this time, the City should also identify right-of-way needs, utility conflicts, property coordination requirements, and environmental constraints early enough to preserve feasible implementation pathways.

Long-Term Strategy (2050 to 2100). During this period, the City should observe performance of the mid-term and near-term improvements to help inform decision-making for implementing long-term strategies. This should include community engagement and assessments on the flood mitigation provided by the improvements to determine when long-term solutions are required. Post implementation monitoring should occur to ensure adaptability over time. The monitoring program should track defined performance metrics, including frequency of roadway or property flooding, observed flood depths and durations, pump station runtime and capacity utilization, tide gate performance, nuisance flooding complaints, maintenance frequency, sea level rise trends, land subsidence, and the combined effects of storm surge, high tides, and larger storm events. Monitoring tools should include tide and rainfall gauges, pump station telemetry, tide gate sensors, field inspections, post-storm documentation, GIS-based flood mapping, LiDAR or elevation surveys, and periodic updates to hydraulic and sea level rise modeling. The City should establish clear triggers for upgrades, such as repeated flooding above acceptable service levels, increasing flood duration, pump capacity exceedance, tide gate overtopping or backflow, accelerated subsidence, updated sea level rise projections, or storm event conditions that can no longer be managed through pumping and isolated



drainage improvements alone. When these triggers are reached, the City should evaluate system upgrades or transition toward the larger-scale options described in this report, including raising Gate 5 Road to function as a protective corridor or levee, constructing a continuous shoreline-aligned seawall with ecological and public-access elements, expanding storage and pumping as needed, and/or supporting gradual raising of properties and structures through redevelopment, regulatory updates, and private investment. Long-term review efforts should also consider how these measures can be phased, combined, or sequenced so that each investment remains compatible with future upgrades and does not preclude more comprehensive protection strategies needed closer to the end of the century.

9. Conclusion

This report establishes a practical, phased strategy for reducing flood risk in the Gate 5 area while preserving flexibility for future adaptation. It provides both an actionable near-term project and mid- and long-term solutions that provide a decision framework to help the City of Sausalito respond effectively as coastal flood hazards intensify through 2035 and beyond.

The vulnerability assessment confirms that current flooding is driven primarily by tidal backflow and storm surge through the drainage system. Over time, sea level rise and land subsidence are expected to increase the frequency, depth, and duration of flooding and shift the dominant flood mechanism toward broader overland inundation from the Bay. These findings support the need for immediate near-term improvements that address existing drainage-system backflow while remaining compatible with larger mid- and long-term adaptation measures.

The recommended near-term approach is a City-led tide gate, pump station, and storm drain improvement project centered on the Coloma Street Canal. This effort should be advanced in coordination with a separate Varda Landing shoreline protection project developed in partnership with affected private property owners. This approach provides the best balance of near-term effectiveness, constructability, public support, cost, and future expandability. It addresses the principal current flood pathways by:

- Preventing Bay water from backing into the storm drain system;
- Providing stormwater pumping capabilities when tide gates are closed;
- Improving connectivity between the Gate 5 and Harbor Drive drainage systems; and
- Reducing overland flooding at Varda Landing for the most frequent storms and tides.

Implementation of the near-term solution should proceed through additional field investigations, model updates, community coordination, environmental review, targeted permitting, phased design, funding applications, procurement, and construction. Continuing temporary pumping during flood events remains an important interim measure until permanent improvements are in place. The proposed implementation roadmap provides a realistic path for advancing the near-term mitigation solutions while allowing funding, permitting, and design activities to proceed in parallel.

Looking beyond the near-term, the City should use this report as a decision framework for staged adaptation of the mid-term and long-term solutions. Future actions should be informed by monitoring tide gate performance, pump station runtime, roadway and property flooding, observed sea level rise, land subsidence, and storm-event impacts.

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Appendix A - Excerpts from Vulnerability Assessment



EXCERPTS FROM:

City of Sausalito

Gate 5 Road Vulnerability Assessment Memo Draft

2026-04-25

1. Introduction

This document summarizes the vulnerability assessment for Gate 5 Road and the surrounding low-lying shoreline area in the City of Sausalito. The purpose of the assessment is to evaluate existing and future flood hazards and to characterize how exposure and risk may change over time due to sea level rise (SLR), storm surge, rainfall-driven (pluvial) flooding, and land subsidence. Flood scenarios were developed using available state and regional guidance and were evaluated for multiple planning horizons to support near-term decision making and longer-term adaptation planning.

This document is organized to provide a clear basis for planning decisions. Section 2 summarizes the hazard conditions and scenarios evaluated, including present-day and future planning horizons. Section 3 summarizes exposure and risk results, including building exposure and key risk metrics. Appendices provide supporting technical information, assumptions, and reference material used to develop the assessment.

2. Hazard Assessment

2.1 Hazard Overview

Several hazard sources exist in the study area that can lead to significant flooding and associated damage and disruption. Key hazard sources include SLR, tidal inundation, storm surge, pluvial flooding and land subsidence.

Sea levels are rising at accelerating rates, leading to increased risk to coastal communities. As sea levels rise, the likelihood of inundation increases chronically during regular tidal patterns and acutely during storm events.

Storm surge is the amount of temporary increase in sea level above the predicted astronomic tide due to changes in the atmospheric and meteorologic conditions. This leads to elevated water levels during storm conditions that contribute to coastal flooding.

Pluvial flooding is flooding that results from rainfall in which water accumulates faster than it can dissipate, either through infiltration or drainage methods. While pluvial flooding can occur independently of coastal processes, its effects in coastal settings are often influenced by elevated baseline water levels, shallow groundwater, and limited drainage capacity associated with tidal conditions.

Subsidence is the downward vertical movement of the Earth's surface, which may include both natural and man-made reasons such as natural compaction or mining. This is a particularly hazardous phenomenon in coastal areas as it lowers the land surface relative to sea level, exacerbating the other hazards mentioned above. Accordingly, subsidence is incorporated in all future-year hazard modeling to reflect relative sea-level change compared to land elevations.

2.2 Flood Scenario Selection and Rationale

Flood scenarios were selected using guidance from state and regional adaptation planning frameworks to ensure consistency with best available science and alignment with regional decision-making practices. Scenario selection was informed by the State of California Sea Level Rise Guidance: 2024 Science & Policy Update published by the California Ocean Protection Council (OPC), and by the Regional Shoreline Adaptation Plan (RSAP) Data Sources and Analytical Methodology Report prepared by the San Francisco Bay Conservation and Development Commission (BCDC).

The OPC guidance provides location-specific sea level rise projections for coastal California, including distinct values for the San Francisco Bay, which were used to define time- and scenario-specific SLR inputs for the study area. The BCDC RSAP methodology provides regional recommendations for flood scenario design in adaptation planning, including guidance on appropriate combinations of tides, storm surge return periods, and planning horizons.

Consistent with this guidance, projected sea level rise was incorporated into the flood scenarios developed for the considered time horizons using time- and scenario-specific SLR projections. This was done to reflect the continually increasing rates of SLR. Storm surge was evaluated using 1-year and 100-year return periods, reflecting both frequent nuisance flooding and extreme coastal flooding conditions recommended for adaptation planning. In addition, a no-surge condition was evaluated to allow isolation and interpretation of non-surge flood mechanisms, such as precipitation-driven and baseline tidal flooding, where appropriate.

The SLR scenarios evaluated include present-day conditions, and future, Intermediate planning scenarios for 2050, 2080, and 2100, as well as a High planning scenario for the 2100 horizon, consistent with the State of California Sea Level Rise Guidance (OPC, 2024). For the San Francisco Bay region, the OPC guidance identifies 0.8 ft of sea level rise by 2050 under the Intermediate scenario, increasing to 3.1 ft by 2100, values that are also reflected in the RSAP.

The emphasis on the Intermediate scenario for mid-century horizons is consistent with recommendations in the RSAP, which identifies 0.8 ft of sea level rise by 2050 as a required minimum coastal flood hazard condition for vulnerability assessment and adaptation planning, and recommends inclusion of higher scenarios primarily at the end-of-century horizon. This approach is further aligned with the Sausalito Shoreline Adaptation Plan (2025), which evaluates 2050 conditions using 0.8 ft of sea level rise and focuses end-of-century analysis on Intermediate and High sea level rise planning scenarios in combination with extreme tide conditions.

Accordingly, the Intermediate SLR scenario was used to represent plausible future conditions for mid-century risk assessment, while both Intermediate and High scenarios were included at the 2100 horizon to support long-term adaptation planning. The set of scenarios for 2025 without SLR was included to characterize present-day or near-term events where future SLR is not a dominant factor in the flooding of Gate 5 Road.

Pluvial flooding was evaluated using 10-, 25-, 50-, and 100-year precipitation return periods. This range of return periods were considered to provide a comprehensive view of events that represent the present and future conditions that may affect the City of Sausalito. These are common return periods used in hazard assessments and can help to prepare an area against flooding under such conditions.

Additionally, these return periods are commonly used for sizing infrastructure to future flood events and therefore will aid any conceptual design based on this study.

Future precipitation projections were evaluated using a single emissions pathway, the Shared Socio-economic Pathway (SSP) 2-4.5, which represents a moderate emissions trajectory and is slightly more conservative than the higher-emissions SSP 3-7.0 pathway, further supporting its selection as a planning scenario. This pathway was selected to maintain consistency with the Intermediate SLR planning scenario and to avoid combining incompatible climate assumptions across hazards. Precipitation projections were therefore not paired with multiple emissions pathways, as the objective of the analysis was to assess flood sensitivity and relative exposure under plausible future conditions rather than to bracket the full range of global emissions uncertainty. This means that if the actual emissions differ from this assumed trajectory, it could result in increased pluvial flooding risk than what is shown in this analysis. Projected changes in extreme precipitation under various SSPs are summarized in Appendix B.

Flood hazard conditions were evaluated using four time horizons including 2025 (present conditions), 2050, 2080, and 2100. Precipitation-driven and compound flooding scenarios were evaluated through 2080, reflecting limitations and increasing uncertainty in precipitation projections at longer horizons. The 2100 horizon was included to support long-term planning and shoreline adaptation considerations related to SLR but was not used in the quantitative risk calculations presented in Section 3.

To fully analyze future flood risk and conditions in the project area, using this framework, a total of 36 scenarios combining pluvial, tidal, SLR and subsidence conditions were defined and analyzed using XP-Stormwater Wastewater Management Model (XP-SWMM) 2026 software from Autodesk (Section 2.4).

2.3 Subsidence

Subsidence is the downward vertical movement of the Earth's surface and can generally be described as a rate that is length over time, such as inches per year (in/yr) or feet per year (ft/yr). There are several types of subsidence with different mechanisms such as local-scale settlements in subsurface materials due to changes in surface loading or groundwater use, or tectonic-scale plate thinning that results in massive inland basins. For this vulnerability assessment, the mechanism of subsidence was not investigated, but it is likely that both local-scale and tectonic-scale factors are contributing to the subsidence in the Gate 5 project area. The following sections will outline and describe how our team determined a subsidence rate for the project area based on publicly available historical ground surface elevation datasets. Recommendations on how to utilize the subsidence rate and future work to help determine a more project specific subsidence rate are also discussed.

2.3.1 Datasets Used and References

Our team utilized ground surface elevation datasets from three locations:

- United States Geological Survey (USGS) National Map (USGS, 2026)
 - Datasets from 2004 and 2010 were available as LiDAR (Light Detection and Ranging) point cloud data (LPC) as .laz files that were decompressed into .las files that were then converted to digital elevation model (DEMs) in ArcGIS Pro (ESRI, 2025)
 - Dataset from 2018 was readily available as a DEM
- NORCE Maps (NORCE, 2026)
 - The NORCE Maps service contains modified Copernicus Sentinel InSAR (Interferometric Synthetic Aperture Radar) data. For the project area, the two data sets utilized were from January 2018 and April 2023. Datasets were viewed directly on the NORCE Maps site.
- Terrain Elevation Difference Analysis 1968-2007 Report (Towill, 2009)
 - Datasets were not directly referenced, but the final elevation difference heat map was utilized

2.3.2 Methods and Assumptions

Data from the three different sources were viewed and analyzed independently from one another.

The three USGS datasets were pulled into GIS as DEMs, and three rasters were made by subtracting the elevation values between the different years: a 2004-2010 raster, a 2010-2018 raster, and a 2004-2018 raster. All datasets utilized a vertical datum of NAVD88 and a horizontal datum of NAD 1983 2011 StatePlane California III FIPS 0403, both in US feet. Ground surface elevation changes were determined by cutting profiles along seven areas of interest on the three elevation change rasters: 1) Gate 5 Rd, 2) Coloma St, 3) Harbor Dr, 4) Bridgeway, 5) Varda Landing Rd, 6) the northernmost Clipper Yacht Harbor point, and 7) the southernmost Clipper Yacht Harbor point (Figure 1).

The two NORCE datasets were similarly analyzed for ground surface elevation changes by cutting the same seven profiles on the NORCE Maps site. The vertical change was presented in millimeters but converted into US inches and feet.

The seven profiles used for subsidence analysis were chosen because of the project's focus on the roadways and stormwater systems that will likely run under the roads in the project area. It was also advantageous to look at the center of roads because it minimizes noise from movable objects (like boats, cars, or buildings).

Note that any spikes in elevation that were not linear (meaning that they are only present in one location along the profile) or any spikes that are anomalous to the rest of the profile (meaning a singular spike of 2 ft when the rest of the profile had a maximum of 0.5 ft) were ignored because they were assumed that it represented a moved object.

Note that positive changes in elevation were largely ignored because they were assumed to represent placement of fill. If the entire profile showed positive elevation change or no change, then a subsidence rate of 0 ft/yr would be assumed.

A rate of subsidence was visually determined for each profile by placing a horizontal line of best fit that ignored spikes in elevation and positive change.

The 2009 Towill report was not used other than to compare the results of the USGS and NORCE data analysis to the Towill heat map. Note that very large and anomalous elevation changes around certain buildings or the coast line were ignored on the heat map; these changes were assumed to be due to construction, specific building settlements, or coastal erosion.



Figure 1 The Seven (7) Profiles of Interest Utilized for Subsidence Analysis.

2.3.3 Data Analysis

Appendix A presents Figure 29 through Figure 35 that represent the elevation changes seen in the seven profiles of interest in the USGS datasets. Note that the vertical axis is elevation change in feet, and the horizontal axis is distance along the select profile. A rate was determined by taking the elevation change in feet and dividing it by the number of years that each raster represented.

Figure 36 through Figure 42 in the Appendix show the elevation changes in the NORCE Maps site. Note that the vertical axis in the bottom graph is the rate of subsidence in mm/yr and the horizontal axis is distance along the select profile. The subsidence rate was then converted into in/yr.

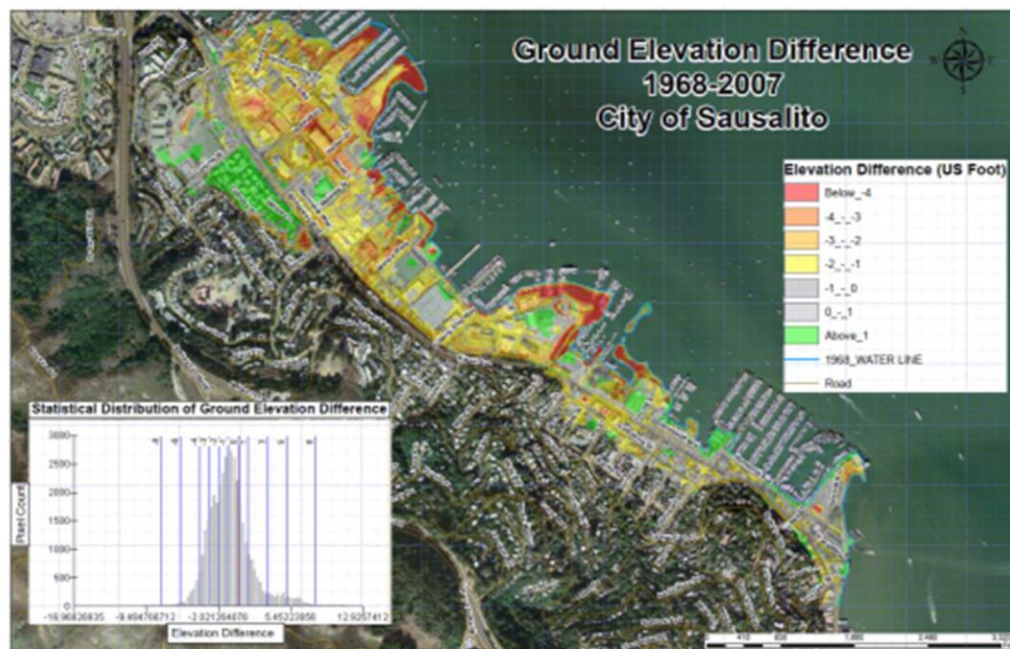


Figure 2 The Towill 2009 Heat Map of Elevation Changes Provided in the Request for Proposals (RFP) for City of Sausalito Gate 5 Area Drainage Management Study (2025).

2.3.4 Conclusions

The USGS datasets and the NORCE Maps datasets are consistent and on average show a range of subsidence values between 0.2 in/yr to 0.6 in/yr. This upper range of 0.6 ft/yr is also largely consistent with the 2009 Towill heat map shown in Figure 2 when we ignore the larger more anomalous settlements seen around some of the buildings and on the coastline. This range of rates for subsidence implies:

- 0.42 ft to 1.25 ft of subsidence in 25 years (2050)
- 0.83 ft to 2.5 ft of subsidence in 50 years (2075)
- 1.25 ft to 3.75 ft of subsidence in 75 years (2100)

While there is a range in the subsidence values, there is not a clear spatial pattern to this range along any of the seven profiles of interest, so this study assumed a single rate of subsidence across the site.

Note that as we go out 75+ years from present, our confidence in the subsidence rate goes down. This is because our analysis is based on historical data mostly constrained in the last 20 years with some data that goes back about 50 years. In the case that subsidence rates or a value is needed to project ground elevations 75+ years out from present, the model should note it is likely the subsidence rate is

conservative, especially if the upper values of the range are utilized. This is because subsidence should slow down as time goes on, especially if groundwater and land use are not significantly changed. An example of a significant change in groundwater or land use would be if a large structure is built in this area that requires a deep foundation and local dewatering.

2.3.5 Future Work

For future stormwater system design, it is recommended that a geotechnical desktop study and exploration be conducted to characterize the upper 80ft of subsurface materials to help with final design, construction recommendations, and determine future infrastructure-related settlements.

2.4 Flood Modeling

To model flooding in the Gate 5 Road area, WSP utilized the XP-SWMM software. WSP utilized this software to combine expected pluvial, tidal, SLR, storm surge and subsidence conditions to assess the potential for flooding in the project area. Additionally, this software allows for the interaction of such conditions with a modeled pipe network that mimics the existing storm drain system in the area. The following sections will detail the model inputs, important assumptions and considerations specific to the XP-SWMM model, and the results that were obtained from it.

2.4.1 Datasets

To locate the topography for the XP-SWMM model, WSP utilized USGS LiDAR Explorer (USGS, 2020). The DEMs were sourced from the CA_NorCal_Wildfires_b5b project, published in 2020 (collected in 2018), which provided the underlying .laz files that were merged to be the base elevation data. The original grid resolution of 3.28 feet was retained. To account for projected land subsidence, three additional DEMs were generated to reflect estimated land elevations for the years 2050, 2080, and 2100. For each scenario, the DEM elevations were lowered by the high end of the corresponding range of estimated subsidence values in Section 2.3.4 to conduct a conservative analysis.

As mentioned previously, the SLR values used in this study were selected from the State of California Sea Level Rise Guidance (OPC, 2024). Location-specific median SLR projections for San Francisco Bay were applied to represent relative sea level change at the project site. As shown in Table 1, the analysis incorporates the Intermediate SLR scenario for mid-century and late-century planning horizons (0.8 ft by 2050, 1.8 ft by 2080, and 3.1 ft by 2100), as well as the High SLR scenario for the 2100 horizon (6.5 ft) to support long-term adaptation planning.

Table 1 Sea Level Scenarios for San Francisco Used in This Study (OPC, 2024)

Year	Sea Level Scenario / Median values of Sea Level Scenarios in feet				
	Low	Int-Low	Intermediate	Int-High	High
2050	0.5	0.6	0.8	1.0	1.3
2080	0.8	1.2	1.8	3.0	4.1
2100	1.0	1.6	3.1	4.8	6.5

Note: Sea Level Scenarios and values used in this study are indicated in bold.

To inform the modeled pipe network of Sausalito's storm drain system, WSP used the CSW-ST2 Technical Assessment Report (CSW-ST2, 2025). The CSW-ST2 Technical Assessment Report was completed in 2025. This report included the evaluation of conditions across the 15 miles of existing storm drain infrastructure in the city of Sausalito. The storm drain system included catch basins, inlets, outlets, and vaults. This assessment evaluated deficiencies, mostly due to degrading material, and recorded their findings using field forms and closed-circuit television footage. This study represented the most complete and recent record of the storm drain system and its condition. The other recent stormwater and flood analysis completed by West and Yost Associates in 2011 (West Yost Associates, 2011) was based on documents and as-builts that originated from the 1970s and 1980s, which were missing critical information, and did not include any field verification of stormwater infrastructure. There were large numbers of discrepancies between the CSW findings and the West and Yost findings. Therefore, one of the two studies had to be selected as the basis for the pipe network modeled within XP-SWMM. The CSW study was selected because it contained more recent data and included field verification of significant portions of the pipe network.

While the CSW survey contained field verified data, the study still lacked sufficient detail for certain elements of the pipe network. As the aim of the CSW assessment was to evaluate condition, several measurements relevant to stormwater modeling, like grate elevations and pipe invert elevations, were missing. General details regarding sizing and location of the system were a component of this report, however WSP had to make some assumptions about the infrastructure sizing based on the surrounding infrastructure. Additionally, there were several missing connections between nodes of the network. WSP therefore did not include portions of the CSW study within the XP-SWMM model.

The tidal inputs used in the model were derived from the updated tidal datums and extreme tide elevations for San Francisco Bay (AECOM, 2016). The study estimated extreme tide elevations based on regionally modeled hydrodynamic conditions. For this project, the tidal datums and extreme tide elevations from Point 15, one of 50 reference points along the Marin County coastline and closest to the project location, was used as a guide. **Table 2** shows this information.

Table 2 Tidal Datum and Extreme Tide Elevations Pulled from AECOM Report.

<u>Location</u>		<u>Tidal Datum</u>						<u>Extreme Tide Elevation</u>							
		FEET-NAVD88						FEET-NAVD88							
County	Point ID	MLLW	MLW	MSL	MTL	MHW	MHHW	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR
Marin	15	0.07	1.09	3.28	3.28	5.47	6.02	7.20	7.55	7.96	8.28	8.76	9.17	9.63	10.94

Land use inputs for the XP-SWMM model were developed using the 2021 National Land Cover Database (NLCD) (USGS, 2021). The NLCD dataset covering the project area was imported into GIS, where land-cover-specific polygons were extracted for the model. These polygons were then imported into the XP-SWMM land use layer and assigned Manning's N values corresponding to each cover type. A total of 12 distinct land-cover classifications were identified within the project area and incorporated into the model. These values are reported in Table 3.

Table 3 Landcover Types and Corresponding Manning N Values.

<u>NLCD Landcover Type</u>	<u>Mannings N</u>
Deciduous Forest	0.1
Mixed Forest	0.12
Evergreen Forest	0.15
Developed, Open Space	0.035
Developed, Low Intensity	0.08
Developed, Medium Intensity	0.12
Developed, High Intensity	0.15
Grasslands and Herbaceous	0.04
Open Water	0.035
Barren Land	0.03
Shrub Scrub	0.08
Woody Wetlands	0.08

2.4.2 Methods

The XP-SWMM model was developed using both 1D and 2D components. The 1D component of the model represents the storm drain network in the project area. The 1D captures both tide and rainfall inputs into the system through the nodes and then models its movement through the network. The 2D component of the model represents the topography of the area and models overland flow from the same tide and rainfall inputs. Additionally, the 2D component of the model captures the water that "leaves" the 1D network by spilling out of a catch basin, manhole, etc. when water in the 1D component overruns the

system. Establishing proper connectivity between the 1D and 2D components was vital to producing realistic system behavior.

Four model versions were created to represent the 2025, 2050, 2080, and 2100 subsidence scenarios; the only differences among these models were the subsidence-adjusted DEMs and corresponding adjustments to node and link elevations. This included lowering the ground elevation and invert elevations at each node because it was assumed that subsidence would cause the stormwater node and link elevations to lower by the same amount as the overall subsidence amount. The 1D network configuration was based strictly on the CSW survey as mentioned above, and very few assumptions were made regarding pipe connectivity.

A 10 ft grid size with sub-grid sampling was used in the 2D domain to improve spatial resolution and enhance model accuracy. Sub-grid sampling was implemented to better utilize the underlying terrain data by generating a stage-storage relationship for each grid cell based on all elevation values within that cell. This approach provides a more accurate representation of local topography compared to applying a single elevation to the entire 10 ft cell.

Model scenarios were developed to evaluate a range of combined rainfall and tidal conditions for the Sausalito area. Future conditions—including extreme tide levels, projected SLR, and increased storm intensity—were incorporated into the scenarios. Rainfall inputs included no rainfall as well as 10-year, 25-year, 50-year, and 100-year, 24-hour storm events for both present conditions and projected years 2050 and 2080. Tide conditions included no surge (Mean Higher High Water [MHHW]), a 1-year, and a 100-year extreme tide surge event with SLR level rise applied (Section 2.4.1). All scenarios are summarized in Table 4. For the 2100 scenarios, both Intermediate and High SLR projections were evaluated.

Table 4 Model Scenario Summary.

Scenario #	Climate Scenario	Year	Sea Level Rise (ft)	Extreme Tide	Still Water Level (ft) NAVD88	Pluvial
1	N/A	2025	0	1-Year	7.2	N/A
2	N/A	2025	0	100-Year	9.6	N/A
3	N/A	2025	0	N/A	6.0	10-Year
4	N/A	2025	0	N/A	6.0	25-Year
5	N/A	2025	0	N/A	6.0	50-Year
6	N/A	2025	0	N/A	6.0	100-Year
7	N/A	2025	0	1-Year	7.2	10-Year
8	N/A	2025	0	1-Year	7.2	25-Year
9	N/A	2025	0	1-Year	7.2	50-Year
10	N/A	2025	0	1-Year	7.2	100-Year

Scenario #	Climate Scenario	Year	Sea Level Rise (ft)	Extreme Tide	Still Water Level (ft) NAVD88	Pluvial
11	N/A	2025	0	100-Year	9.6	10-Year
12	N/A	2025	0	100-Year	9.6	100-Year
13	Intermediate	2050	0.8	1-Year	8.0	N/A
14	Intermediate	2050	0.8	100-Year	10.4	N/A
15	Intermediate	2050	0.8	N/A	6.8	10-Year
16	Intermediate	2050	0.8	N/A	6.8	25-Year
17	Intermediate	2050	0.8	N/A	6.8	50-Year
18	Intermediate	2050	0.8	N/A	6.8	100-Year
19	Intermediate	2050	0.8	1-Year	8.0	10-Year
20	Intermediate	2050	0.8	1-Year	8.0	100-Year
21	Intermediate	2050	0.8	100-Year	10.4	10-Year
22	Intermediate	2050	0.8	100-Year	10.4	100-Year
23	Intermediate	2080	1.8	1-year	9.0	N/A
24	Intermediate	2080	1.8	100-Year	11.4	N/A
25	Intermediate	2080	1.8	N/A	7.8	10-Year
26	Intermediate	2080	1.8	N/A	7.8	100-Year
27	Intermediate	2080	1.8	1-Year	9.0	10-Year
28	Intermediate	2080	1.8	1-Year	9.0	100-Year
29	Intermediate	2080	1.8	100-Year	11.4	10-Year
30	Intermediate	2080	1.8	100-Year	11.4	100-Year
31	Intermediate	2100	3.1	N/A	9.1	N/A
32	Intermediate	2100	3.1	1-year	10.3	N/A
33	Intermediate	2100	3.1	100-Year	12.7	N/A
34	High	2100	6.5	N/A	12.5	N/A
35	High	2100	6.5	1-year	13.7	N/A
36	High	2100	6.5	100-Year	16.1	N/A

The NRCS (SCS) 24-Hour Design Storm Type IA, most common for this part of California (USDA/NRCS, 1986), was used for the rainfall distributions input into the model. The distributions were in 6-minute increments and for each rainfall event, they were adjusted using a multiplier that was determined from

NOAA Atlas 14 24-HR precipitation frequency data in the project area (USDC/NOAA, 2014). For the future precipitation predictions in 2050 and 2080, the NOAA multiplier values were adjusted using the predicted percent change from current values (See Appendix B).

To determine the catchment basins for the nodes throughout the stormwater network, WSP used the terrain data to delineate the overland flow paths and the boundaries of each catchment basin. WSP then measured key features within each catchment basin, such as the longest flow path length and average slope. The NLCD land cover data was used to determine a composite curve number for each catchment basin. With this information, the time of concentration for each catchment basin was found by utilizing the SCS Lag Time Method. Table 5 below shows key characteristics of the catchment basins along with the time of concentration calculated for each of them.

Table 5 Catchment Basin Characteristics and Time of Concentrations.

Outlet Node / Watershed Name	Longest Flow Path Length (ft)	Avg Slope (%)	Composite Curve Number	S	Lag Time (hours)	Time of Concentration (minutes)
CB 381	584	3.4	98	0.20	0.05	5
CB 383	235	4.2	98	0.20	0.02	2
CB 386	287	3.3	98	0.20	0.03	3
CB 388	786	3.9	97	0.28	0.07	7
CB 382	1030	15.4	87	1.48	0.07	7
CB 385	547	2.1	90	1.12	0.10	10
CB 374	733	3.6	98	0.20	0.06	6
CB 370	946	4.3	94	0.61	0.08	8
CB 369	938	5.1	86	1.68	0.11	11
MH 73	1294	6.9	87	1.52	0.12	12
MH 76	1319	11.4	85	1.77	0.10	10
MH 77	948	15.4	85	1.79	0.07	7
MH 104	790	5.3	88	1.34	0.09	9
MH 75	704	8.7	87	1.49	0.06	6
CB 314	704	24.1	89	1.28	0.04	4

2.4.3 Assumptions and Limitations

Some key assumptions and limitations of this XP-SWMM model and its analysis include:

- The input data used for model development, such as stormwater network information and climate projections, are based on the best available data at the time of model development in January 2026. Climate projections for future conditions are inherently uncertain despite also being based on available data and best practices.
- Model performance is constrained by the solvers and methods within the software. While they are advanced in their capabilities; there is no perfect model of physical hydrodynamics or surface

water processes or their interactions with each other. Therefore, there is inherent uncertainty in the model results no matter the quality of the input data.

- Spatial resolution is limited to available LiDAR and processing software. Even if a finer resolution were available, it is not always feasible due to the increase of model run time and decrease of model efficiency.
- The 1D pipe network in the model is based on incomplete survey data. While generally detailed, significant measurements and connections were missing from the technical assessment report (CSW-ST2, 2025). More specifically, the missing measurements and data from the report were concentrated along Gate 5 Road where the focus of the model results is located. Field survey and verification of these nodes and links could significantly alter model results.
- There was no consideration of private storm water systems or flood mitigation measures on private property. For example, if individual property owners have installed pumps, they were not reflected in the models. As this data was not available in a comprehensive manner and was beyond the scope of this project, it was not included.
- The model results may not convey the worst-case scenario as the peak of the tidal oscillation for the various conditions was not aligned with the peak of the design storm hydrographs. This represents a natural variation but not the ultimate peak flooding that could occur within the reality of the flooding scenarios considered. Simulating all the combinations of how a peak rainfall event and a peak storm surge event could align was outside the scope of this analysis.
- This analysis is limited to the project area and its watershed, which is bound by the northbound lane of Highway 101.

2.4.4 Results

From the XP-SWMM model, several data rasters, such as water depth, duration of inundation and water surface elevation, were generated and used to evaluate the scenarios listed in Table 4. These rasters included Maximum Depth (ft), Maximum Water Surface Elevation (ft) and Duration of Inundation (hr). Together, these outputs were used to assess the extent and characteristics of flooding along Gate 5 Road and the greater project area.

To illustrate the flooding extents and drivers for the various scenarios, a comparison was made for the simultaneous 10-yr rainfall and 1 yr surge events across the four-time horizons. Flooding for this scenario across time horizons is illustrated in Figure 3. Under existing conditions (2025 time horizon), a 10-yr rainfall event and 1-yr surge causes flooding by surcharge from the storm drain system. Approximately 480 ft of Gate 5 Road would be inundated with about 0.5 ft of water in this scenario. This figure is centered on Heath Way running along the STG Beaverton LLC and Modernist Factory LLC properties. The adjacent ditches and parking lots in the surrounding area experience greater water depths reaching 1.6 ft near Heath Way. This area is estimated to remain inundated on average between 4-7 hours with the other areas remaining flooded for up to 16 hours. In this scenario, flooding is also occurring along Varda Landing Road and in the parking lot of Clipper Yacht Harbor. The flooding in

these two areas is directly driven by the 1-yr surge because of the lack of storm infrastructure, such as tide gates, in these areas and their proximity to Richardson Bay. These areas are estimated to remain flooded between 1 and 6 hours, varying by specific location. Along Coloma Street the flooding is approximately 0.4 ft in depth. Another location of flooding is seen on the edge of the intersection of Bridgeway Boulevard and Ebbtide Avenue where there is about 1 ft of water. In this scenario, those catch basins are flooded for less than hour.

Under the same rainfall and surge conditions in the 2050 time horizon, the extent of Gate 5 Road extending from Harbor Drive to roughly 60 ft south of Varda Landing would be inundated. This represents over half of Gate 5 Road that would be flooded, and the flooding is estimated to last anywhere from 3 hours to 18 hours in the lower parts of the road, particularly around Heath Way. The water depths seen for this event, like in 2025, vary by location, but can be as deep as 2 ft directly on the road. In this case, most of the project area to the east of Gate 5 Road toward the coastline is inundated with water.

For the 2080 time horizon, Gate 5 Road up to about 500 ft away from Bridgeway Boulevard would be inundated. The water depths along the road in this scenario are deeper than the previous time horizons, ranging from 3 to 6 feet on the road and in the surrounding area, while it remains inundated between 13 and 20 hours along the road. Similar depths and duration of inundation are seen between Gate 5 Road and the coastline.

While no rainfall scenarios were considered for the 2100-time horizon, the 1-yr surge conditions (both Intermediate and High) are severe enough that a 10-yr rainfall event would have little impact on the flood depths seen in this scenario. In both the Intermediate and High case for 2100, the entirety of Gate 5 Road is flooded with water. The flood depths in the Intermediate-risk case range from 4 to 8 ft along Gate 5 Road with it being inundated between 16 and 24 hours. In the High-risk scenario, flood depths range from 5 to 12 ft along the road, and most of which is inundated for 24 hours. Additionally, in both cases, flooding extends up to and beyond Bridgeway Boulevard. This results in flooding most of MLK Park and much of the neighborhood between Bridgeway Boulevard and Tomales Street in the High-risk scenario. In this area, flood depths range from 2 to 9 ft and can last anywhere between 2 and 20 hours.

Flooding in the project area is primarily driven by storm surge influence from Richardson Bay. This is particularly true in the future time horizons of 2050, 2080 and 2100, but is also true for parts of the project area under existing conditions. Under existing conditions, most of the surge impacts are due to backflow through the stormwater network. In the future scenarios, overland flow is substantially more significant due to higher water surface elevations and lower ground levels caused by subsidence. Surges are mostly impacting the areas closest to the coastline such as along Varda Landing Road and along the Clipper Yacht Harbor. The flooding that is seen at higher elevations, along Coloma Street, west of Bridgeway Boulevard and parallel to MLK Park, only occurs during 25-yr, 50-yr and 100-yr rainfall events across surge conditions.

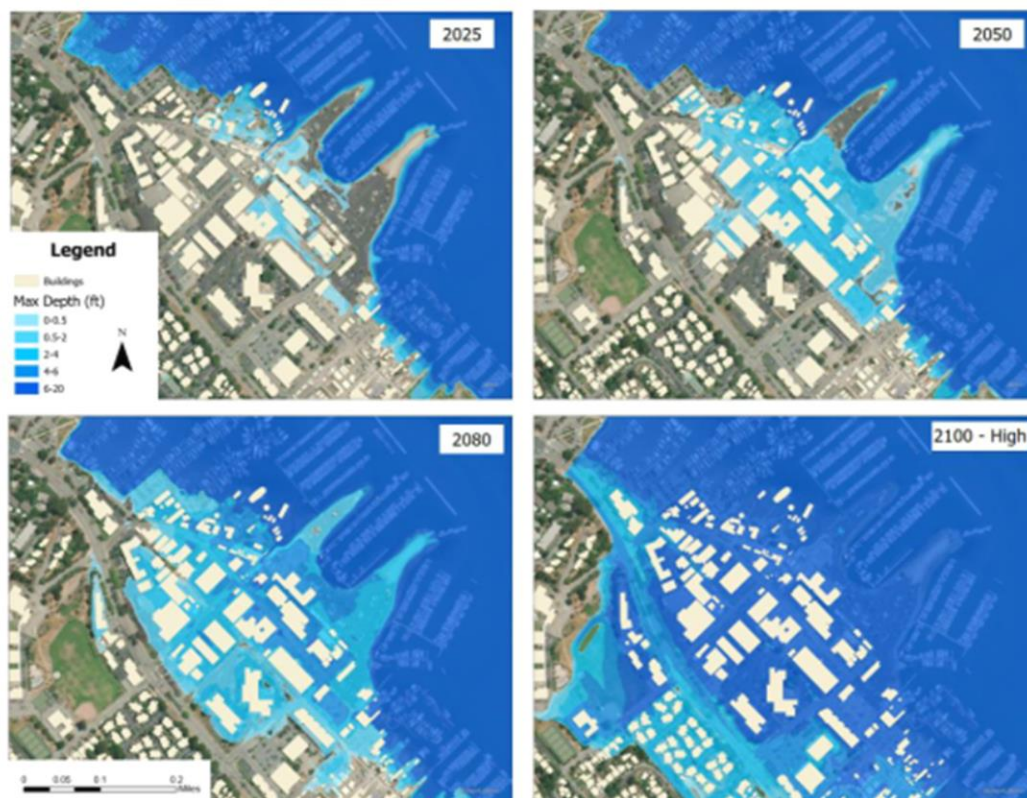


Figure 3 10-yr Rainfall and 1-yr Surge Conditions for all Time Horizons.

At certain tidal surge conditions, overland flow from Richardson Bay becomes the driving force of the flooding seen in the area. This means that flooding becomes independent of the storm drain system along Gate 5 Road and floods as a direct result of tide or storm surge elevations increasing above the land elevations. Under 2025 sea level and subsidence conditions, overland flooding becomes the primary source of flooding during a 100-yr surge event. The effects of rainfall during this surge event are minimal as water covers the project area. Overland flooding leads to flooding along the coast and upland of Gate 5 Road. The flood depths range from 0.5 to 4 ft and can last up to 16 hours. While some overland flooding occurs close to the coastline for the 1-yr surge event in 2025 conditions, flooding in most of the project area is a result of the storm drain system flooding. For the 2050-time horizon, the overland flooding does not become the primary source of flooding until the 1-yr surge event. This results in flood depths of 0.5 to 4.5 ft from the coast up to Gate 5 Road that last up to 18 hours. Under a normal tide cycle (MHHW) in 2050 conditions, the flooding in the project area is a result of both overland flooding and flooding of the storm drain system. This is not the case for 2080 or 2100 when SLR and

land subsidence are greater. In these time horizons, overland flooding is the primary source of inundation, even in the absence of a high storm surge event. In 2080 and 2100, the project area will be inundated with water during a typical tidal cycle (MHHW) where most of the area from the coast up to Gate 5 Road will be under water between 18 and 24 hours of the day.

Figure 4 shows the difference between the areas of rainfall-driven flooding and storm surge-driven flooding for the 100-yr rainfall event under current conditions. To show that rainfall has a less significant impact on flooding than tide conditions, the MHHW tide and 100-yr surge conditions are shown. The depth in blue is flooding as a result of the tide/surge while the orange and red depths are a result of rainfall. As shown in the figure, the rainfall-driven depths are rather minimal once overland flow becomes the driving force of flooding.



Figure 4 Rainfall Driven Flooding Versus Tidal Driven Flooding in the 2025-Time Horizon.

A comparison across time horizons was also made during MHHW and no rainfall event, which are shown in Figure 5. During a typical tide in 2025 when the MHHW is 6.02 ft and there is no rainfall, the areas with flooding include a small portion of Gate 5 Road centered around the storm water infrastructure at Heath Way. The maximum water depth in this area is minimal at less than 0.5 ft and stays flooded between 1 and 4 hours. For a typical tide in the 2050-time horizon when MHHW is 6.9 ft and there is no rainfall, there is flooding on the majority of Gate 5 Road extending from Harbor Drive to about Varda Landing Road. The maximum flood depths seen across the road in this scenario range from 0.2 ft to 2.5 ft. The duration of flooding along Gate 5 increases to about 1 to 5 hours. Under these 2050 conditions, the extent of flooding is greater and much of the land between Gate 5 Road and the coast and along Varda Landing is flooded with depths up to 3 ft that lasts around 4 to 14 hours. Looking at these conditions in 2080 when the MHHW increases to 7.9 ft, flooding is more extensive. The flooding extends from below Harbor Drive to approximately 200 ft past Varda Landing Road. Like in 2050, the area east towards the coast is mostly flooded, but also continues up Coloma Street towards Bridgeway Boulevard. The flood depths in this scenario get as high as 5 or 6 ft along the roadways and remain flooded for 8 to 21 hours depending on location. For both the Intermediate and High-risk 2100 typical tide with MHHW

values of 9.2 and 12.6 ft respectively, the flooding is extensive. Under the Intermediate-risk scenario, flooding occurs in most of the area between Bridgeway Blvd and the coast, including Gate 5 road. Under the High-risk scenario, the flooding extends beyond Bridgeway Boulevard and up Coloma Street, inundating most of MLK park and the neighborhood. The flood depths for the 2100 scenario range from 2 to 10 ft and the flooding lasts between 12 and 24 hours.

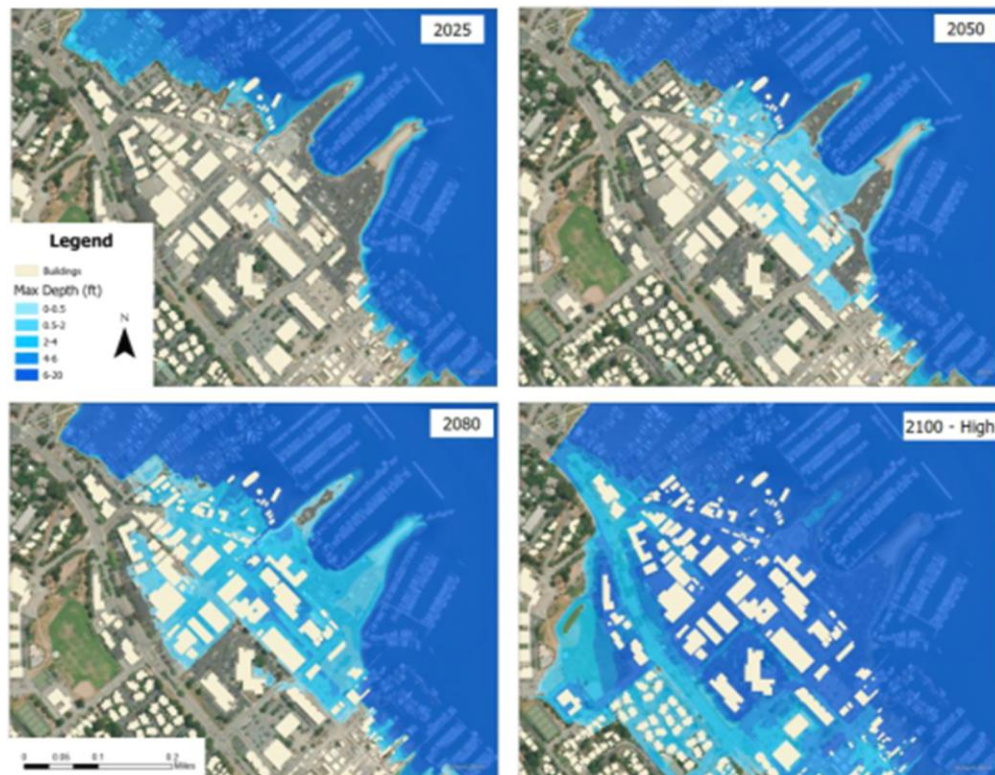


Figure 5 MHHW with No Rainfall for All Time Horizons.

The modeling conducted for this analysis indicates that future flooding in the study area will be driven primarily by overland flow due to SLR and land subsidence. Figures 6 and 7, presented below, show the results of a 1-yr surge and 100-yr surge event across all time horizons respectively. These results illustrate the anticipated flood extents and depths in the absence of mitigation measures and can be referenced when considering future flooding conditions that the Gate 5 Road area will face.

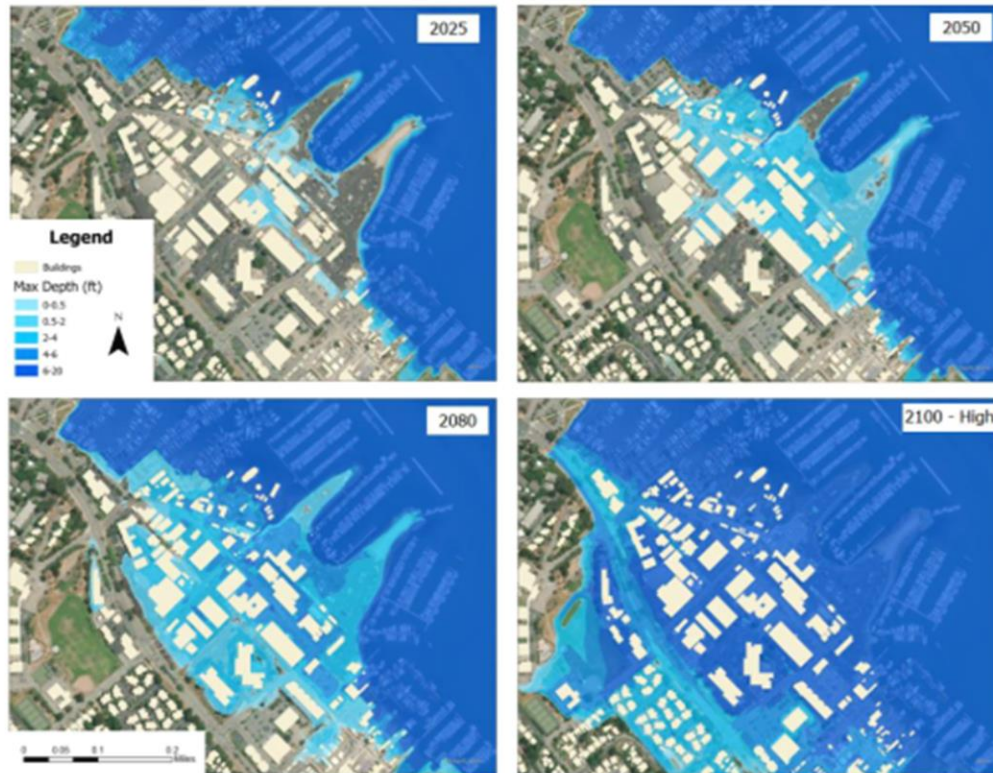


Figure 6 No Rainfall and 1-yr Surge Conditions Across All Time Horizons.

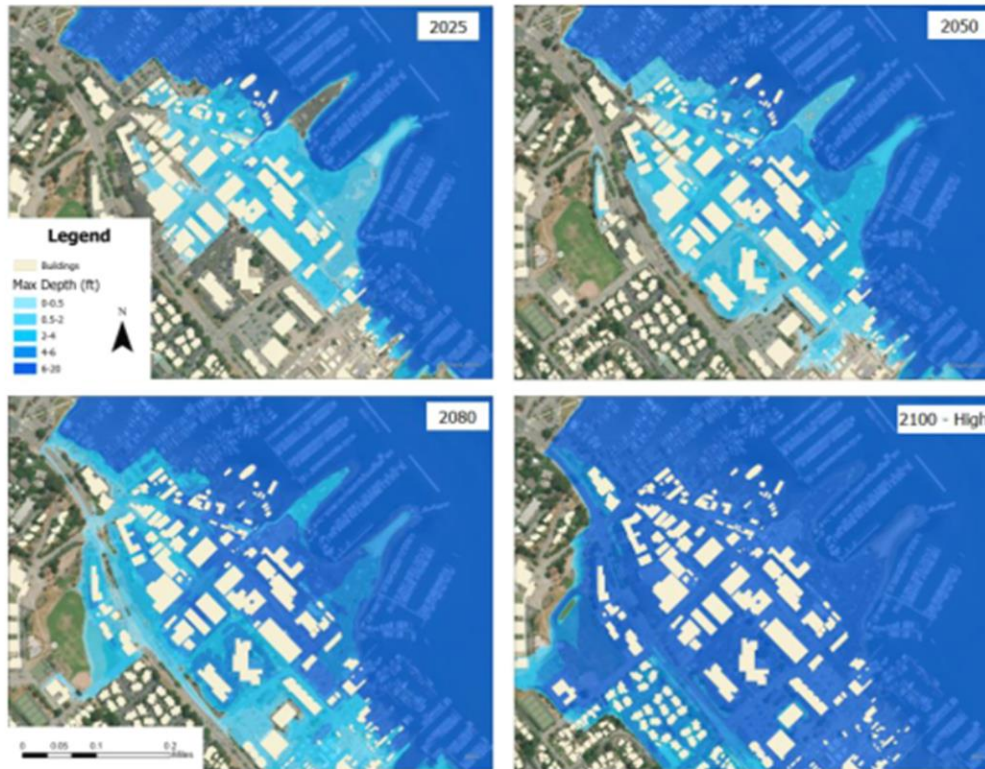


Figure 7 No Rainfall and 100-yr Surge Conditions Across All Time Horizons.

3. Risk Assessment

This section presents the flood risk assessment for the study area, including both exposure and risk analysis. The first part introduces the methodology used and the second part summarizes the results of the analysis.

3.1 Methodology

This section describes the methodological framework used to assess flood exposure and risk. It outlines the data preparation steps, exposure analysis procedures, and risk quantification methods applied to estimate average annual losses, lifecycle risk, chronic inundation triggers, and the sensitivity of results to compound flooding assumptions.

3.1.1 Building Data Preparation and Development

Building-level datasets were assembled and processed to develop a consistent inventory of structures and attributes used in the exposure and risk analyses. The following datasets were used to develop the building inventory for the flood risk assessment:

Marin County

1. Assessor Data:
 - a. Land Value
 - b. Improvement Value
2. Parcel Boundaries: Used to spatially join assessor data to the building footprints
3. Building Footprints: Used as unit of analysis and for building type to gap fill missing information.

National Structure Inventory (NSI) (USACE)

1. Structure
2. Foundation height (first floor elevation)
3. Number of stories
4. Structure value
5. Contents value

City of Sausalito

1. Critical Infrastructure: Includes Lycee Francais de San Francisco-Private Elementary School and Willow Creek Academy Charter Elementary School within the study area.

An initial total of 439 buildings were developed as part of the study area. Buildings located seaward of the shoreline were excluded from the analysis, as the flood control interventions evaluated in this study are not expected to affect structures outside the coastal boundary. Some of the features are

inconsistently represented in the source dataset, further supporting their exclusion from the building-level analysis. This resulted in a total of 427 buildings included in the risk analysis.

Due to data constraints, assessor data at the parcel level was used as the primary value assigned to each building. If more than one building sat on a parcel, the assessed values were allocated proportionally to each building by area. When a single building intersected more than one parcel, they were manually reviewed to assign the appropriate assessor data whether that be a single parcel or more than one parcel. If a building legitimately spans multiple parcels, assessed values from all intersecting parcels were summed to represent the total value available for allocation.

NSI points were spatially joined to building footprints to supplement missing assessor values and or structural information. Multiple NSI points sometimes overlapped with the same building footprint but contained conflicting attributes. If that was the case the value fields were summed, the maximum number of stories was used, and the minimum foundation height was retained.

For each building, the maximum value between assessor-derived and NSI-derived values was retained for use in [the risk](#) analysis. Consistent with FEMA's Hazards United States (HAZUS) methodology, building content value is represented as a percentage of the building replacement value and varies by occupancy type. HAZUS assumes that the value of contents in residential buildings is approximately 50% of the structure value, while content values for non-residential buildings can range from 50% to 150% depending on the occupancy and intensity of use (FEMA, 2009). For this analysis, content value was assumed to be 50% of building value for residential buildings and 100% of building value for non-residential buildings, representing a mid-range estimate commonly applied in flood loss assessments.

3.1.2 Exposure Analysis

A GIS model was used to identify buildings in the study area that would be inundated by flood waters under the different flood scenarios. For each building, the maximum water depth was calculated for each modeled flood simulation raster.

3.1.3 Risk Quantification

3.1.3.1 Building-Level Loss Estimation

The analysis focused on flood [damages](#) to building structures and their contents in the study area. Losses were estimated for each building under each modeled flood scenario and analysis year using building-level exposure outputs (projected flood depths by horizon year and return period at each building's location). Flood damages were evaluated for the 2025–2080 period.

Depth–damage functions from the FEMA HAZUS flood methodology were used to translate inundation depth into percent damage for structures and contents. HAZUS provides standardized depth–damage relationships for multiple occupancy types and building characteristics, enabling estimation of building and contents losses for a given flood depth. Occupancy classifications from the NSI were used to assign each building an appropriate HAZUS damage function.

3.1.3.2 Average Annual Loss

AAL represents the long-term expected value of flood losses in a given analysis year by combining the likelihood of flood events with their consequences. For each analysis year and building, event losses were estimated across a set of return periods. Each return period T was converted to an annual exceedance probability (AEP) using the standard approximation $P=1/T$. AAL was then computed via trapezoidal numerical integration over the exceedance probability domain, consistent with common graphical risk-integration approaches (i.e., computing the area under a loss-exceedance curve using discrete probability-loss points). AAL for a given analysis year was calculated as follows:

$$AAL = \sum_{i=1}^n 0.5 \times (L_i + L_{i-1}) \times (P_i - P_{i-1})$$

Where:

- L_i = Loss for event i
- P_i = Annual exceedance probability for event i
- n = Number of modeled events/return periods

3.1.3.3 Cross-Horizon Return-Period Mapping for AAL Estimation

To support AAL estimation, losses are evaluated across a set of modeled storm surge scenarios representing key benchmark return periods at discrete horizon years (e.g., 2025, 2050, 2080, and 2100). To further enhance the resolution of the probability-loss relationship used in AAL integration—without requiring additional hydrodynamic simulations—the analysis applied a cross-horizon return-period mapping approach to reuse modeled water levels as additional probability points in other analysis years.

A storm surge frequency relationship was derived from stillwater elevation–return period pairs provided in the AECOM (2016) report for the study area (Table 2). Using this relationship, each modeled total water level (including SLR and subsidence adjustments) was assigned an equivalent return period relative to the storm surge frequency curve of a given reference year. This allowed modeled scenarios from one horizon year to be interpreted as representing additional return periods in another horizon year (i.e., “equivalent return periods”), thereby expanding the loss-exceedance curve used to compute AAL.

For example, the 2050 1-year storm surge water level corresponds to an estimated ~54-year return period under the 2025 storm surge frequency relationship. In this way, the 2050 1-year scenario was used as an additional probability-loss point when estimating 2025 AAL. Similar cross-horizon mappings were developed to supplement the probability-loss curves for the 2050 and 2080 AAL calculations using modeled scenarios from adjacent time horizons. The mapping approach and supporting calculations are summarized in Appendix B. The Log-Pearson Type III fitting procedure and parameters used to perform the return-period mapping are provided in the Appendix.

3.1.3.4 Present Value of Expected Losses

Lifecycle “do-nothing” risk was computed by projecting annual losses over the analysis period (2025–2080) and converting them to present value using selected discount rates. Discounting reduces the

weight assigned to losses occurring later in the analysis period and allows comparison of long-term risk on a consistent economic basis. The analysis reports the present value of expected losses as undiscounted totals and discounted totals using 2% and 7% discount rates.

To represent the transition from intermittent flooding to chronic flooding under rising sea levels, the lifecycle analysis incorporates a trigger-year assumption based on a planning threshold (in Section 3.1.4). Buildings are considered to enter chronic inundation when projected water levels reach at least 0.5 ft above first-floor elevation (FFE), a condition intended to reflect frequent, persistent flooding that would disrupt functionality and make continued occupation or repeated repair impractical under a no-action scenario. The first year a building reaches this threshold is defined as its trigger year.

In the lifecycle cost time series, buildings that reach the chronic inundation threshold are assigned a one-time total loss in the trigger year. After that point, additional annual losses for those buildings are not accumulated under the do-nothing condition, reflecting that the building is treated as functionally lost once chronic inundation occurs.

To support lifecycle analysis, AAL estimates computed at milestone years (2025, 2050, 2080) were converted into an annual loss time series across the 2025–2080 analysis period. Because flood modeling results were produced for discrete horizon years, annual losses for intermediate years were estimated by interpolating AAL at the building level between milestone years. For each building and loss component (structure and contents), AAL was computed at the available milestone years and then converted into an annual time series over the 2025–2080 analysis period using piecewise linear interpolation. This produces a continuous annual loss series that reflects gradual changes in surge-driven flood depths under SLR assumptions, while preserving the modeled AAL values at the milestone years.

3.1.4 Chronic Inundation Trigger

To represent the onset of chronic tidal flooding, the analysis defines a planning threshold of 0.5 ft above FFE. When this threshold is reached, a building is assumed to transition into a condition where flooding becomes frequent and persistent enough to disrupt functionality and make continued occupation or repeated repair impractical under a no-action scenario. The timing of this transition is estimated using projected mean water levels driven by SLR and subsidence, evaluated at milestone years and interpolated to identify the first year the threshold is reached.

FFE values are provided as height above local ground (above grade) (see Section 3.1.1). To compute a building-specific trigger in a consistent vertical reference frame, the first floor is converted to an absolute elevation by combining (i) building-level ground elevation in the project vertical datum and (ii) the provided first-floor height above grade. Subsidence projections are provided as cumulative downward land motion relative to 2025. For reporting purposes, subsidence is treated as lowering the effective first-floor elevation over time, reducing freeboard between the first floor and tidal water levels. A depth threshold of 0.5 ft above the first floor is then applied to define a building-specific trigger elevation.

Mean water levels are evaluated at milestone years (2025, 2050, 2080, and 2100) using MHHW in 2025 as the baseline, with SLR increments applied at future milestone years. The threshold exceedance year

is computed as the earliest year when the projected mean water level reaches or exceeds the building's trigger elevation. Because projections are available at milestone years, exceedance timing is estimated using piecewise linear interpolation between milestones (2025–2050, 2050–2080, and 2080–2100). If the threshold is not reached by the end of the analysis horizon, the exceedance year is recorded as not exceeded within the study period.

This mean water-level exceedance year is used as a planning trigger representing when baseline tidal levels (inclusive of SLR and subsidence effects) would be expected to reach a defined depth above the first floor. It does not represent event-driven inundation, and it is not intended to substitute for modeled flood depths that incorporate storm surge, precipitation, stormwater system performance, and other transient or nonlinear processes.

3.1.5 Compound Flooding Stress Test Methodology

Results from the flood modeling analysis (see Section 2.4.4) indicate that storm surge is the dominant driver of coastal flooding in the study area, particularly under future SLR and land subsidence conditions. As mean sea level increases and the land subsides, inundation becomes increasingly controlled by elevated coastal water levels, while the relative contribution of precipitation decreases once widespread overland flooding from the coast is established. Based on this understanding, precipitation was not treated as a co-equal probabilistic driver in the baseline risk analysis. Instead, precipitation effects were evaluated using a stress-test framework to assess potential sensitivity to rainfall conditions.

Compound flooding can occur when multiple flood drivers—such as storm surge and intense rainfall—co-occur or occur in close succession, potentially increasing flood impacts relative to assessments that consider drivers independently. In this study, detailed joint probabilities of coincident storm surge and precipitation events were not available; therefore, compound influences were evaluated using a stress-test framework rather than a fully probabilistic joint-occurrence model. This approach is intended to bound potential impacts and test the sensitivity of flood losses to precipitation conditions, while maintaining transparency regarding uncertainties in event dependence.

The stress test estimates conditional AAL under two rainfall conditions (10-year and 100-year precipitation return periods), paired with the coastal surge conditions used in the baseline analysis. Results are reported as “AAL given precipitation scenario,” meaning they represent expected annual losses under the assumed precipitation condition. These results should not be interpreted as unconditional long-term AAL unless the probability of the precipitation condition and its dependence with storm surge are explicitly characterized.

Conditional AAL estimates are intended to provide context on the potential sensitivity of flood losses to precipitation effects and are not summed with, or interpreted as replacing, the surge-only baseline risk results.

3.1.6 Assumptions and Limitations

- The analysis assumes that the building footprint polygons when used in conjunction with the data on the number of stories provides an accurate proxy for the square footage of the buildings themselves. The building footprints were not checked against aerial imagery.
- The USACE NSI dataset was developed using a generalized statistical approach rather than locally verified data. The FFE and number of stories values are likely inaccurate in some cases.
- The selection of FEMA HAZUS damage functions is not an exact science. Choosing an appropriate damage function for each building relies on accurate information about the type and purpose of the building. It was assumed that the NSI data correctly documented this information as it was beyond the scope of the project to ground-truth it.
- HAZUS depth-damage functions for contents assume that contents are fully present and unprotected at the time of flooding. In areas subject to frequent or recurring flood exposure, such as portions of the Gate 5 Road corridor, property owners may have adapted by relocating or protecting movable assets prior to flood events, which would result in lower actual content losses than those estimated by the damage functions. As such, content loss estimates may represent an upper bound in locations where adaptive behavior is likely.
- The analysis focuses only on costs associated with flooding damage to buildings and contents. A broader analysis could consider other potential sources of flood-related costs, including flooding damage to infrastructure, land values, lost state and local tax revenue, and social and environmental impacts, aside from buildings.
- The analysis focuses only on direct economic impacts. Quantitative impacts assessed in this study are limited to direct flood damages to buildings and their contents. The analysis does not account for broader economic ripple effects, including indirect impacts on state and local tax revenues, businesses, induced impacts on households, or other secondary consequences. In addition, the analysis does not quantify costs associated with transportation disruptions (e.g., lost travel time or roadway closures); lost sales or business interruption; or costs related to injuries or fatalities during flood events.

3.2 Exposure Analysis Results

This section presents the results of the exposure analysis, focusing on the number and spatial distribution of buildings exposed to flooding under the modeled scenarios and time horizons. In addition to building-level exposure, flood exposure was also evaluated in terms of inundation duration, with a focused assessment of effects along Gate 5 Road.

3.2.1 Building Exposure Analysis

Table 8 summarizes the number of buildings exposed to flooding under each modeled scenario. Exposure is defined as flood depth exceeding the FFE, such that buildings counted as “exposed”

experience positive depth above the first floor in the modeled scenario. Figure 8 summarizes the number of buildings exposed to flooding through time (2025, 2050, 2080).

Overall, the results show that storm surge drives the majority of building exposure, with exposed building counts increasing substantially over time under SLR. Under surge-only conditions, the number of exposed buildings increases from 10 buildings for the 2025 1-year surge event to 55 in 2050 and 77 in 2080. For the more severe surge event, exposed building counts increase from 64 buildings under the 2025 100-year surge to 77 in 2050 and 110 in 2080, indicating expanding inundation extent and increasing numbers of affected assets over time.

In contrast, pluvial-only (no surge) scenarios show limited exposure in 2025 (3–6 exposed buildings). By 2050 and 2080, exposed-building counts increase (approximately 38–39 buildings in 2050 and 68–74 in 2080); however, the relatively small change across precipitation return periods within each horizon year suggests that this increase is driven primarily by higher baseline water levels under SLR (and associated overland/coastal influence) rather than precipitation severity alone.

Table 6 Number of Exposed Buildings by Scenario and Analysis Year (Exposed = Flood Depth > 0 ft Relative to First Floor Elevation)

Scenario #	Scenario	Exposed Buildings (Count)
1	2025 - No Rain, 1-YR Surge	10
2	2025 - No Rain, 100-YR Surge	64
4	2025 - 10-YR Pluvial, No Surge	3
5	2025 - 25-YR Pluvial, No Surge	3
6	2025 - 50-YR Pluvial, No Surge	4
7	2025 - 100-YR Pluvial, No Surge	6
8	2025 - 10-YR Rain, 1-YR Surge	12
9	2025 - 25-YR Rain, 1-YR Surge	12
10	2025 - 50-YR Rain, 1-YR Surge	13
11	2025 - 100-YR Rain, 1-YR Surge	16
12	2025 - 10-YR Rain, 100-YR Surge	64
13	2025 - 100-YR Rain, 100-YR Surge	66
14	2050 - No Rain, 1-YR Surge - Int	55
15	2050 - No Rain, 100-YR Surge - Int	77
16	2050 - 10-YR Pluvial, No Surge - Int	38

Scenario #	Scenario	Exposed Buildings (Count)
17	2050 - 25-YR Pluvial, No Surge - Int	38
18	2050 - 50-YR Pluvial, No Surge - Int	39
19	2050 - 100-YR Pluvial, No Surge - Int	39
20	2050 - 10-YR Rain, 1-YR Surge - Int	55
21	2050 - 100-YR Rain, 1-YR Surge - Int	56
22	2050 - 10-YR Rain, 100-YR Surge - Int	77
23	2050 - 100-YR Rain, 100-YR Surge - Int	77
24	2080 - No Rain, 1-YR Surge - Int	77
25	2080 - No Rain, 100-YR Surge - Int	110
26	2080 - 10-YR Pluvial, No Surge - Int	68
27	2080 - 100-YR Pluvial, No Surge - Int	74
28	2080 - 10-YR Rain, 1-YR Surge - Int	77
29	2080 - 100-YR Rain, 1-YR Surge - Int	83
30	2080 - 10-YR Rain, 100-YR Surge - Int	110
31	2080 - 100-YR Rain, 100-YR Surge - Int	113

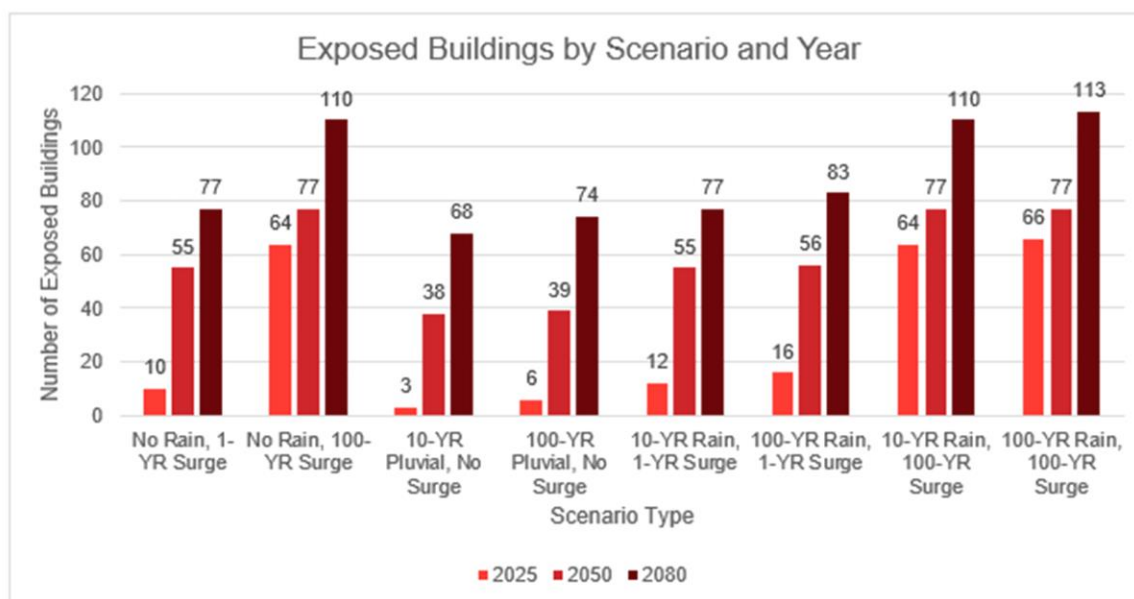


Figure 8 Exposed Buildings by Scenario and Year.

Compound scenarios (surge and precipitation) show that precipitation can increase exposure above surge-only conditions, but the incremental effect is modest relative to surge. For example, in 2025 the 1-year surge exposure increases from 10 buildings (no rain) to 12–16 buildings with rainfall, depending on precipitation return period. Under the 100-year surge in 2025, exposure increases slightly from 64 buildings (no rain) to 66 buildings under the 100-year precipitation condition. In 2050, exposure under the 1-year surge changes minimally with precipitation (55 to 56 buildings), and under the 100-year surge remains unchanged (77 buildings with or without precipitation). In 2080, precipitation increases exposure under the 1-year surge from 77 buildings to 83 buildings under the 100-year precipitation condition, while exposure under the 100-year surge increases from 110 to 113 buildings.

The following maps illustrate building-level flood depths relative to FFE for storm-surge flooding at two event severities (1-year and 100-year surge) and across multiple horizon years (2025, 2050, 2080, and 2100). Buildings are symbolized by depth bins (in feet) above the finished floor, so warmer colors indicate deeper inundation within the structure.

Across both event severities, the maps show a clear expansion in the number of exposed buildings and an increase in depth above FFE over time, consistent with rising sea levels elevating surge-driven water levels. In the 1-year surge sequence, exposure grows from a small cluster in 2025 to broader, deeper impacts by 2050 and 2080, with additional intensification by 2100. In the 100-year surge sequence, the exposed footprint is larger in every year, and higher-depth categories become more prevalent over time—highlighting not only more widespread exposure, but also a shift toward more severe inundation.



Figure 9 Flood Depth Above First Floor Elevation (ft) for 2025 1-year Storm Surge (Left), and 2050 Intermediate Scenario, 1-year Storm Surge (Right).



Figure 10 Flood Depth Above First Floor Elevation (ft) for 2080 Intermediate Scenario, 1-year Storm Surge (Left), and 2100 Intermediate Scenario, 1-year Storm Surge (Right).

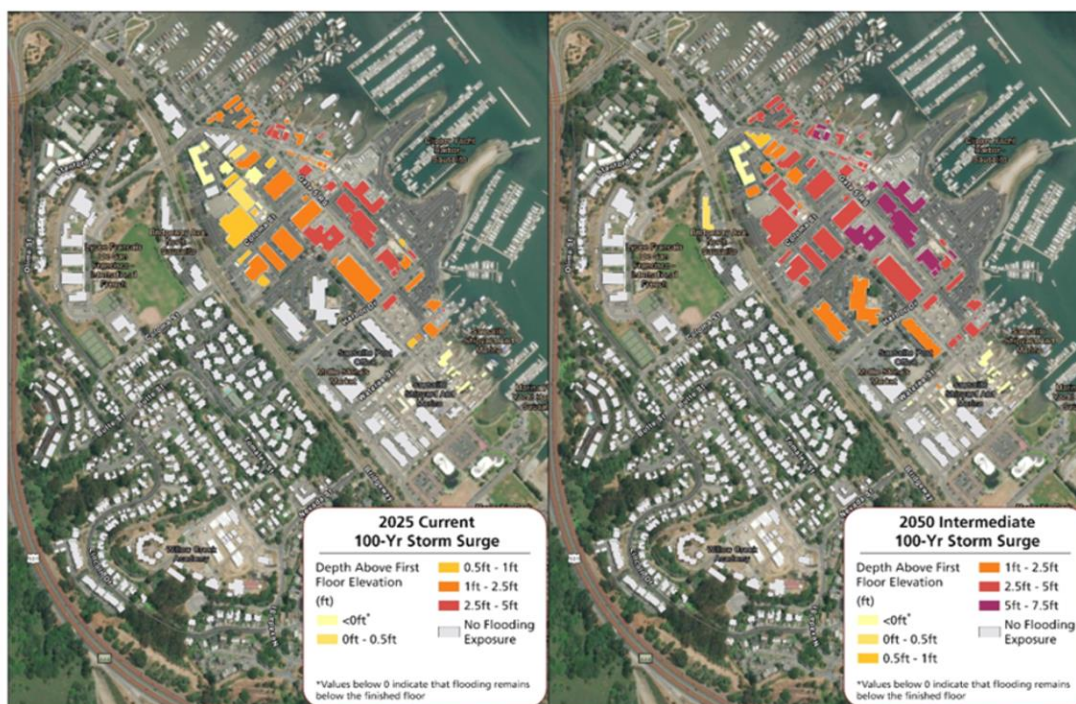


Figure 11 Flood Depth Above First Floor Elevation (ft) for 2025 100-year Storm Surge (Left), and 2025 Intermediate Scenario, 100-year Storm Surge (Right).

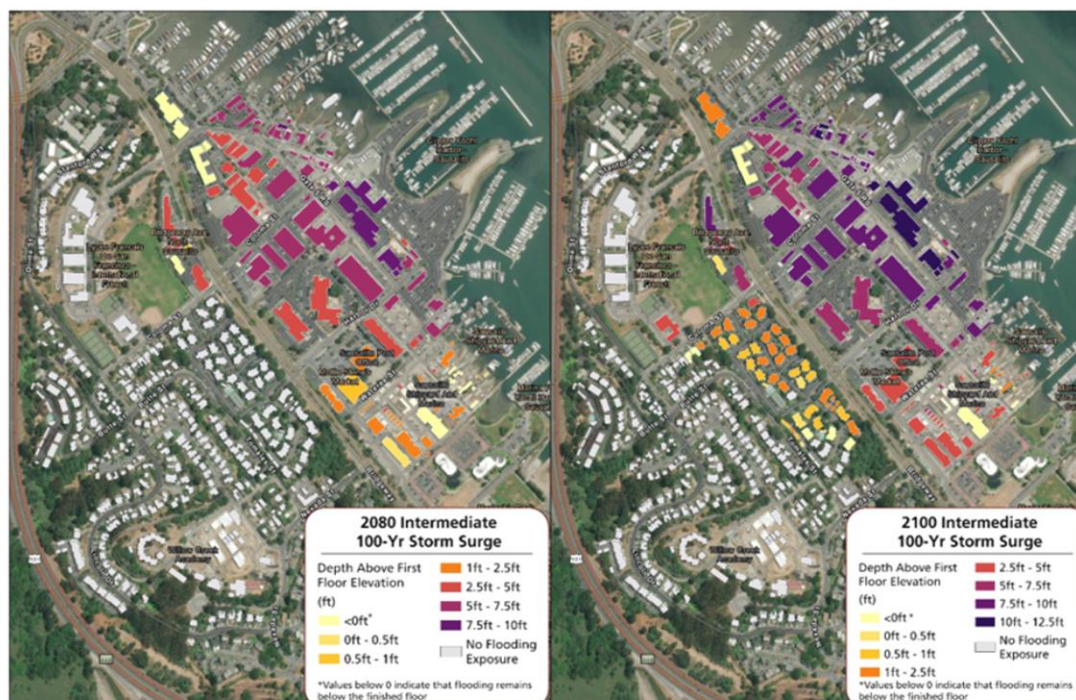


Figure 12 Flood Depth Above First Floor Elevation (ft) for 2080 Intermediate Scenario, 100-year Storm Surge (Left), and 2100 Intermediate Scenario, 100-year Storm Surge (Right).

3.2.2 Exposure of Gate 5 Road to 1-year Surge Flooding

Results from the XP-SWMM model allowed WSP to evaluate the duration of inundation across the project area and focus on Gate 5 Road. For each scenario run, as detailed in Table 4, a duration of inundation raster was produced. This recorded how much time the flooding in the area was greater than 0 ft over the 24-hour simulation period. Additionally, WSP drew a profile line, shown in orange in Figure 13 along Gate 5 Road to illustrate ground elevation, water elevation and duration of flooding. The data pulled from this section are shown in Figure 14 to Figure 17, showing the scenarios with No Rainfall and a 1-yr surge across all four time-horizons. As shown in these figures, the increasing water level across time horizons is in part due to the subsidence that is estimated to occur. As the ground elevation lowers, the flood depths and duration of inundation increases. The lowest point along Gate 5 Road is at the intersection with Heath Way, where Heath Ceramics is located, and this is the point where the longest flood durations along the road occur.

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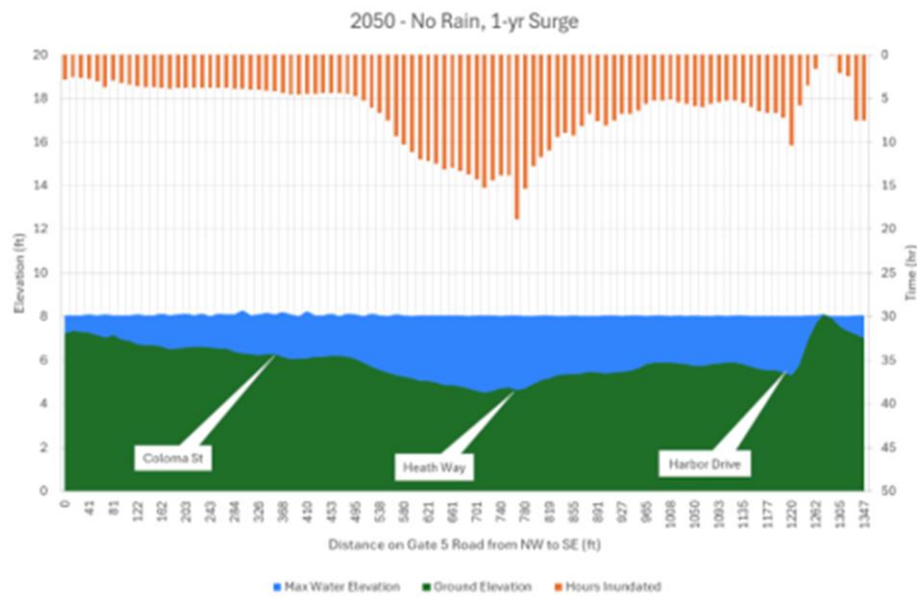


Figure 15 2050 Water Elevation and Inundation Duration Along Gate 5 Road Profile for No Rain and 1-Yr Surge Event.

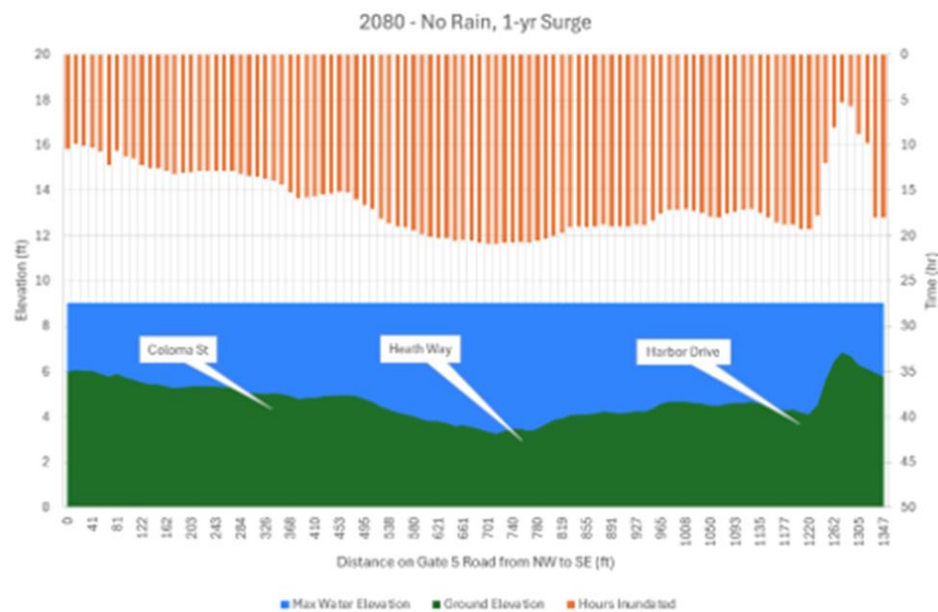


Figure 16 2080 Water Elevation and Inundation Duration Along Gate 5 Road Profile For No Rain And 1-Yr Surge Event.

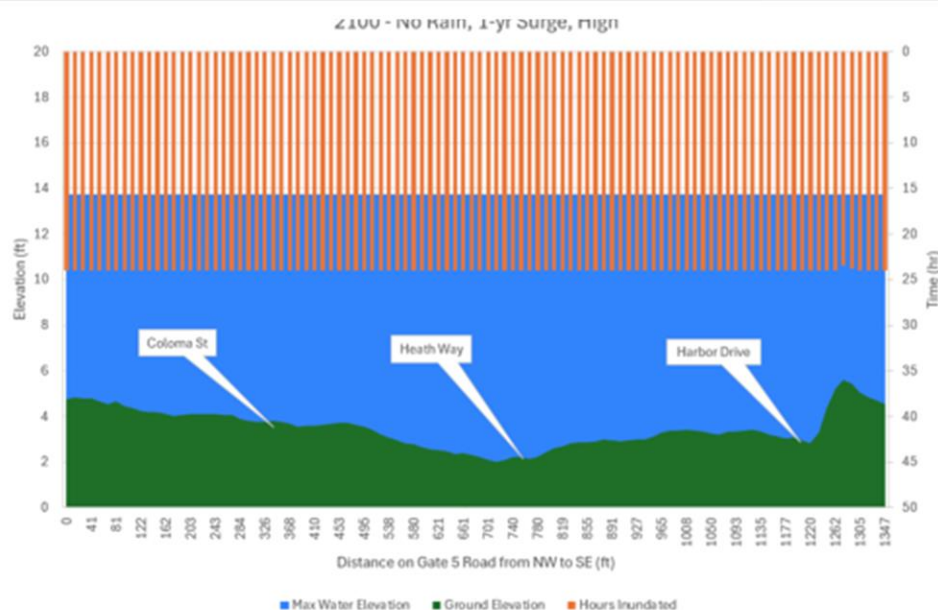


Figure 17 2100 Water Elevation and Inundation Duration Along Gate 5 Road Profile for No Rain and 1-yr Surge Event.

The maximum duration of flooding within the project area for the no rain, 1-yr scenarios, is summarized in Table 7. Additionally, the duration of inundations at the intersections of Gate 5 Road with Coloma Street, Heath Way and Harbor Drive is shown in Table 8. Both illustrate that future conditions will lead to more severe flood impacts in the area.

Table 7 Maximum Duration of Inundation for the No Rain and 1-yr Surge Scenarios Across Time-Horizons.

Scenario	Maximum Duration of Inundation (hr)
2025	8.5
2050	18.9
2080	20.9
2100-Int	23.9
2100-High	24.0

Table 8 Duration of Inundation at Intersections on Gate 5 Road for No Rain and 1-yr Surge Scenarios.

<u>Intersection</u>	<u>2025</u>	<u>2050</u>	<u>2080</u>	<u>2100-Int</u>	<u>2100-High</u>
Coloma Street	0	4.1	13.9	19.5	24
Heath Way	8.5	18.9	20.8	23.7	24
Harbor Drive	0	6.6	18.7	21.3	24

Figure 18 shows a 100-yr surge event to show both the extent of a 100-yr surge and the increasing durations along Gate 5 Road with increasing condition of severity beyond a 1-yr surge event.

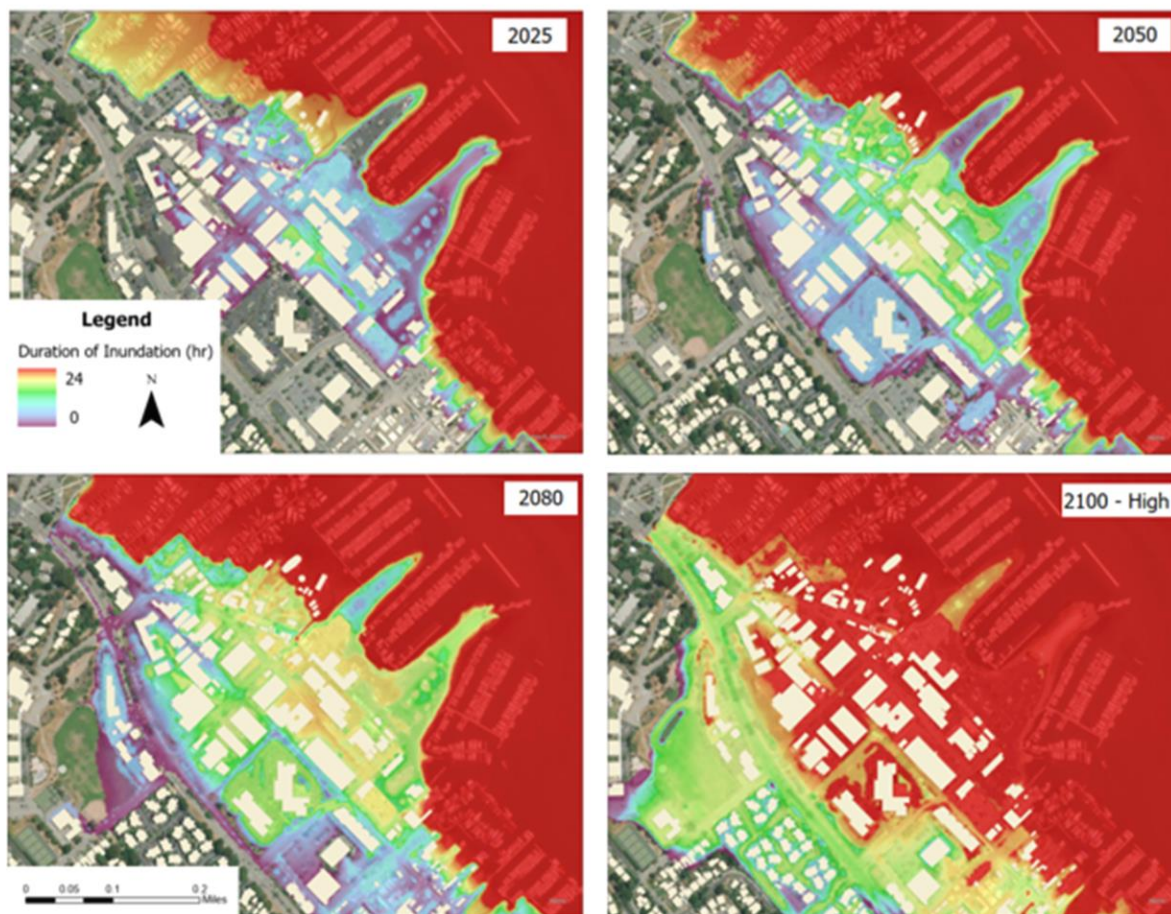


Figure 18 Duration of Inundation in Project Area for No Rain and 100-yr Surge Events Across Time-Horizons.

3.3 Risk Assessment Results

This section describes the results of the risk analysis. Results are presented first for the surge-only baseline, using AAL by analysis year and maps of building-level AAL. The section then evaluates lifecycle “do-nothing” risk through discounted expected losses over the analysis period and identifies buildings projected to experience chronic inundation based on a threshold exceedance criterion. Finally, a compound-flood stress test is presented to examine how plausible precipitation conditions could influence losses when joint probabilities of surge and rainfall events are uncertain.

3.3.1 Surge-Only Coastal Flood Risk

This section summarizes the results of the flood risk assessment considering storm surge flooding only, excluding precipitation and other flood mechanisms. This surge-only analysis provides a baseline

characterization of coastal flood risk under existing and future SLR conditions. Risk is expressed as AAL and evaluated across multiple analysis years, as well as lifecycle risk.

3.3.1.1 Average Annual Loss and Spatial Distribution of Risk

The surge-only flood risk analysis indicates a substantial increase in AAL over time for buildings in the analysis area, driven by storm surge exposure under progressively higher sea levels. As shown in Table 9 and Figure 19, total AAL is estimated at approximately \$17.6 million in 2025, increasing to \$49.8 million by 2050, and \$113.7 million by 2080. Losses are dominated by contents damage across all analysis years, reflecting the sensitivity of building contents and inventory to flooding.

Table 9 Total Average Annual Loss due to Coastal Flooding (Storm Surge and Sea Level Rise) by Type of Loss (Buildings, Contents, Total – Buildings and Contents).

Year	AAL Buildings	AAL Contents	AAL Total
2025	\$4,919,895	\$12,720,247	\$17,640,142
2050	\$12,992,490	\$36,840,224	\$49,832,714
2080	\$29,980,442	\$83,723,229	\$113,703,670

The growth in AAL over time reflects rising sea levels that elevate surge-driven water levels and expand the extent and depth of inundation at exposed buildings. Between 2025 and 2050, total AAL nearly triples, with continued acceleration through 2080 as larger portions of the building inventory become exposed to damaging flood depths. Maps of building-level AAL further illustrate the spatial concentration of surge-related flood risk, identifying clusters of higher-loss assets that drive a disproportionate share of total [damages](#).

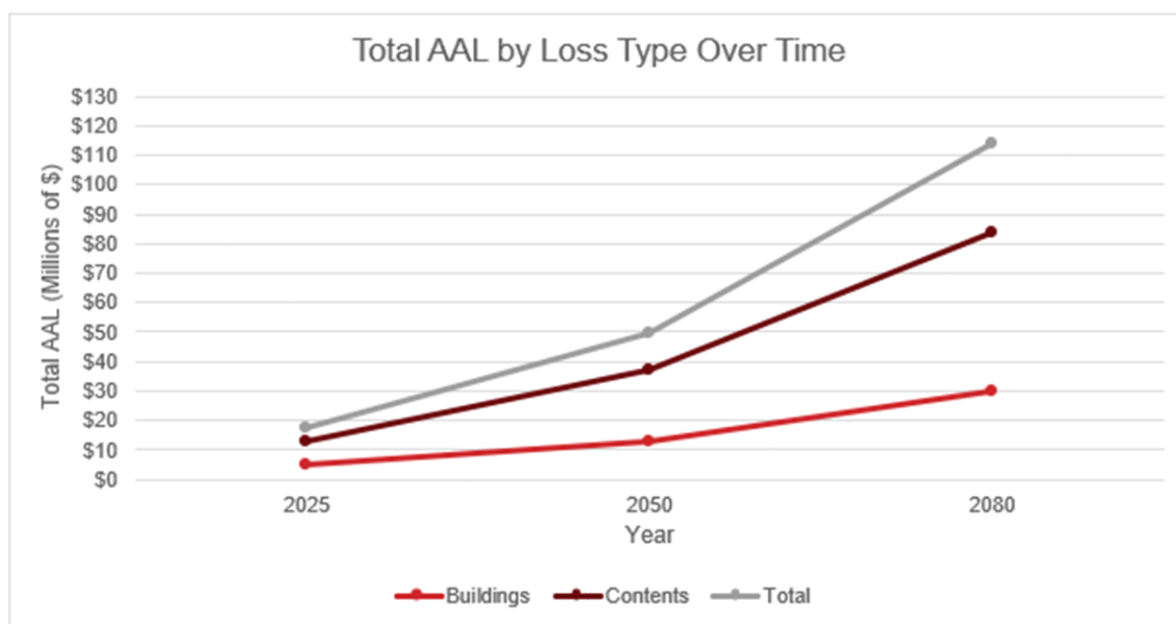


Figure 19 Total Average Annual Loss (AAL) Due To Coastal Flooding (Storm Surge and Sea Level Rise) Over Time by Type of Loss (Buildings, Contents, Total – Buildings and Contents).

Across all mapped years, the building-level AAL maps show that surge-related flood risk is spatially concentrated, with higher losses clustered in low-lying areas closest to the shoreline and tidal channels, as well as along primary access corridors and waterfront parcels. In 2025, higher-loss buildings are limited to a smaller set of assets; however, by 2050 and 2080 these clusters expand both in extent and magnitude, reflecting increased surge depths and higher expected damages under SLR.



Figure 20 Average Annual Losses for Storm Surge (Undiscounted) for 2025, 2050, and 2080, Accounting for Total Losses (Buildings and Contents).

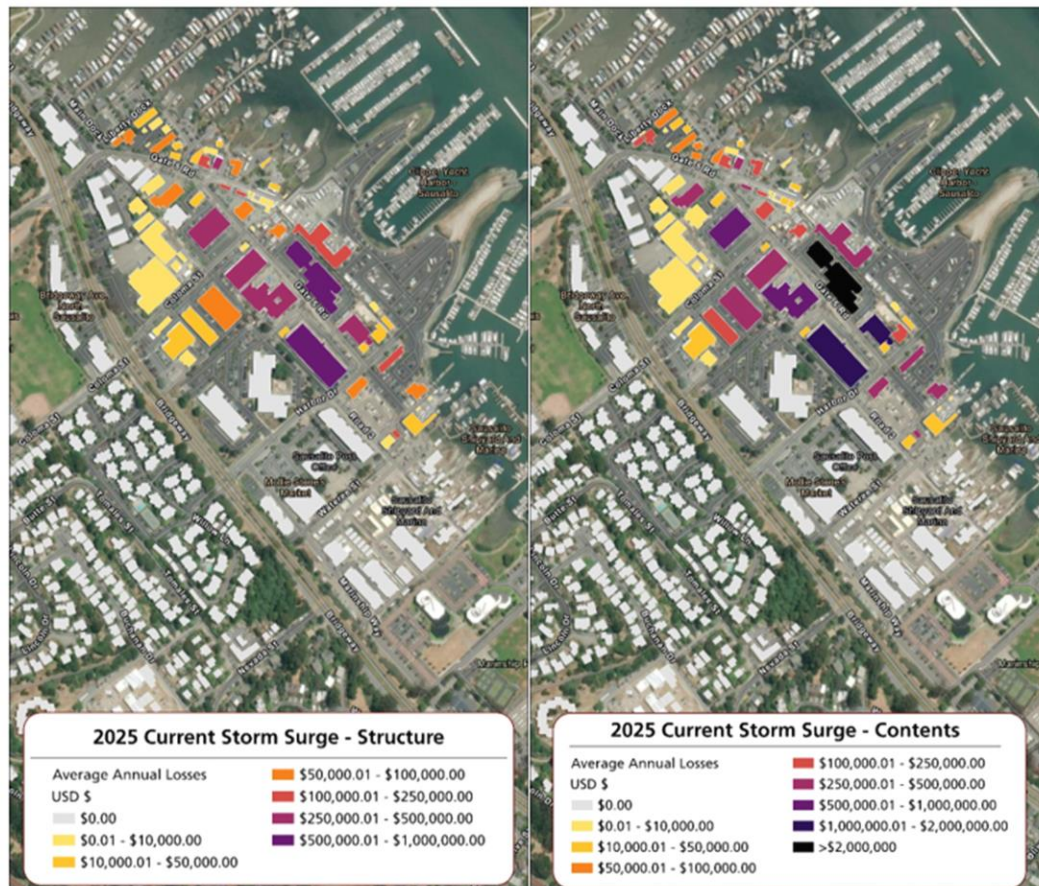


Figure 21 Average Annual Losses for Storm Surge for 2025 (undiscounted) Accounting for Losses to Buildings (Left) and Contents (Right).

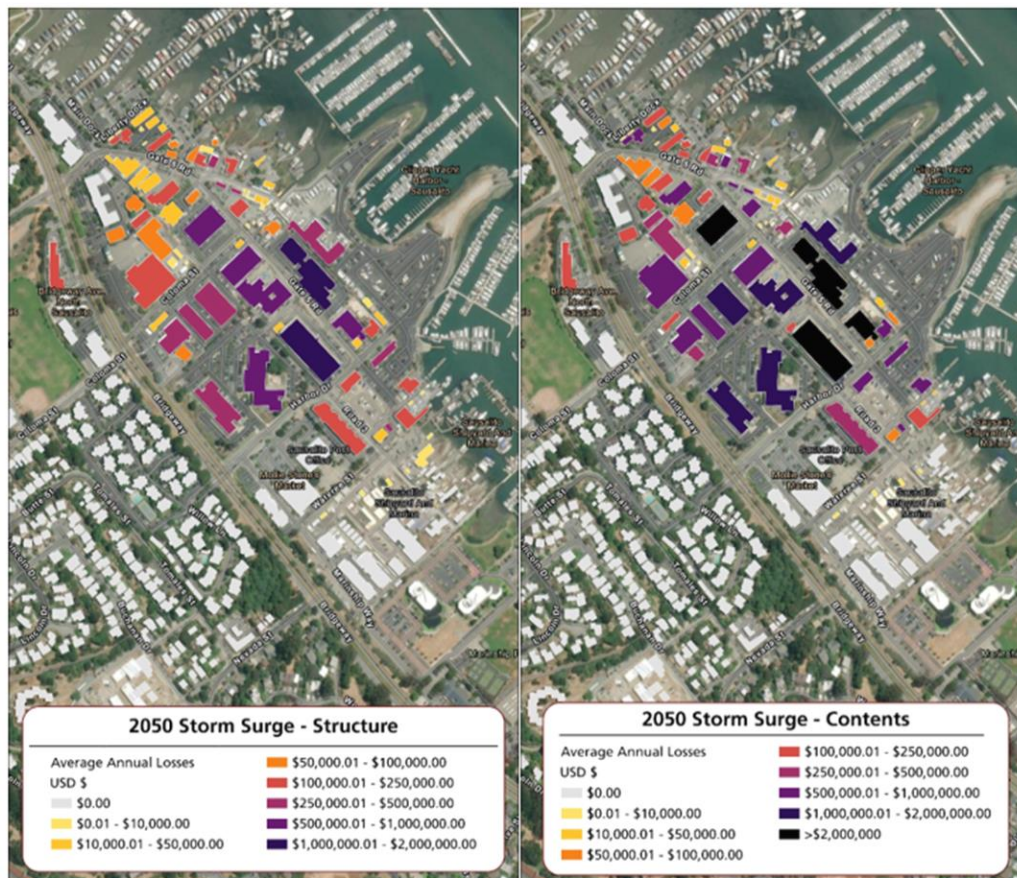


Figure 22 Average Annual Losses for Storm Surge for 2050 (undiscounted) Accounting for Losses to Buildings (Left) and Contents (Right).

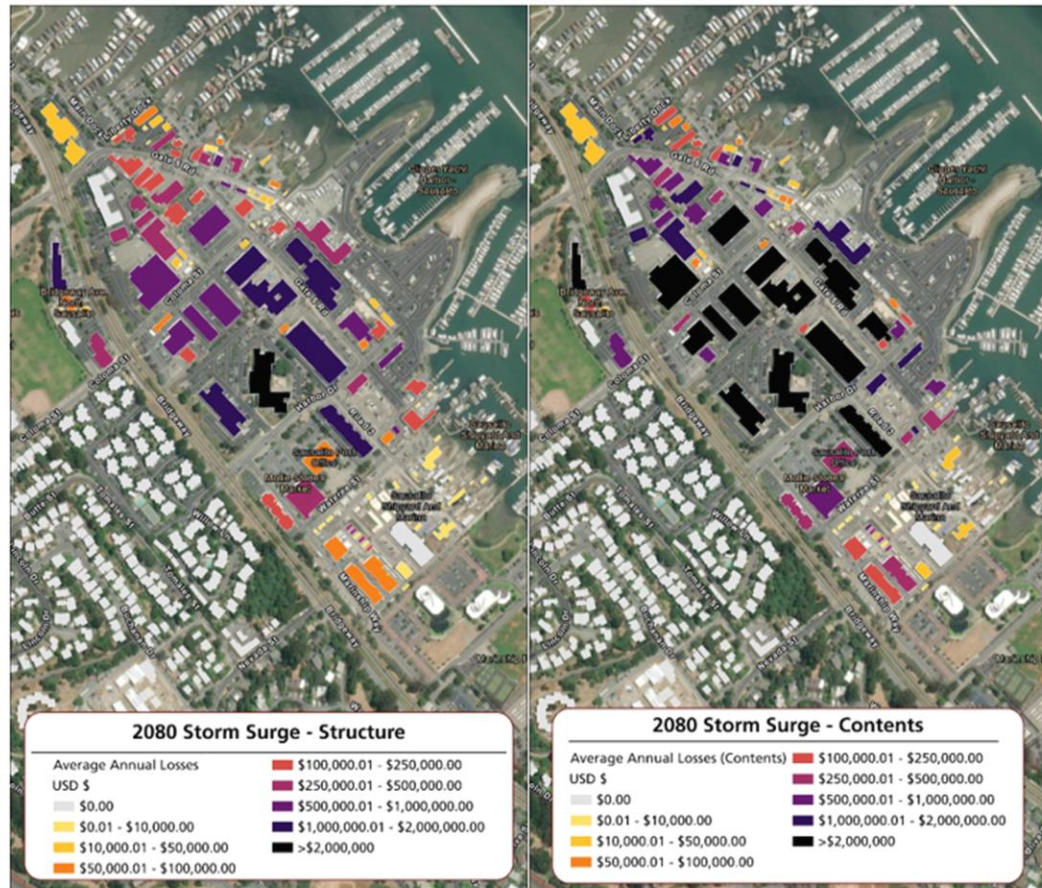


Figure 23 Average Annual Losses for Storm Surge for 2080 (undiscounted) Accounting for Losses to Buildings (Left) and Contents (Right).

This section extends the surge-only AAL results by evaluating expected flood damages over the full analysis period under a no-action ("do-nothing") scenario. Annual losses are projected through time and converted to present-value terms using selected discount rates, allowing comparison of long-term flood risk on a consistent economic basis.

3.3.1.2.1 Chronic Inundation and Trigger-Year Summary

This subsection summarizes when buildings are projected to transition into chronic inundation. Chronic inundation is defined as reaching at least 0.5 ft of flood depth above FFE during MHHW. The first year in which a building meets or exceeds this threshold is referred to as the building's trigger year. Results are presented as (1) the number of buildings entering chronic flooding in each year and (2) the cumulative number of buildings under chronic flooding over time. These outputs provide context for the lifecycle cost results by explaining years in which one-time total losses are concentrated when multiple buildings cross the threshold in the same year.

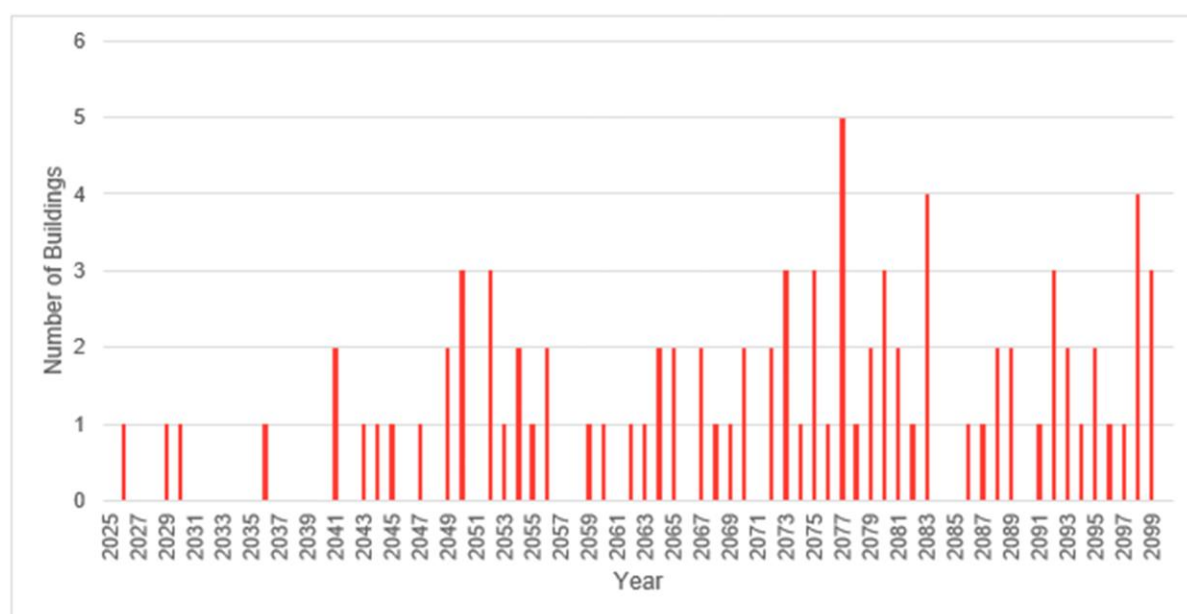


Figure 24 Buildings Entering Chronic Flooding by Year.

The annual trigger-year results show that buildings enter chronic flooding intermittently, with most years affecting a small number of buildings and occasional years in which several buildings cross the threshold (Figure 24, bars show the number of buildings that first reach ≥ 0.5 ft of flood depth above FFE in each year). The cumulative results show a steady increase in the number of buildings under chronic flooding over the analysis period, indicating that chronic inundation becomes progressively more widespread.

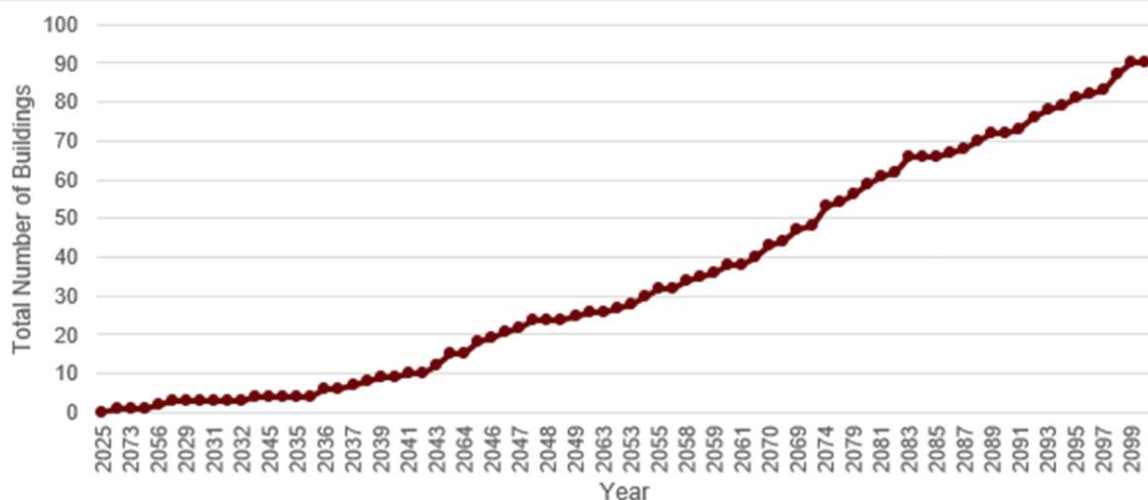


Figure 25 Cumulative Buildings Under Chronic Flooding. Cumulative count of buildings that have reached the chronic inundation threshold (≥ 0.5 ft above FFE).

To summarize when buildings are projected to enter chronic flooding, trigger years were grouped into multi-year intervals. The table below reports the number of buildings that first reach the chronic inundation threshold (≥ 0.5 ft above FFE) within each interval and the cumulative total by the end of the interval.

Table 10 Buildings Entering Chronic Flooding by Time Interval (≥ 0.5 ft above FFE), with Cumulative Total (Screened through 2100).

Year Interval	Buildings Entering Chronic Flooding	Cumulative at End of Interval
2025-2034	3	3
2035-2044	5	8
2045-2054	13	21
2055-2064	9	30
2065-2074	14	44
2075-2084	22	66
2085-2094	13	79
2095-2100	11	90
TOTAL	90	-

3.3.1.2.2 Lifecycle Risk

This section summarizes lifecycle “do-nothing” risk as the present value of expected flood losses over the 2025–2080 analysis period. Table 11 and Figure 24 show results for three discount-rate cases: undiscounted (simple sum of annual losses), 2%, and 7%.

Table 11 Present Value of Expected Flood Losses by Discount Rate.

Discount Rate	PV of Expected Building Losses	PV of Expected Contents Losses	PV of Total Expected Losses
Undiscounted	\$660,621,977	\$1,706,553,241	\$2,367,175,219
2%	\$368,416,739	\$952,048,181	\$1,320,464,920
7%	\$129,569,200	\$336,545,625	\$466,114,824

Over 2025–2080, undiscounted lifecycle losses total approximately \$2.37 billion, consisting of \$660.6 million in building (structure) losses and \$1.71 billion in contents losses. Applying discounting reduces the present value of future losses, with total lifecycle losses decreasing to approximately \$1.32 billion at a 2% discount rate and \$466.1 million at a 7% discount rate. Across all discount-rate cases, contents losses account for approximately 72% of total lifecycle losses, indicating that contents remain the dominant contributor to expected flood damages.

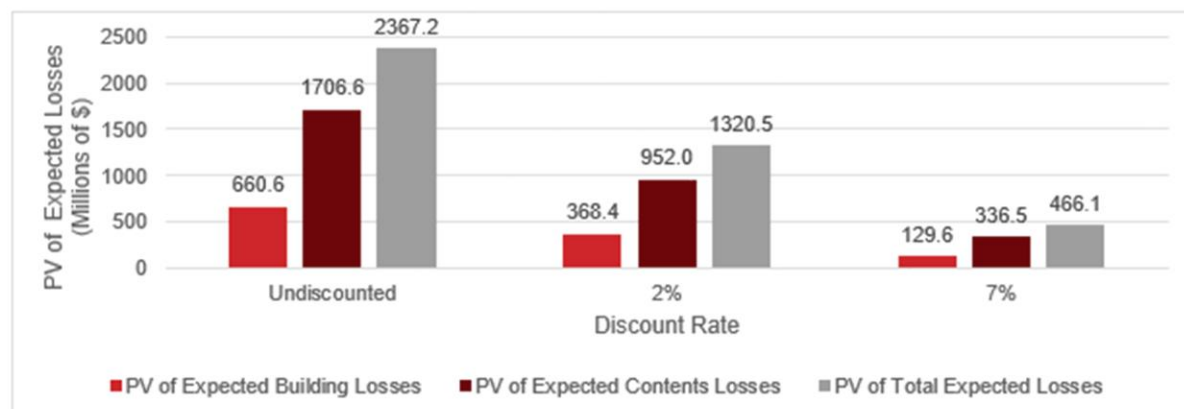


Figure 26 Present Value of Expected Flood Losses (No Action) by Discount Rate.

Figure 27 shows the estimated annual “do-nothing” costs (expected annual losses) from 2025–2080 for the undiscounted series and discounted cases (2% and 7%) for comparison. Discounting reduces the contribution of later-year damages to lifecycle present value totals and therefore lowers the discounted time series relative to the undiscounted series, particularly in the later decades.

The time series includes intermittent peaks associated with the chronic inundation trigger-year assumption: when a building first exceeds 0.5 ft above FFE, a one-time total loss is applied in that year and the building is excluded from subsequent annual loss calculations under the “do-nothing” condition. Years in which a larger number of buildings become chronically inundated show temporary spikes in annual losses, because a one-time total loss is applied when each building first crosses the threshold.

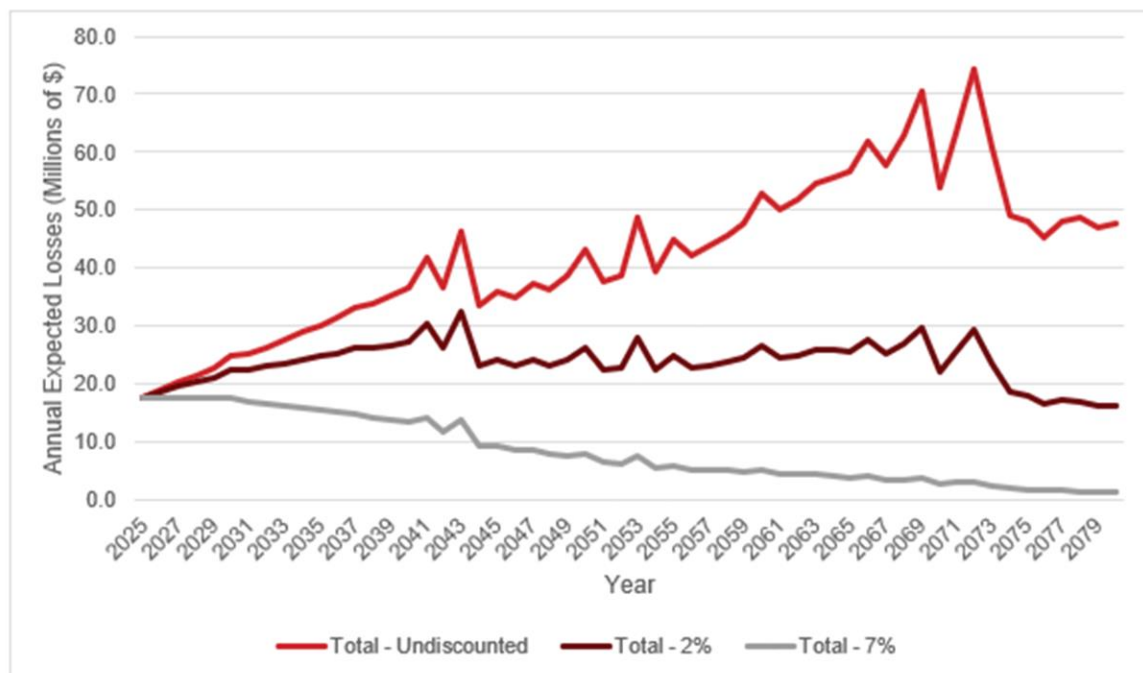


Figure 27 Do-Nothing Annual Expected Losses by Discount Rate, 2025–2080.

Discount rates are used to convert future losses to present value for lifecycle totals. Peaks reflect the chronic inundation trigger-year assumption (0.5 ft above FFE), where buildings are assigned a one-time total loss in the trigger year and excluded from subsequent annual loss calculations

3.3.2 Compound Flooding Stress Test

Results from the compound flooding stress test are summarized in Table 12 and Figure 28, which compare the surge-only baseline to conditional AAL estimates under 10-year and 100-year precipitation conditions. Conditional AAL values represent expected losses under the assumed precipitation return-period condition and are shown in Figure 28 for comparison to the surge-only baseline.

Across all analysis years, total conditional AAL remains close to the surge-only baseline, indicating that storm surge continues to drive the majority of estimated losses, with precipitation contributing an incremental increase under the stress-test assumptions.

Table 12 Total Average Annual Loss — Surge-Only Baseline vs. Compound Flooding Stress-Test (Conditional AAL).

Year	Total Average Annual Loss		
	Surge-only (baseline)	Surge + 10-yr precip (conditional)	Surge + 100-yr precip (conditional)
2025	\$17,640,142	\$18,636,480	\$20,592,813
2050	\$49,832,714	\$50,407,835	\$52,520,032
2080	\$113,703,670	\$114,381,594	\$116,833,822

In 2025, total AAL increases from \$17.6M (surge-only) to \$18.6M under the 10-year precipitation condition (+5.7%) and to \$20.6M under the 100-year condition (+16.7%). By 2050, the incremental effect is smaller in relative terms, with total AAL increasing from \$49.8M (surge-only) to \$50.4M (+1.2%) for the 10-year condition and \$52.5M (+5.4%) for the 100-year condition. In 2080, conditional total AAL increases from \$113.7M to \$114.4M (+0.6%) for the 10-year condition and to \$116.8M (+2.8%) for the 100-year condition.

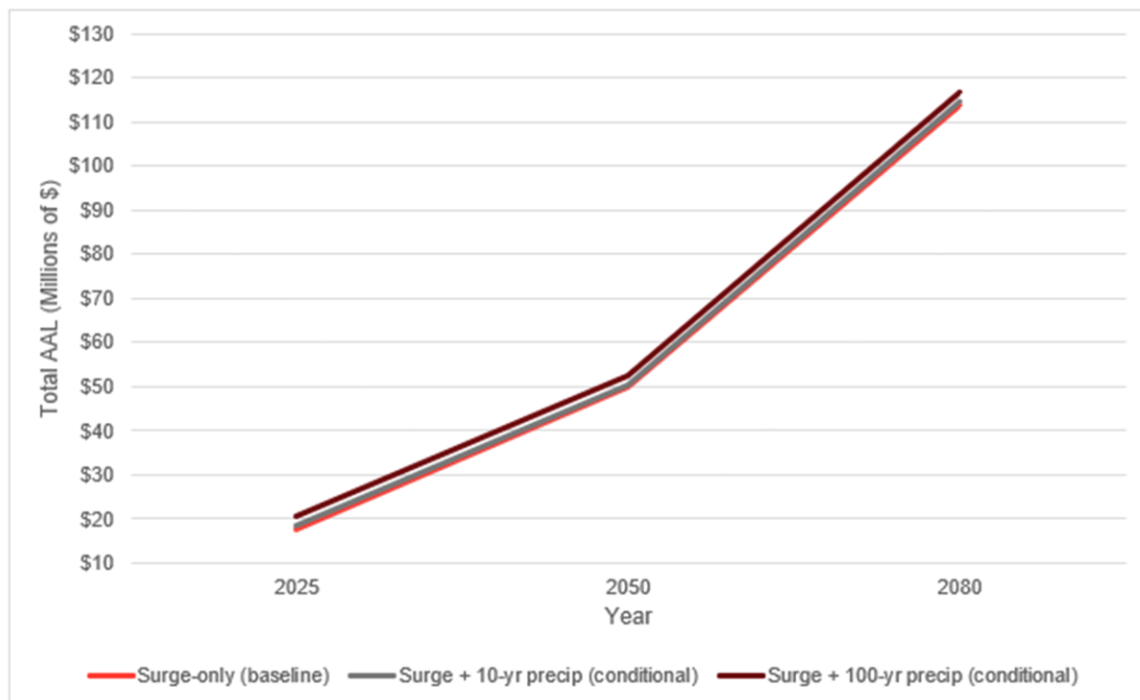


Figure 28 Total Average Annual Loss by Year — Surge-Only Baseline vs. Precipitation Stress-Test (Conditional AAL).

Losses remain dominated by contents across all scenarios and years (Table 13). Under the stress test, both buildings and contents AAL increase relative to the surge-only baseline, but the proportional increase is generally larger in earlier years and under the 100-year precipitation condition. Overall, the results suggest that while precipitation can increase losses under plausible compound conditions, the relative influence of precipitation diminishes over time as rising sea levels elevate surge-driven coastal water levels and expand surge-controlled inundation.

Table 13 Average Annual Loss by Loss Type — Surge-Only Baseline vs. Compound Flooding Stress-Test (Conditional AAL)

Year	Loss Type	Average Annual Loss		
		Surge-only (baseline)	Surge + 10-yr precip (conditional)	Surge + 100-yr precip (conditional)
2025	Buildings	\$4,919,895	\$5,209,044	\$5,990,356
	Contents	\$12,720,247	\$13,427,436	\$14,602,457
	Total	\$17,640,142	\$18,636,480	\$20,592,813
2050	Buildings	\$12,992,490	\$13,226,455	\$14,129,457
	Contents	\$36,840,224	\$37,181,380	\$38,390,576
	Total	\$49,832,714	\$50,407,835	\$52,520,032
2080	Buildings	\$29,980,442	\$30,237,344	\$31,314,297
	Contents	\$83,723,229	\$84,144,250	\$85,519,525
	Total	\$113,703,670	\$114,381,594	\$116,833,822

4. Discussion and Key Takeaways

Key takeaways from the analysis include the following:

- Coastal flood hazards account for a large majority of the flooding impacts in the study area. The projected worsening of flood conditions over time reflects the compounding effects of sea level rise and ongoing land subsidence, which lowers ground elevations and reduces freeboard over time.
- By 2050, a majority of Gate 5 Road (from Harbor Drive to about Varda Landing Road) will be inundated on a daily or near daily basis, with shallow inundation of properties on the shoreward side and directly inland from the road.
- While overland flow from Richardson Bay is not the primary source of flooding during most events under current conditions, it becomes the primary source during the 2050 1-year event and events of greater magnitude. In 2080 and 2100, overland flow occurs regularly, and most of Gate 5 Road is expected to be under water for 18 to 24 hours a day. Under the 2100 High scenario, Bridgeway Boulevard and some properties inland of Bridgeway will be inundated on a daily or near daily basis.
- In terms of building exposure, the analysis shows 10 buildings with flooding during the 1-year event under current conditions. This increases to 55 buildings during the 1-year event during 2050, with many buildings on both sides of Gate 5 Road exposed. This increases to 77 buildings during the 2080 1-year event. For the 100-year event, the number of exposed buildings is 64 under current conditions, 77 in 2050, and 110 in 2080.
- According to the analysis, there is already almost \$5 million in flood-related average annual losses to building structures in 2025 conditions. This more than doubles to almost \$13 million in 2050 and more than doubles again to almost \$30 million in 2080. Losses are much higher when building contents are considered, though content losses may be overestimated to the extent that property owners in frequently flooded areas have adapted by relocating or protecting contents prior to flood events. There are significant losses during all three timeframes on either side of Gate 5 Road. The shoreward side of the road is primarily exposed to direct overland flow from Richardson Bay as surge-driven water levels overtop low-lying coastal areas, while the inland side is primarily affected by storm drain surcharge and backflow through the stormwater network. These expected losses suggest a major potential benefit in investing in flood protection measures that would mitigate flooding on both sides of Gate 5 Road.
- Over the next 10 years (by 2035), it's expected that 3 buildings will experience over half a foot of flooding during MHHW. By 2045, that total will reach 8, and by 2055, it will reach 21. It's expected to reach 66 by 2085 and 90 by 2100.
- In aggregate, do-nothing costs from flooding are substantial, with total undiscounted losses of approximately \$2.37 billion (structures and contents), of which \$660 million correspond to building (structure) losses. Even when future losses are heavily discounted at a 7% annual discount rate, do-

nothing costs for structures are roughly \$130 million. This figure is over \$368 million with a 2% discount rate. Costs are much higher when building contents are included. Costs are slightly higher when heavy precipitation is combined with storm surge, but coastal flooding accounts for the large majority of damages.

- The high do-nothing costs point to the clear need for coordinated flood protection measures in the study area and large potential benefits of investing in this protection. Annual expected losses are projected to double around 2040. The results underscore the need for both a near-term solution that addresses sources of flooding now, but also the relatively frequent overland flooding that will occur soon in the future.
- It is important to note that the quantitative economic impacts assessed in this study are limited to direct flood damages to building structures and their contents. The analysis does not account for broader economic consequences, including lost time due to roadway disruption and closures, lost sales revenue and business interruption, indirect impacts on state and local tax revenues, or costs associated with injuries and fatalities during flood events. These unquantified impacts would further increase the total economic burden of flooding in the study area, reinforcing the case for investment in flood protection measures.

Appendix B - Community Engagement Workshop



Community Workshop Recap and Reflections

City of Sausalito Gate 5 Area Drainage Management Study

April 29, 2026

Bay Model Visitor Center





Event Summary

On April 29, 2026, the City of Sausalito hosted a community workshop for the Gate 5 Area Drainage Management Study. The event was hosted from 4:30 to 6pm at Bay Model Visitor Center, 100 Bridgeway, Sausalito, CA 94965. There were 51 attendees who signed in, plus seven WSP staff in person, one WSP staff member attending virtually, and three City staffers running the event: Sara Khorshidifard, Alexandra Anderson, and Patrick Guasco. There were 15 comments collected and 86 sticky dots placed as votes on preferences in the various table activities throughout the workshop.

The format of the event was an open house with five tables, with the overall goal to actively engage the community in a series of activities that build on each other and creates a narrative, showing the tradeoffs of different solutions for the shoreline. Each table had 1-2 WSP staff members, printed materials on the table, posterboards on easels, and an interactive activity. Although slides were displayed on a loop, no formal presentation was given. Instead, the team answered questions one-on-one at the tables in front of the visually-focused display boards and activity sheets, helping to explain technical concepts at a pace tailored to each attendee.

Tables and Activities

Table	Description	Activity
Table 1: Project Background	Participants were given information about the background of the project. They viewed posters with the project's goals and a map of the study area. Materials: Factsheets printed as handouts, blown up fact sheet on poster board, map of project area Objective: Participants understand the project scope and have an informed background to weigh-in at other tables.	What Makes Sausalito Unique? Place sticky dots on what you think makes Sausalito/Marinship unique. Provide additional details on a sticky note.
Table 2: Current and future flooding	Table had maps showing different current flood scenarios, such as flooding during a 1-year storm surge event, 10-year storm, etc. for current conditions, 2050, 2080, and 2100. Other exhibits showed the costs of building damages, where flooding is coming from, and how the City is currently dealing with flooding. Objective: The project team has a detailed picture of where flooding is occurring and how it affects community members. Guests	Describe Your Flooding Large map of flooding on January 2, 2026, available on the table. Guests invited to place sticky dots on the current conditions maps if they experience flooding at areas outside of what is shown in the maps (from modeling). Comment cards were available to provide more details on the



	understand where the flooding is coming from and the costs of doing nothing under future flood scenarios.	flooding they experience. These comments will be used to inform and refine the assumptions in modeling.
Table 3: Potential Near-Term Solutions	Provided materials explaining what pump stations and tide gates are and how they work. Simple drawings showed how these function during high and low tides. A map of a possible pump station and tide gate locations were shown. Exhibits showed how a pump station placed on the canal would look and example designs of pump stations. Objective: The public has an understanding of near-term solutions and how they work. The project team has a clearer understanding of which solutions are most popular.	Evaluate Potential Near-Term Solutions Large table of potential near-term solutions on table, with handouts to show evaluation criteria. Place a sticky dot next to each option based on your level of support. Provide additional details on a sticky note.
Table 4: Potential Mid- and Long-Term Solutions	Provided simple drawings of proposed concept designs for future flooding/sea level rise. These did not show specific locations or properties; disclaimers were provided that the displays are for planning only. Solutions shown included potential vertical elements (road raising, seawalls, etc.). Showed how green infrastructure works. Objective: The public has an understanding of longer-term solutions and how they work. The project team has a clearer understanding of which solutions are most popular.	Evaluate Potential Mid- and Long-Term Solutions Large table of potential near-term solutions on table, with handouts to show evaluation criteria. Place a sticky dot next to each option based on your level of support. Provide additional details on a sticky note. Ask an engineer: Get technical questions answered by an engineer. WSP engineer available virtually.
Table 5: Surveys and Feedback	Provided preliminary survey results. Had some surveys printed for people to take, as well as evaluation surveys and comment cards. Objective: Encouraged guests to take the survey.	Take Evaluation and Community Surveys Complete the community survey, evaluation survey, and general comments.

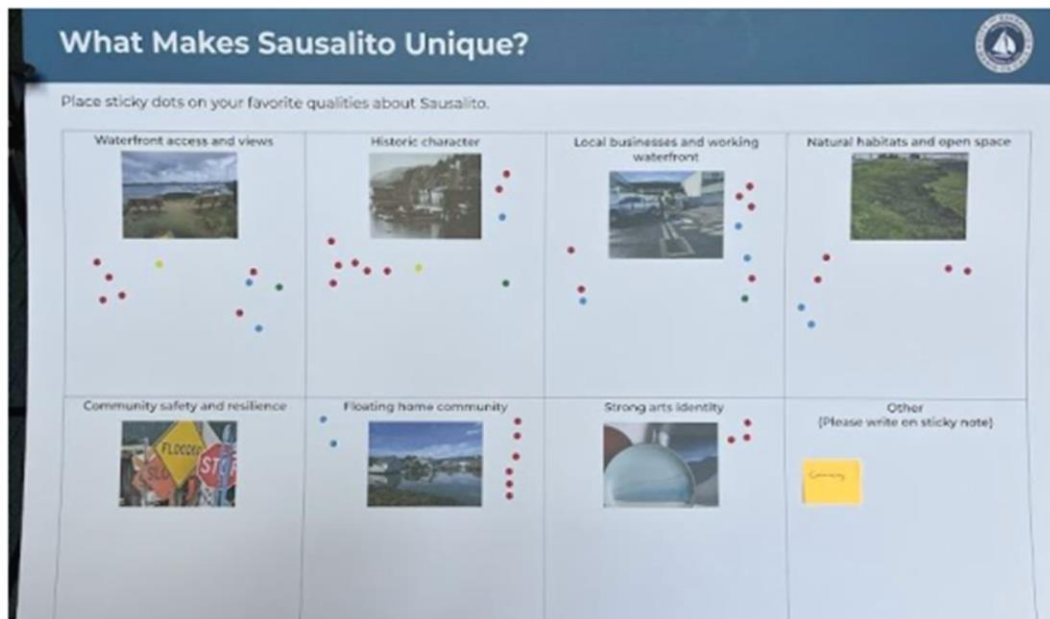


Table 1: Project Background

At Table 1, guests were given a fact sheet with an overview of the project. Key terms were defined on the table, and a map of the project area was shown. Guests were asked to rank their favorite qualities that make Sausalito unique. There were 49 dots left on the board, with 22% of respondents saying they valued the City's historic character, 20% choosing waterfront access and the working waterfront each, 16% choosing the floating homes community, and 12% choosing natural habitats and open space.



Table 1 had fact sheets and a project map showing the general directions of flooding into the project area.



Guests were invited to place sticky dots on their favorite Sausalito qualities. One person added "community" in bottom right.



Table 2: Current and Future Flooding

On Table 2, guests were asked to place sticky dots on a map if they experienced flooding outside the blue area on January 2, 2026. However, one resident pointed out that Varda Landing and Clipper Yacht Club did not flood, and circled the area where flooding did not occur. The guest added that there is a short seawall at Varda Landing already that is not shown in the maps.



A map displayed on Table 2 encouraged guests to point out where they experienced flooding on January 2. One guest circled the area that did not flood.



A posterboard at Table 2 showed where flooding is coming from under current conditions.

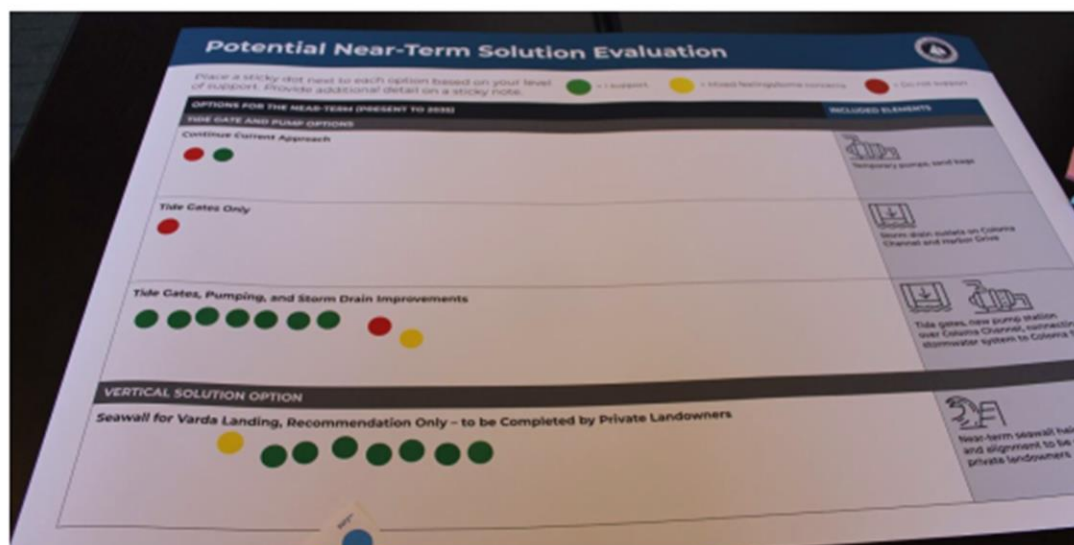


Table 3: Near-Term Solutions

At Table 3, guests were given information about tide gates and pump stations and were asked to provide feedback about which near term solutions they preferred. One goal of the table was to explain the need for both tide gates and pump stations, and based on the popularity of those solutions together (seven people voting in favor), it appears that many people were able to learn about how these solutions work. A near-term seawall for Varda Landing also proved to be a popular choice, with seven people voting in favor of that solution as well.



Two WSP project leads explained tide gates and pump stations at Table 3.



Guests voted on their preferred near-term solutions at Table 3, with tide gates and pump stations together proving to be a popular combination.

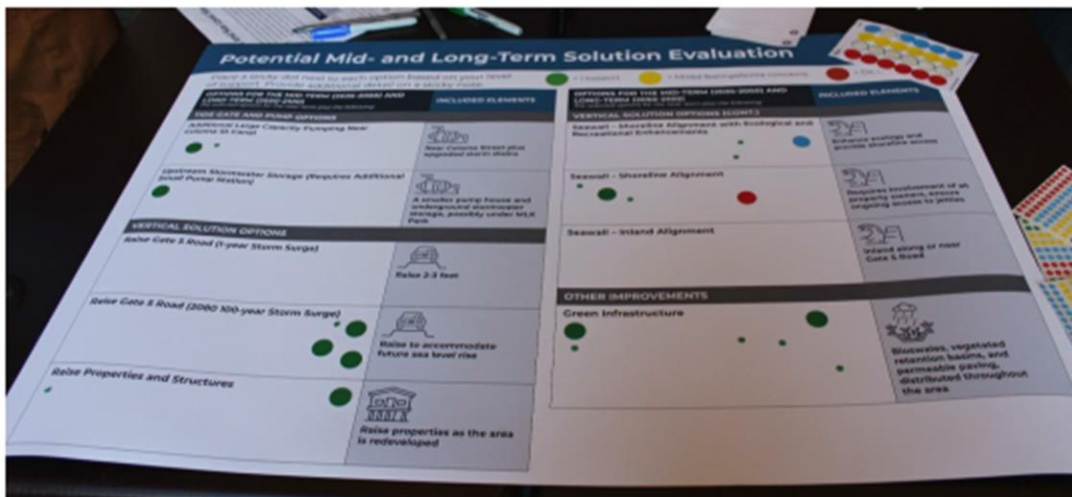


Table 4: Mid- and Long-Term Solutions

The voting activity on Table 4 was similar to Table 3, but the most popular solutions were green infrastructure and road raising. However, the information on the boards described the limited effectiveness of these solutions. Directly across from Tables 3 and 4, guests could speak with WSP engineer Eric Slauch virtually to answer more complex technical questions, which proved to be a popular aspect of the workshop.



There were many boards at Table 4 to visit, including information on sea walls, road raising, and longer term pumping and stormwater capture. Guests could also speak with an engineer virtually at a small table across from Tables 3 and 4.



Of all the solutions available to vote on, six people were in favor of green infrastructure, four were in favor of road raising, and three were in favor of a seawall along the shoreline.



Table 5: Surveys and Feedback

As guests were leaving, they were asked to take an evaluation survey to describe how much they learned from the event. They were also encouraged to take the community survey (if they hadn't already) either by scanning a QR code or filling out printed versions of the survey. Preliminary survey results were displayed on the table.



A WSP staff member encouraged guests to take surveys as they were leaving the event.

Summary of Feedback

Several key themes emerged from the conversations had at the event.

Strong Concern for Near-Term Flooding, Particularly at Varda Landing

Almost everyone expressed their concern about flooding within the project area and wanted immediate action. Many guests recounted their experiences with flooding, including damage to their vehicles. People were particularly concerned about the flooding at Varda Landing, and a near-term solution for Varda Landing (a seawall proposed at Table 3) was a popular proposal. A few people also suggested raising the Varda Landing area or the road leading to it. In addition, a few people commented that they wished for Gate 5 Road to be re-paved and repaired to improve the existing experience driving on the road.

Support for Nature-Based Solutions and Stormwater Storage

Many participants expressed enthusiasm for greener or more creative approaches. Suggestions included vegetated basins and oyster-based protection. Some guests expressed concern about placing a pump station over Coloma Canal and placing tide gates at the shoreline; they preferred having these features inland to avoid damaging shoreline and canal habitats. A few guests also expressed their support for stormwater storage basins.



Concerns about Costs and Funding Mechanisms

Participants repeatedly asked about the financial implications of different strategies. Questions focused on the cost of intermediate solutions (e.g., short seawalls, road raising) and long-term investments. Participants proposed potential funding tools such as bonds or tax districts.

Desire for Multi-Jurisdictional Approaches

Participants emphasized that Sausalito cannot solve flooding alone. People pointed to flooding in Marin City, including along the bike trail and at Target, arguing that solutions must be coordinated across jurisdictions to avoid simply shifting risk. They are concerned that only addressing flooding in small areas would leave Sausalito vulnerable to flooding from overland flows from unprotected areas. One guest suggested putting a flood gate across the Golden Gate Bridge to prevent high tides from impacting all communities along the Bay. Guests clearly understood the need for public-private partnerships, with many expressing their willingness to help and work with one another.

Stressing the Importance of Explaining Technical Solutions

At first, many guests did not understand how tide gates and pump stations worked. WSP staff used the diagrams on the posterboards to explain why both are needed to work in tandem. Guests originally thought that seawater pumped back into the Bay would continue flooding lowland areas; WSP staff carefully explained that tide gates help prevent tidal backflow. At Table 3, several guests liked the pump stations shown from other areas, particularly the glass pump house. People were also concerned that seawalls would leave certain areas unprotected or could cause seawater to come underneath and emerge inland. Staff acknowledged that seawalls would need to be connected to each other or to raised roads across jurisdictions for maximum effectiveness.

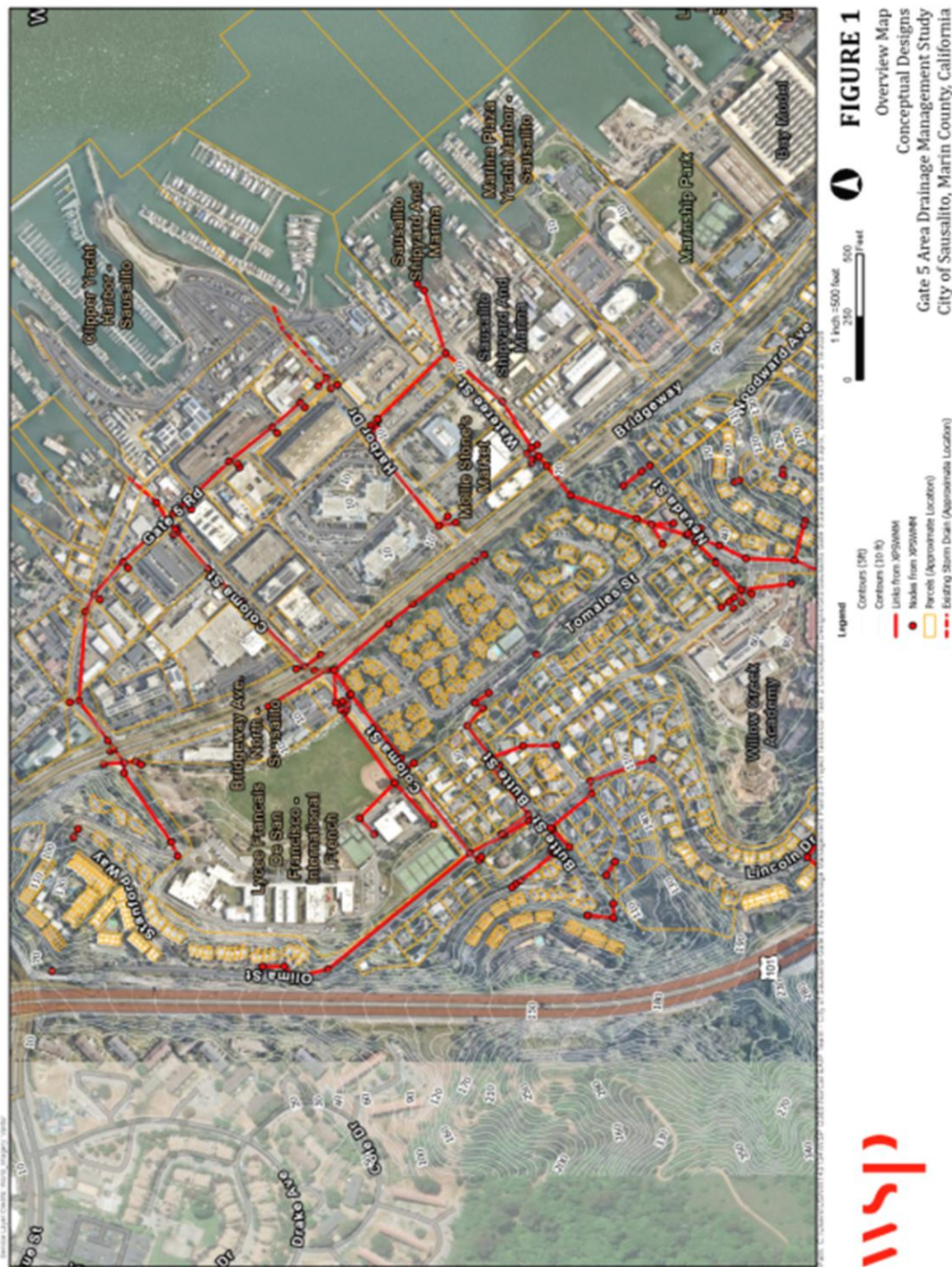
Costs of Doing Nothing, Redevelopment, and Managed Retreat

Some guests expressed skepticism that any engineered solution could relieve flooding, and some added that they had already moved out of the floodplain. Some were concerned about being forced out of the area and expressed concern about high-rise construction. Many acknowledged the need to move off the ground floor and redevelop the entire area.

Next steps

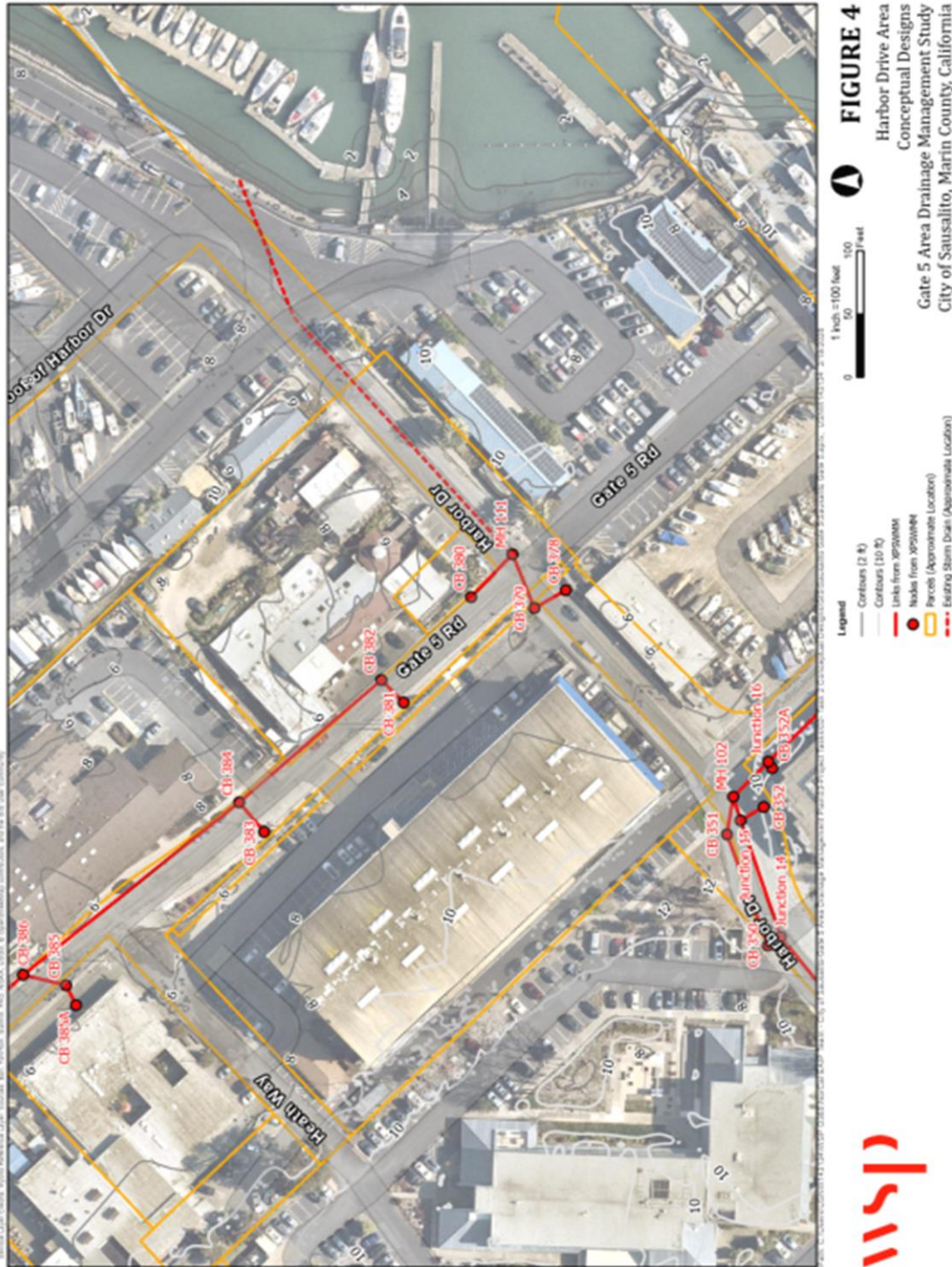
Participant input provided during the community workshop will be reviewed by the engineering teams as the planning and design stages progress. This input will inform the conceptual designs specifically for the near, mid and long-term solutions and ultimately be summarized in the Implementation Report that will be presented at two Council meetings this year. Other stakeholder engagements will also continue throughout the project, including information updates via the project website, newsletters, and emails to the stakeholder list.

Appendix C - Storm Drain Model Maps













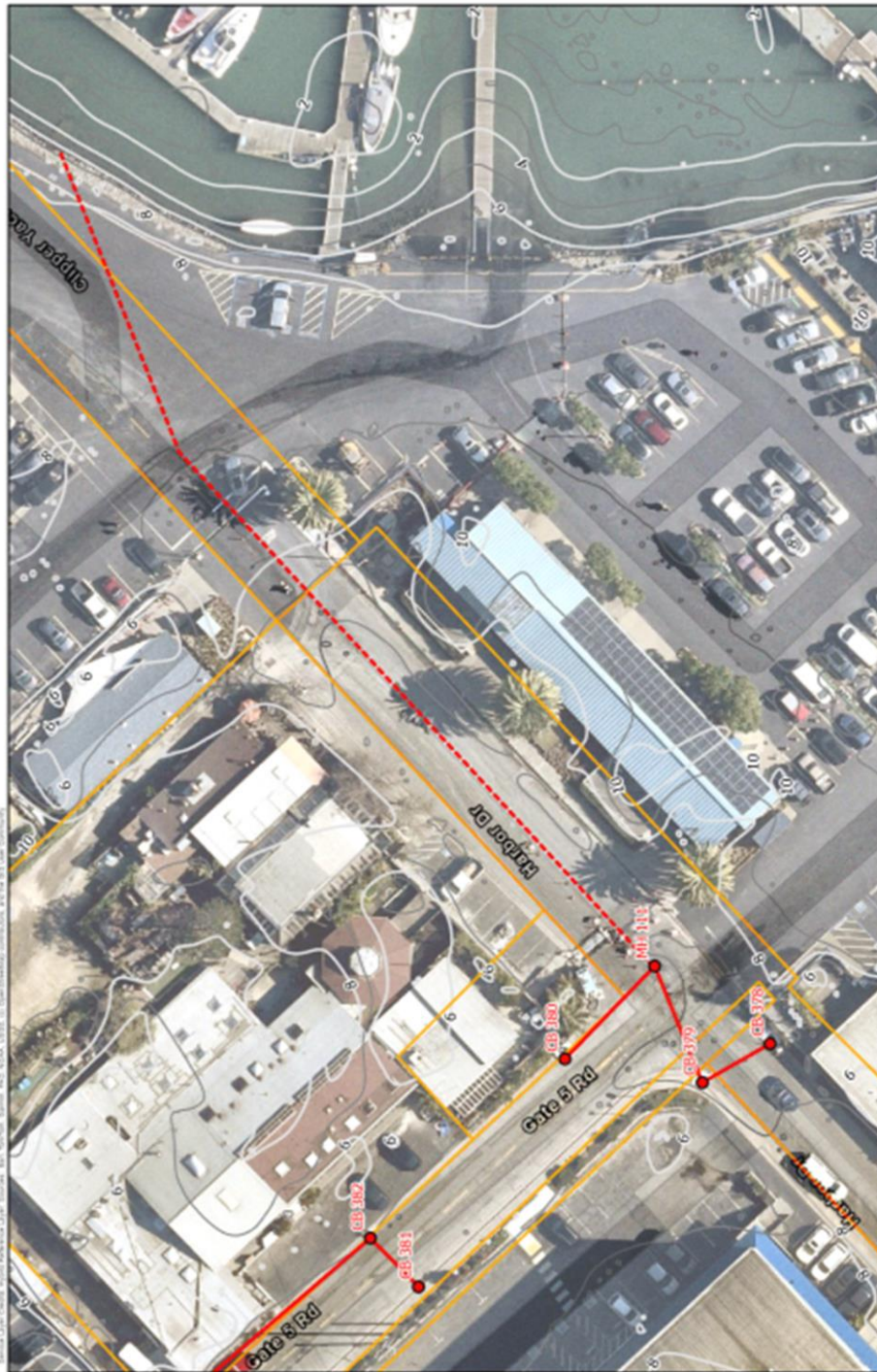
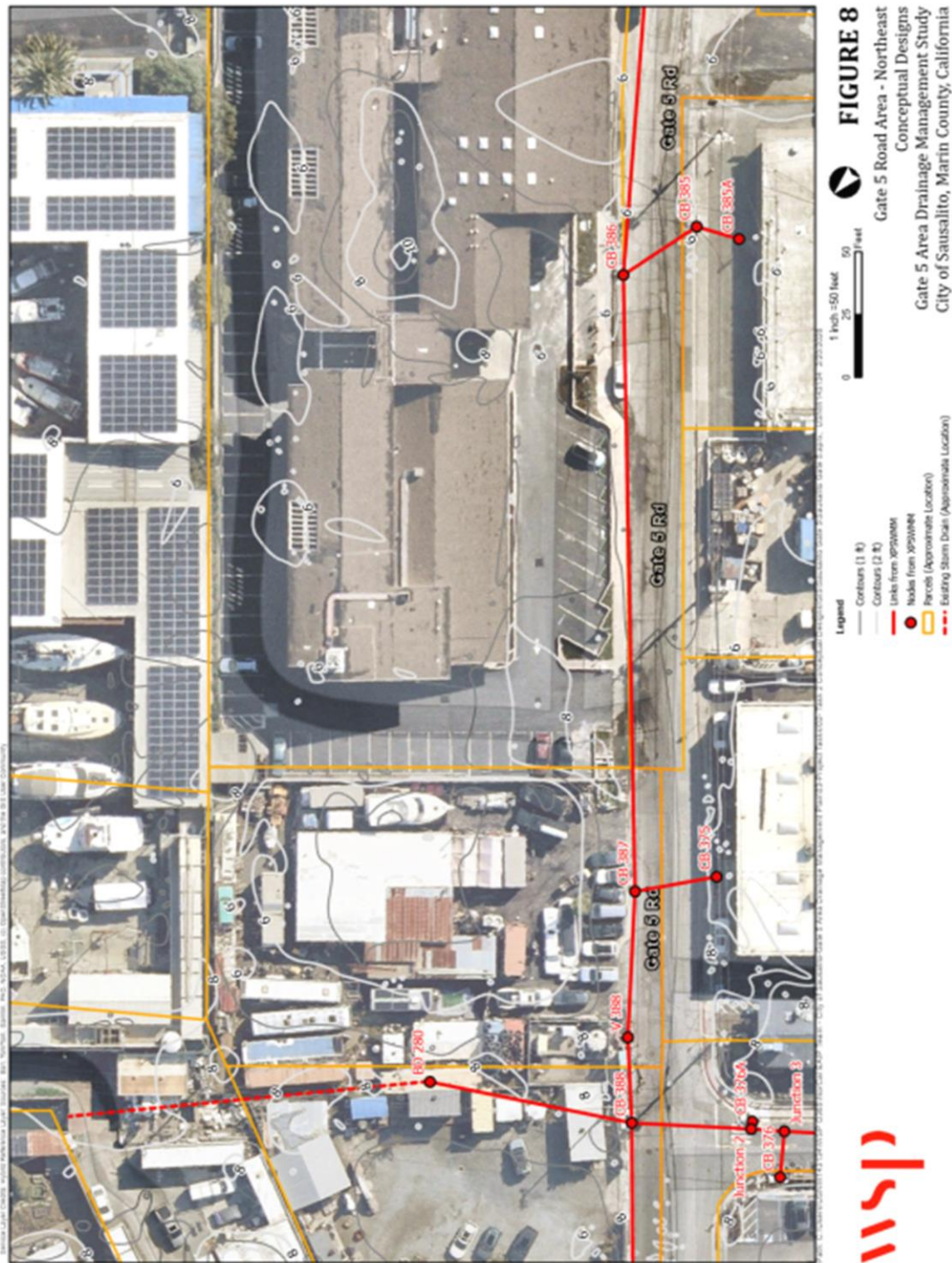
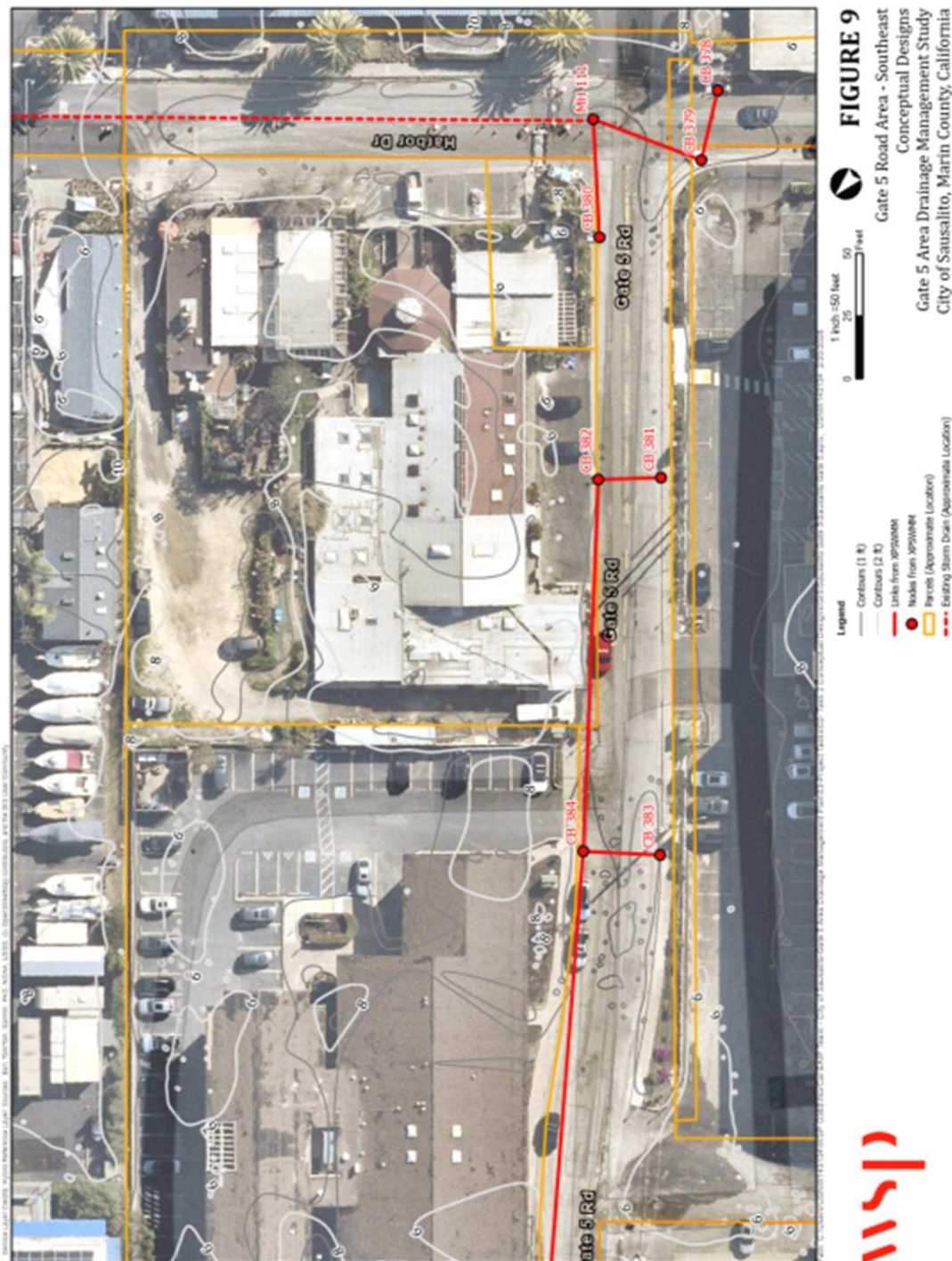


FIGURE 7
Harbor Drive and Gate 5 Road Area
Conceptual Designs
Gate 5 Area Drainage Management Study
City of Sausalito, Marin County, California





WSD

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