



# Larkspur Ferry Terminal Sea Level Rise Impact Assessment

Larkspur Ferry Service Expansion and Parking Project

Golden Gate Bridge, Highway and Transportation District



October 6, 2026

## Executive Summary

### Introduction

The Larkspur Ferry Terminal (LFT) is a coastal facility vulnerable to sea level rise (SLR). Consistent with the typical requirements of environmental reviews, state funding programs, infrastructure planning processes, and permitting, the Golden Gate Bridge, Highway and Transportation District (District) commissioned Jacobs to perform this assessment to evaluate the impacts of SLR on the LFT as a part of the Larkspur Ferry Service Expansion and Parking Project (Project).

The SLR impact assessment included the following tasks:

- Task 1 – Collection and Analysis of Information
- Task 2 – Site Visit
- Task 3 – Hazard Identification
- Task 4 – Vulnerability Assessment
- Task 5 – Risk Assessment and Adaptation Plan

Information reviewed, collected, and analyzed included:

- State of California Sea Level Rise Planning Guidance 2024 from the Ocean Protection Council (OPC 2024)
- A 1-meter resolution Digital Elevation Model (DEM) of the LFT and surrounding areas provided by the National Oceanic and Atmospheric Administration (NOAA) (NOAA 2025a)
- Tidal datums from NOAA station 9414863 Richmond (NOAA 2025b)
- 100-year total water level (TWL) data from NOAA station 9414290 San Francisco (NOAA 2025b)
- The Bay Area Conservation and Development Commission Shoreline Vulnerability Index (BCDC 2021)

Voids of information were filled with assumptions based on standard engineering practice and experience on similar projects.

### Site Visit

A site visit was conducted on January 14, 2026, to assess the overall condition of the LFT, inspect shoreline structures and assets, and identify potential floodwater breaching points and pathways and potential flooding areas. The visit included a walk-through, visual inspection of the LFT perimeter and waterfront structures, photo and video recording, and rudimentary measurements. Interviews with District staff were conducted to learn about the history, condition, expected service life, maintenance, and improvement plans of the facilities and waterfront structures, as well as accounts of high-water level and flooding events and their consequences. Figure ES-1 shows an aerial view of the LFT, key locations, and perimeter inspected.



**Figure ES-1. Aerial view of the Larkspur Ferry Terminal, key locations and perimeter inspected (image source: Google Earth Landsat/Copernicus)**

The perimeter inspection started at Berths 2 and 3 and proceeded counterclockwise along a paved pathway that forks toward a pedestrian bridge over East Sir Francis Drake Boulevard (SFD Boulevard) and an undeveloped, low elevation area vulnerable to flooding. Moving west along the SFD Boulevard and onto a bike path, the inspection noted an unnamed Creek, equipped with gates at the SFD Boulevard to prevent upstream high-water propagation. In the relatively low and vulnerable southwest corner, a 4-foot engineered concrete levee surrounds four Fuel Tanks, while the Butler Building, Hazardous Materials (HazMat) Locker, and Backup Generator are elevated on concrete pads above grade. Continuing east along the southern boundary, a low vegetated berm separates the LFT from the marsh and Corte Madera Creek, where an underground stormwater outfall provides a floodwater pathway to the main parking lot. The inspection ended at the Administration Building.

To identify potential floodwater breaching points and pathways, an accurate representation of the LFT's topography was required. To verify the accuracy of the existing National Oceanic and Atmospheric Administration's (NOAA's) Digital Elevation Model (DEM), elevation measurements were taken and referenced to North American Vertical Datum 1988 (NAVD88) using NOAA station 9414863 Richmond tidal data (NOAA 2025b). Additionally, photos taken by District staff during the extreme high tide event of January 2 to 4, 2026, were analyzed for further verification. Because both the physical measurements and the extent of flooding visible in the photos correlated well with the NOAA DEM, the NOAA DEM was adopted for the assessment.

## Hazard Identification

Hazards can affect the LFT in diverse ways. For example, there may be physical, operational, business, and environmental impacts. In this assessment, only physical and operational impacts were considered, such as flooding of terminal facilities, damage to structures and mechanical or electrical equipment, and service interruptions.

Hazard identification involves describing the coastal processes and conditions that may adversely affect the LFT's assets and operations. SLR is understood as a long-term driver that increases baseline water

levels and amplifies the effects of coastal hazards. The primary hazard affecting the LFT is coastal flooding. Episodic flooding may occur during extreme high-water levels caused by the combined effects of tides, storm surge, waves, tsunamis, and El Niño. Over the long term, SLR may result in permanent inundation of low-lying areas.

Wave runup and overtopping are negligible and not a hazard to the LFT. Wind records at NOAA station TIBC1 Tiburon Pier (NOAA 2025c) from May 2006 to October 2024 (595,323 15-minute observations) show that winds blow from the LFT's most exposed direction (120 to 130 degrees, which has an approximately 12-mile fetch to the southeast), about 5% of the time. For winds blowing from this exposed direction, these winds are less than 12 knots 92% of the time, generating waves at the LFT smaller than 1 foot high and negligible wind setup. Vessels transit at low speeds and produce minimal or no wakes. Tsunamis are also not considered a potential hazard. The measured water levels at NOAA station 9414863 Richmond (NOAA 2025b) due to the Tohoku Oki tsunami produced an elevation of the water level of about 1 foot above the predicted astronomical tide, and the simultaneous occurrence of tsunamis with extreme high-water levels is unlikely.

A relevant hazard to the LFT is the future extreme TWL resulting from SLR (an unusually high or low coastal water height caused by rare or severe events like king tides, storms, and heavy winds). These were estimated by combining the current 100-year TWL of 8.60 feet NAVD88 (derived from NOAA station 9414290 San Francisco [NOAA 2025b]) with SLR projections for five different risk aversion scenarios (OPC 2024). Figure ES-2 shows the TWLs for the five risk aversion scenarios for years 2020 through 2100.

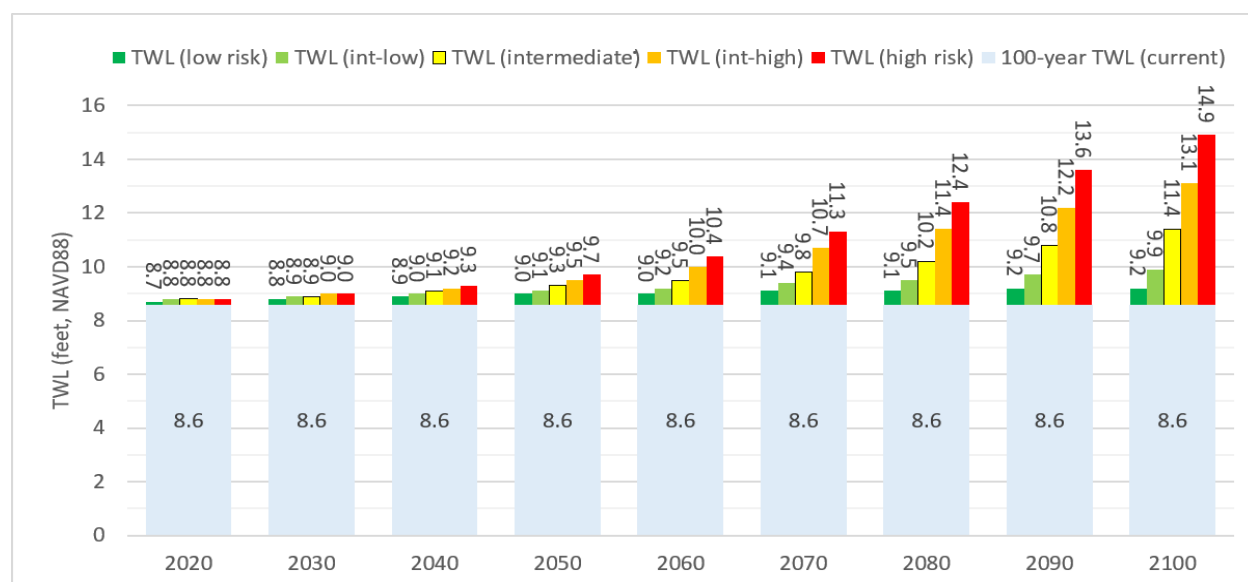


Figure ES-2. TWLs for the five risk aversion scenarios for years 2020 through 2100

Since the LFT is bordered by the Corte Madera Creek along its waterfront and lacks cut-off walls or other subsurface barriers, long-term groundwater emergence is expected to be primarily controlled by the mean sea level (MSL), rising progressively in response to SLR. In the short term, however, transient events such as extreme high tides and intense rainfall may temporarily elevate groundwater levels (GLs) above the MSL. But these elevated GLs are expected to dissipate relatively quickly, returning to pre-event conditions as these transient events recede.

Therefore, flooding due to long-term GL induced by SLR constitutes a hazard. This was estimated by combining the current MSL of 3.3 feet NAVD88 with the SLR projections. Figure ES-3 shows the GLs for the low, intermediate, and high risk aversion scenarios for years 2020 through 2100.

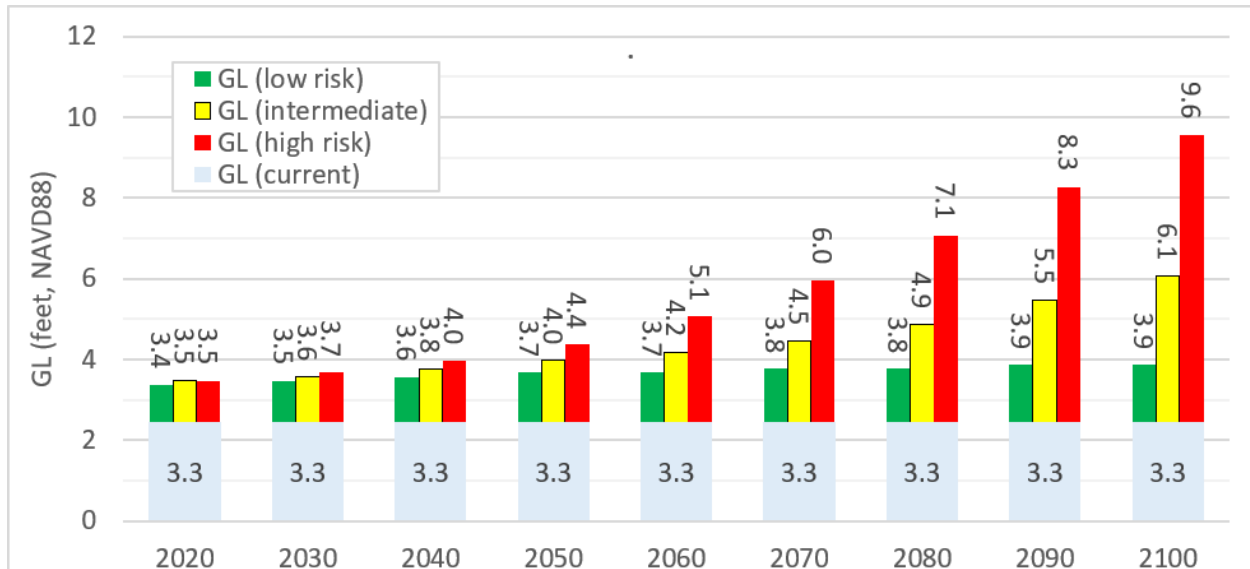


Figure ES-3. Groundwater Levels for the low, intermediate and high-risk aversion scenarios for years 2020 through 2100

## Vulnerability Assessment

The LFT was divided into eight areas, where each area shares similar physical and operational conditions, asset types, levels of criticality, and adaptive capacities. Figure ES-4 shows the areas selected for the assessment.



Figure ES-4. Areas selected for the assessment (image source: Google Earth Vexcel Imaging US Inc.)

Despite not being on the waterfront, the SFD Boulevard is vulnerable to high TWL flooding and is a pathway to LFT flooding. The paved (i.e., asphalt- and concrete-surfaced) area, including the main parking lot, roadways, pathways, bike paths, walkways, and the planned Main Lot Parking Garage Structure (Main Lot Garage), could be vulnerable to flooding due to groundwater emergence.

For the identified high TWL flooding and groundwater emergence flooding hazards, the vulnerability of each area was assessed using the following methodology:

- High TWL flooding:
  - Identify floodwater breaching point elevation in the NOAA DEM, i.e., the lowest elevation in the area.
  - Select risk aversion scenario to define SLR projection based on site conditions, consequences of flooding, adaptive capacity, exposure to high TWL, LFT lifespan, and other criteria.
  - Delineate floodwater pathways and flood map derived from the NOAA DEM.
  - Cross-reference breaching point elevation with the sum of the current 100-year TWL and the projected SLR for the selected risk aversion scenario. This determined the ultimate horizon year by which adaptation measures must be fully operational, establishing a reverse-engineered timeline for project planning, design, permitting, funding, and construction.
- Groundwater emergence flooding:
  - Select risk aversion scenario to define SLR projection based on site conditions, consequences of flooding, adaptive capacity, exposure to groundwater emergence, LFT lifespan, and other criteria.
  - Define projected long-term GL due to SLR combining the current MSL at NOAA station 9414863 Richmond (NOAA 2025b) with the risk aversion scenario SLR projection.

- Define groundwater emergence by subtracting the projected long-term GL from the ground elevations in the NOAA DEM.

Table ES-1 lists the LFT areas and selected risk aversion scenarios.

**Table ES-1. Larkspur Ferry Terminal areas and selected risk aversion scenarios**

| Area               | Risk Aversion Scenario |
|--------------------|------------------------|
| LFT Buildings      | High                   |
| Undeveloped        | Low                    |
| East SFD Boulevard | Intermediate           |
| Creek              | Intermediate           |
| Fuel Tanks         | Intermediate           |
| Butler Building    | Intermediate           |
| Marsh              | Intermediate           |
| Paved              | High                   |

Table ES-2 lists the areas ordered from the earliest to the latest, when the breaching points in each area are expected to be exceeded by the projected TWLs for the selected risk aversion scenarios.

**Table ES-2. Years when the projected TWLs for the selected risk aversion scenarios would exceed the breaching points in each area**

| Years     | Area               | Breaching Point Elevation (feet NAVD88) | Risk Aversion Scenario | Projected TWL (feet NAVD88) |
|-----------|--------------------|-----------------------------------------|------------------------|-----------------------------|
| 2020-2030 | Butler Building    | 7.7                                     | Intermediate           | 8.8 – 8.9                   |
| 2020-2030 | Creek              | 8.4                                     | Intermediate           | 8.8 – 8.9                   |
| 2020-2030 | Undeveloped        | 8.5                                     | Low                    | 8.7 – 8.8                   |
| 2040-2050 | Marsh              | 9.2                                     | Intermediate           | 9.1 – 9.3                   |
| 2060-2070 | Fuel Tanks         | 9.7                                     | Intermediate           | 9.5 – 9.8                   |
| 2060-2070 | LFT Buildings      | 11.2                                    | High                   | 10.4 – 11.3                 |
| 2070-2080 | East SFD Boulevard | 9.8                                     | Intermediate           | 9.8 – 10.2                  |

The Paved area is vulnerable to groundwater emergence flooding. It includes the existing main parking lot, roadways, pathways, bike paths, and walkways, which are critical to LFT operations. No practical or cost-effective solutions are available to prevent flooding caused by groundwater emergence, as groundwater can surface through pavement cracks, edges, drainage structures, and utility vaults, rendering conventional flood prevention largely ineffective. Therefore, the high-risk aversion scenario was selected for the Paved area.

The assessment showed that, in the Paved area and for the high-risk scenario, no groundwater would emerge before the year 2080. However, groundwater is expected to emerge within the fuel tank containment area between 2070 and 2080. Additionally, the assessment showed that if the first floor of the Main Lot Garage is built at the current ground elevation, long-term GLs within the perimeter of the Main Lot Garage in the southern area would be 1 to 2 feet below ground level (BGL) by 2080 and within 1 foot or at the ground level by 2090, and groundwater would emerge by 2100.

Table ES-3 lists the current MSL, high risk aversion scenario SLR projections and GLs for years 2080 through 2100.

**Table ES-3. Current MSL, high risk aversion scenario SLR projections and GLs for years 2080 through 2100**

| Year | MSL<br>(feet NAVD88) | SLR<br>(feet NAVD88) | Groundwater Level<br>(feet NAVD88) |
|------|----------------------|----------------------|------------------------------------|
| 2080 | 3.3                  | 3.8                  | 7.1                                |
| 2090 | 3.3                  | 5.0                  | 8.3                                |
| 2100 | 3.3                  | 6.3                  | 9.6                                |

## Risk Assessment and Adaptation Plan

The risk assessment complemented the vulnerability assessment by evaluating the significance of the vulnerabilities based on the likelihood of the flood hazards and their potential consequences, providing a basis for prioritizing areas and allocating resources.

The risk assessment was performed using the PIANC (2020) risk assessment matrix and based on qualitative ratings of likelihood and consequences. Likelihood ratings were assigned from Rare (1) for the high-risk aversion scenario to Almost Certain (5) for the low risk aversion scenario. Consequence ratings ranged from Insignificant (1) to Severe (5), based on the presence of critical assets and potential operational disruptions. According to the risk assessment, the following actions are recommended

- High Risk Level: East SFD Boulevard, Fuel Tanks and Butler Building areas: adaptation required as a high priority.
- Moderate Risk Level: LFT Buildings, Undeveloped, Creek, Marsh and Paved areas: adaptation required within existing asset management (maintenance, repair, rehabilitation, and replacement) cycles.

A phased approach to SLR adaptation planning at the LFT is recommended, including considerations for the Main Lot parking garage. A phased approach aligns adaptation investments with projected vulnerability timeframes, avoiding over-investment too early. It allows costs to be distributed over time, incorporates adaptive management principles as SLR projections are subject to uncertainty, and provides opportunities to integrate adaptation measures with existing asset management cycles. General adaptation measures considered feasible include floodwalls (I or T-type walls), gates, ramps, and elevating existing levees, provided they do not encroach into the Corte Madera Creek. Conclusions and recommendations include considerations for the Main Lot parking garage (12.c in the following list).

## Conclusions

The following conclusions were made:

1. The site visit was very beneficial. It allowed for gaining first-hand knowledge about the characteristics and condition of the LFT waterfront and the impact of the high TWLs of January 2 to 4, 2026, and allowed the team to perform spot elevation measurements to verify the NOAA DEM.
2. The NOAA DEM showed good agreement with the spot elevation measurements and was adopted for the identification of potential floodwater breaching points and pathways and flooding areas for the different SLR projections selected.
3. High TWLs flooding and groundwater emergence flooding were identified as the principal hazards.

4. The LFT was divided into eight areas, where each area shares similar physical and operational conditions, asset types, levels of criticality, and adaptive capacities. These were the LFT Buildings, Undeveloped, East SFD Boulevard, Creek, Fuel Tanks, Butler Building, Marsh, and Paved areas.
5. For the waterfront areas, floodwater breaching point (lowest) elevations were identified, risk aversion scenarios and SLR projections were selected, floodwater pathways and flood maps delineated and ultimate horizon years by which adaptation measures must be fully operational were determined.
6. For the Paved area within the LFT, a risk aversion scenario and SLR projections were selected, projected long-term GLs and groundwater emergence locations and years were defined.
7. The vulnerability assessment showed that:
  - a. The Butler Building, the Undeveloped and Marsh areas are currently vulnerable to high TWL flooding.
  - b. Adaptation measures for high TWL flooding will be needed in the:
    - i. Marsh area by 2040 – 2050 (southern area of the LFT : main parking lot, road and utility vaults)
    - ii. Fuel Tanks area by 2060 – 2070 (fuel tanks and pipelines)
    - iii. LFT Buildings area by 2060 – 2070 (buildings, passenger and ferry boarding areas, and utility vaults)
    - iv. East SFD Boulevard area by 2070 – 2080 (roads, main parking lot and utility vaults)
  - c. Adaptation measures for groundwater emergence flooding will be needed in the:
    - i. Fuel Tanks area by 2080 (containment area)
    - ii. Butler Building, Marsh, Paved areas by 2090 (employee and main [south] parking lots, bike path, and utility vaults)
    - iii. Paved area by 2100 (main parking lot [north], and Main Lot Garage)
8. The risk assessment complemented the vulnerability assessment by evaluating the significance of the vulnerabilities based on the likelihood of the flood hazards and their potential consequences, providing a basis for prioritizing areas and adaptation measures and allocating resources.
9. Based on qualitative ratings of likelihood and consequences, the risk assessment showed that:
  - a. The East SFD Boulevard, Fuel Tanks and Butler Building are areas at high risk, and adaptation is recommended as a high priority.
  - b. The LFT Buildings, Undeveloped, Creek, Marsh and Paved are areas at moderate risk, and adaptation within existing asset management cycles is recommended.
10. While a vulnerability assessment may indicate that an asset will not be exposed until a time far into the future, the risk assessment may identify that asset as a high priority because of its critical physical and operational characteristics, the severe consequences if impacted by the hazard, and/or the long lead time required to develop the adaptation measure. This does not necessarily imply that a particular adaptation measure should be implemented immediately. Rather, it indicates that

immediate actions (planning, design, etc.) are warranted to ensure that the measure can be delivered before the identified vulnerability threshold is reached.

11. A phased approach to adaptation is recommended. A phased approach recognizes both the long implementation timelines associated with waterfront adaptation measures and the varying vulnerability timeframes across the LFT. It enables proactive, cost-effective, and adaptive decision-making, ensuring that adaptation measures are delivered when needed while maintaining flexibility in the face of future uncertainty.

## Recommendations

In alignment with a phased approach, the following is recommended.

- a. Perform hydrodynamic flood modeling to determine the duration of high TWLs exceeding the breaching point elevations, and to determine flooding pathways and quantify spatial extent and depth of flooding. This would assist in the definition of adaptation measures.
- b. Decommission (plug, remove) the underground outfall that conveys the stormwater collected by the approximately 120-foot-long drain in the southern area of the main parking lot to the Corte Madera Creek. The outfall constitutes a path for the Corte Madera Creek seawater to flood the main parking lot in high TWLs.
- c. Given that it does not have adaptation capacity, design and build the Main Lot Garage (planned to be in operation by 2040) so that its first floor is at the 11.4 feet NAVD88 elevation to prevent groundwater emergence flooding by 2100.
- d. Butler Building is a high risk area; commence planning toward the immediate implementation of an adaptation measure for high TWL flooding by 2030 and for groundwater emergence flooding by 2090.
- e. Creek and Undeveloped are moderate risk areas; within an existing asset management cycle, commence planning toward implementing adaptation measures for high TWL flooding by 2030.
- f. Marsh is a moderate risk area; within an existing asset management cycle, commence planning toward implementing an adaptation measure for high TWL flooding by 2040 - 2050 and for groundwater emergence flooding by 2090.
- g. Fuel Tanks is a high-risk area; commence planning toward the implementation of an adaptation measure for high TWL flooding by 2060 – 2070 and for groundwater emergence flooding by 2080.
- h. LFT Buildings is a moderate risk area; within an existing asset management cycle, commence planning toward implementing an adaptation measure for high TWL flooding by 2060 - 2070.
- i. East SFD Boulevard is a high-risk area; commence planning toward the implementation of an adaptation measure for high TWL flooding by 2070 – 2080.
- j. Paved area at LFT is a moderate risk area; within an existing asset management cycle, commence planning toward implementing an adaptation measure for groundwater emergence flooding by 2090.

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## Acronyms and Abbreviations

|                 |                                                         |
|-----------------|---------------------------------------------------------|
| BGL             | below ground level                                      |
| DEM             | Digital Elevation Model                                 |
| District        | Golden Gate Bridge, Highway and Transportation District |
| GL              | groundwater level                                       |
| HazMat          | hazardous materials                                     |
| IT              | information technology                                  |
| LFT             | Larkspur Ferry Terminal                                 |
| Main Lot Garage | Main Lot Parking Garage                                 |
| MSL             | mean sea level                                          |
| NAVD88          | North American Vertical Datum 1988                      |
| NOAA            | National Oceanic and Atmospheric Administration         |
| SFD Boulevard   | Sir Francis Drake Boulevard                             |
| SLR             | sea level rise                                          |
| SVI             | Shoreline Vulnerability Index                           |
| TWL             | total water level                                       |

## 1. Introduction

The Larkspur Ferry Terminal (LFT) is a coastal facility vulnerable to sea level rise (SLR). Consistent with the typical requirements of state funding programs, infrastructure planning processes, and environmental reviews and permitting, the Golden Gate Bridge, Highway and Transportation District (District) commissioned Jacobs to perform this assessment to evaluate the impacts of SLR on its future infrastructure developments.

The SLR impact assessment included the following tasks:

- Task 1 – Collection and Analysis of Information
- Task 2 – Site Visit
- Task 3 – Hazard Identification
- Task 4 – Vulnerability Assessment
- Task 5 – Risk Assessment and Adaptation Plan

The following sections describe the work performed and the results of the assessment.

## 2. Collection and Analysis of Information

Jacobs reviewed, collected, and analyzed the following information:

- State of California Sea Level Rise Planning Guidance 2024 (OPC 2024)
- LFT and surrounding areas Digital Elevation Model (DEM) at 1-meter resolution (NOAA 2025a)
- National Oceanic and Atmospheric Administration (NOAA) station 9414863 Richmond tidal datums, tidal datums (NOAA 2025b)
- NOAA station 9414290 San Francisco, 100-year total water level (TWL) (NOAA 2025b)
- NOAA station TIBC1 Tiburon Pier (NOAA 2025c)
- LFT AutoCAD drawings (District 2026)
- Bay Area Conservation and Development Commission Shoreline Vulnerability Index (SVI) (BCDC 2021)
- Aerial imagery (ESRI ArcGIS, Google Earth)

Voids of information were filled with assumptions based on standard engineering practice and Jacobs's experience on similar projects.

### 3. Site Visit

A site visit was conducted on January 14, 2026, to:

- Assess the overall condition of the LFT
- Inspect shoreline structures and assets
- Identify potential floodwater breaching points and pathways and potential flooding areas

The visit included a walk-through, visual inspection of the LFT perimeter and waterfront structures, photo and video recording, and rudimentary measurements (tape measure, visual estimates, etc.).

Interviews with District's staff were conducted to learn about the history, condition, expected service life, maintenance and improvement plans of the facilities and waterfront structures, accounts of high-water level and flooding events and their consequences (historical vulnerabilities), and any other relevant anecdotal information. Figure 1 shows an aerial view of the LFT, key locations and the perimeter inspected.



Figure 1. Aerial view of the Larkspur Ferry Terminal, key locations and perimeter inspected (image source: Google Earth Landsat/Copernicus)

#### 3.1 Perimeter Inspection

The inspection started at Berths 2 and 3, then continued in a counterclockwise direction along the perimeter of the LFT. Figure 2 and Figure 3 show east and south views of Berth 3, respectively.



**Figure 2. East view of Berth 3**



**Figure 3. South view of Berth 3, Berth 2 and the Larkspur Ferry Terminal Building in the background**

After Berths 2 and 3, the inspection proceeded along the mostly natural waterfront to the north of Berth 3. A pedestrian paved pathway extends to the north as shown in Figure 4. The pathway forks to the west into a pedestrian bridge over East Sir Francis Drake Boulevard (SFD Boulevard) and to the east to an undeveloped, low elevation area vulnerable to flooding. To the west of the pathway, an approximately 5-foot-high above-grade vegetated berm separates the pathway from the main parking lot.



**Figure 4. Pedestrian pathway to the north of Berth 3, bridge over the Sir Francis Drake Boulevard and undeveloped, low elevation area (background and right)**

From the pedestrian bridge and SFD Boulevard, the inspection proceeded west along SFD Boulevard, which bounds the LFT to the north. This section is approximately 560 feet long and consists of a sidewalk and planters that separate the LFT from SFD Boulevard. Immediately west of the pedestrian bridge, there is a one-lane main parking lot exit road. Near the midpoint, at the intersection with Larkspur Landing Court, a three-lane exit and a two-lane entrance connect to the LFT access road that runs counterclockwise around its perimeter. Figure 5 shows a west view from the pedestrian bridge of SFD Boulevard and the northern area of the main parking lot.



**Figure 5. West view of the Sir Francis Drake Boulevard (right), main parking lot (left)**

Upon reaching the west end of the sidewalk along SFD Boulevard, the inspection proceeded onto a bike path, which begins at SFD Boulevard and extends into the LFT. An unnamed Creek runs parallel to the on the east side of the bike path, originating at SFD Boulevard and flowing downstream to the Corte Madera Creek, forming the western boundary of both the LFT and the adjacent main parking lot. At SFD Boulevard, two gates are in place to prevent high water levels in the Creek from propagating upstream. The bike path trends southeast, with the Creek to the west and the main parking lot to the east. The path is generally level and has an elevation consistent with the adjacent main parking lot. Figure 6 shows the creek at SFD Boulevard, and Figure 7 shows a south view of the bike path.



**Figure 6. Creek at the Sir Francis Drake Boulevard, gates semi-submerged**



**Figure 7. South view of the bike path by the Creek**

Approximately 400 feet from SFD Boulevard the Creek turns to the south. From that location, the bike path extends until it reaches the marsh at the Corte Madera Creek to then turn east. On the west side, the bike path borders four Fuel Tanks, an employee parking lot and ancillary facilities and, on the east side, the main parking lot. Figure 8 shows an aerial view to the south of the Creek, LFT perimeter, Fuel Tanks and ancillary facilities.

This area, in the southwest corner of the LFT, is relatively low and, as relayed by District's staff, vulnerable to flooding. An about 4-foot-high engineered concrete levee surrounds the Fuel Tanks in a containment area which protects the LFT and Creek from accidental spills and the tanks from flooding. Rainwater collected within the containment area is conveyed with ditches to a sump in the southwest corner where is pumped out into the Corte Madera Creek.

Additional assets in this area include the employee parking lot, the Butler Building where the information technology (IT) server room is housed and mooring equipment and hardware are stored, the Hazardous Materials (HazMat) (oil, paint, etc.) Locker, and the Backup Generator. These are built on concrete pads and elevated above grade; the Butler Building floor is about 13 inches above grade, the HazMat Locker doorway about 17 inches above grade, and the Backup Generator bottom 12 inches. Figure 9 shows the Fuel Tanks and Pump Station, Figure 10 the Butler Building, Figure 11 the HazMat Locker, and Figure 12 the Backup Generator.



**Figure 8. Aerial view to the south of the southwest corner of the Larkspur Ferry Terminal, perimeter (yellow), Fuel Tanks and ancillary facilities (Google Earth Landsat/Copernicus n.d.)**



Figure 9. North views of Fuel Tanks, west side (left) and east side and Pump Station (right)



Figure 10. Butler Building



Figure 11. HazMat Locker



Figure 12. Backup Generator

From the Butler Building, the inspection continued east along the bike path that borders the marsh and which fronts the LFT along its approximately 550-foot southern boundary. The bike path is generally level and has an elevation consistent with the adjacent main parking lot. A low, vegetated berm about 3-foot-high above-grade separates the bike path from the marsh and Corte Madera Creek. This waterfront area is relatively low and, as relayed by District's staff, vulnerable to flooding. Stormwater collected in an approximately 120-foot-long drain in the LFT access road adjacent to the bike path is conveyed through an underground outfall to the Corte Madera Creek. The outfall constitutes a path for the Corte Madera Creek seawater to flood the main parking lot in high water events. Figure 13 shows a general view of the marsh to the east from the Butler Building. Figure 14 shows a west view of the bike path along the LFT southern boundary.



**Figure 13. East view of the marsh from the Butler Building**



**Figure 14. West view of the bike path and vegetated berm along the southern boundary of the Larkspur Ferry Terminal**

The inspection ended at the Administration Building located at the southeast corner of the LFT (Figure 15). Like the passenger boarding pier where Berths 1 and 2 are located, the Administration Building is built on a pile-supported concrete deck. The perimeter of both is protected by approximately 44-inch-high concrete parapets and steel railings.



Figure 15. Southwest view the Administration Building (left) and northeast view of Larkspur Ferry Terminal Building Berth 1

### 3.2 Digital Elevation Model Verification

To identify potential floodwater breaching points and pathways and flooding areas, an accurate representation of the LFT topography was needed. For this purpose, the NOAA DEM (NOAA 2025a), which is referenced to North American Vertical Datum 1988 (NAVD88), was acquired. To verify the NOAA DEM elevations, 16 measurements were taken during the site visit. Figure 16 shows the locations and times of the measurements.



Figure 16. Locations and times of the 16 measurements taken to verify NOAA DEM

Twelve measurements were taken from fixed and uniform level surfaces to the water surface. To refer these measurements to NAVD88, corresponding elevations of the water surface relative to NAVD88 at NOAA station 9414863 Richmond (NOAA 2025b) were added.

For example, at 10:16 AM, the vertical distance measured from the deck at the north corner of Berth 2 to the water surface was 74 inches (6.17 feet). At that time, the water surface at NOAA station 9414863 the water level was 5.32 feet NAVD88 (NOAA 2025b), which results in an elevation of the deck of approximately 11.5 feet NAVD88, which is consistent with the 11.2 feet NAVD88 elevation in the NOAA DEM. Later at 1:06 PM, the vertical distance measured from the deck at the east corner of Berth 1 to the water surface was 168 inches (14 feet). At that time, the water surface at NOAA station 9414863 was 1.86 feet NAVD88 (NOAA 2025b), which results in an elevation of the deck of approximately 15.9 feet NAVD88, which is the same as the 15.9 feet NAVD88 in the NOAA DEM. Table 1 lists the measurements, measured and NOAA DEM elevations relative to NAVD88. Where available and representative, elevations extracted from Bay Area Conservation and Development Commission's SVI dataset (BCDC 2021) are included; however, discrepancies with the measurements and NOAA DEM are noted, likely due to the relative distance between the verification locations and the relief of the shoreline, especially in areas of steep slopes.

**Table 1. Measurements taken on January 14, 2026, and NOAA DEM elevations**

| Time<br>(Local) | Location                                     | Distance to<br>Water<br>Surface | Water Level<br>(feet<br>NAVD88) <sup>[a]</sup> | Elevations (feet NAVD88) |          |      |
|-----------------|----------------------------------------------|---------------------------------|------------------------------------------------|--------------------------|----------|------|
|                 |                                              |                                 |                                                | Measured                 | NOAA DEM | SVI  |
| 10:16 AM        | Deck at north corner of Berth 2              | 74" (6.2')                      | 5.32                                           | 11.5                     | 11.2     | 12.4 |
| 10:22 AM        | Deck at south corner of Berth 3              | 128" (10.7')                    | 5.24                                           | 15.9                     | 15.7     | 15.2 |
| 10:24 AM        | Deck at Berth 3                              | 128" (10.7')                    | 5.21                                           | 15.9                     | 15.7     | 16.0 |
| 10:36 AM        | Deck at Berth 3 north access                 | 75" (6.3')                      | 5.04                                           | 11.3                     | 11.1     | 12.1 |
| 10:48 AM        | Top of culvert                               | 43" (3.6')                      | 4.83                                           | 8.4                      | 9.9      | 10.0 |
| 10:50 AM        | Deck at Berth 3 south access                 | 80" (6.7')                      | 4.79                                           | 11.5                     | 11.5     | 12.4 |
| 11:15 AM        | SFD Boulevard and bike path at Creek         | 54" (4.5')                      | 4.27                                           | 8.8                      | 8.3      | N/A  |
| 12:00 PM        | Deck at north corner of Administration Bldg. | 94" (7.8')                      | 3.26                                           | 11.1                     | 11.4     | 11.5 |
| 12:02 PM        | Deck at west corner of Berth 1               | 96" (8.0')                      | 3.22                                           | 11.2                     | 11.4     | 13.2 |
| 01:02 PM        | Deck at Berth 1                              | 165" (13.8')                    | 1.95                                           | 15.8                     | 16.0     | 16.0 |
| 01:06 PM        | Deck at east corner of Berth 1               | 168" (14')                      | 1.86                                           | 15.9                     | 15.9     | N/A  |
| 01:46 PM        | Deck at east corner of Administration Bldg.  | 119" (9.9')                     | 1.15                                           | 11.1                     | 11.3     | N/A  |

<sup>[a]</sup> Feet NAVD88, measured at NOAA station 9414863 Richmond (NOAA 2025b)

N/A = not available

Four spot measurements were taken within the LFT for additional verifications. At 10:26 AM, the height of the wall at the south corner of the picnic area was measured at 89.5 inches (7.46 feet). The wall extends above the elevation of the deck at Berth 3 (i.e., a parapet) by 42.5 inches (3.54 feet). Considering that the elevation of the deck at the south corner of Berth 3 is 15.7 feet NAVD88, the elevation of the ground at the south corner of the picnic area is  $15.7 - 7.46 + 3.54 = 11.8$  feet NAVD88, which is consistent with NOAA DEM 12 feet NAVD88.

Between 1:17 PM and 1:20 PM, a 56-inch (4.67-foot) elevation difference was measured between the top and bottom of the eight-step stairway in the Fuel Tanks area, shown in Figure 17. The NOAA DEM shows an elevation of 14.3 feet NAVD88 at the top and 9.8 feet NAVD88 at the bottom of the steps (top of the levee) which translates to a difference in elevation of 4.5 feet (54 inches) which is consistent with the measurement.

At 1:27 PM, a 42-inch (3.5 feet) elevation difference was measured between the top and bottom of the five-step stairway from the top of the levee to the Fuel Tanks ground, shown in Figure 17. The NOAA DEM shows an elevation of 9.6 feet NAVD88 at the top and 6.7 feet NAVD88 at the floor of the containment area, which translates into a difference in elevation of 2.9 feet (37 inches). The discrepancy can be justified based on the rudimentary nature of the measurement and the potential inaccuracy of the NOAA DEM within the containment area.

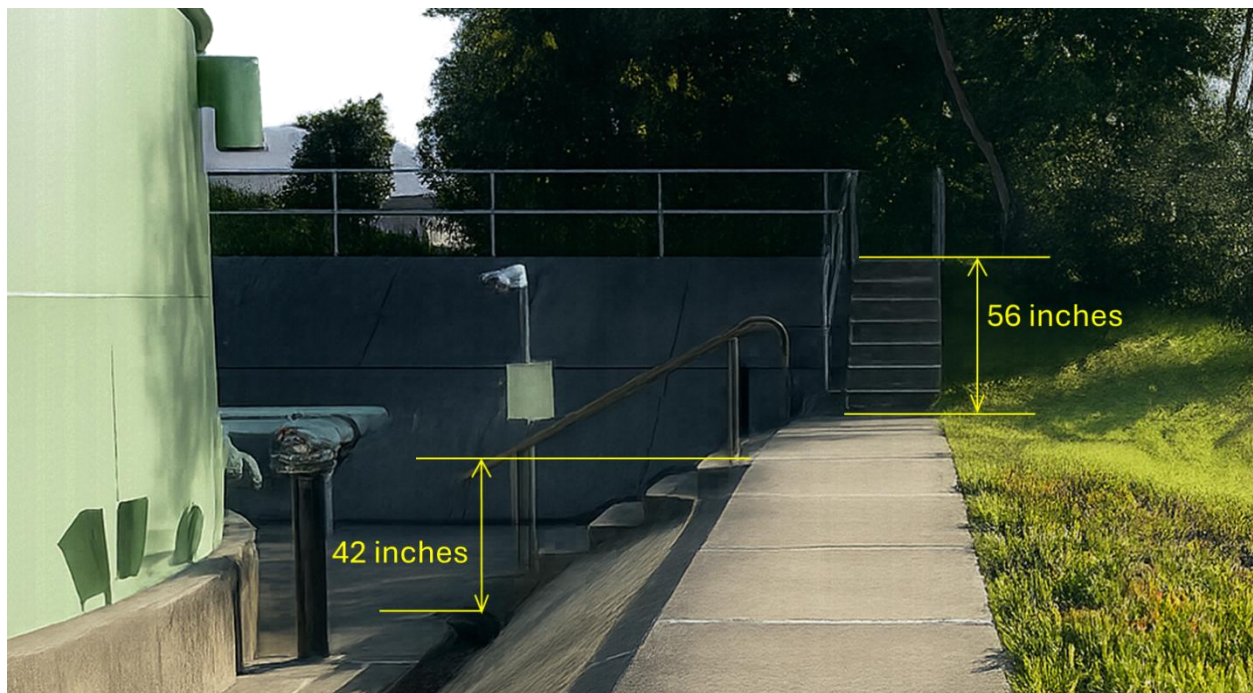


**Figure 17. Differences in elevations in the Fuel Tanks area**

The site visit was conducted about 10 days after an extreme high tide event which peaked between January 2 to 4, 2026. Photos taken by District staff during that event were used for additional verification of the NOAA DEM.

Figure 18 and Figure 19 show District's photos taken on January 2, 2026, at 9:39 AM when the TWL was 8.31 feet NAVD88 (NOAA 2025b). Figure 18 shows the flooded area in front of the Butler Building and Figure 19 shows the flooded area in the southern section of the LFT access road. Figure 20 shows a very good correlation between the flooded area according to the NOAA DEM and the extent of flooding from

the interpretation of the District's photos; the edge of the floodwater is close to the entrance of the Butler Building and the HazMat Locker is above water. Furthermore, the southern section of the LFT access road is partially flooded due to the intrusion of seawater through the outfall under the bike path and vegetated berm and drain along the road.



**Figure 18. Flooded area in front of the Butler Building on January 2, 2026, at 9:39 AM, TWL = 8.31 feet NAVD88 (NOAA 2025b)**



**Figure 19. Flooded area in the southern section of the Larkspur Ferry Terminal access road on January 2, 2026, at 9:39 AM, TWL = 8.31 feet NAVD88 (NOAA 2025b)**



**Figure 20. Flooded area in the Butler Building area and southern section of the Larkspur Ferry Terminal access road according to the NOAA DEM on January 2, 2026, at 9:39 AM, TWL = 8.31 feet NAVD88 (NOAA 2025b)**

Figure 21 shows a District's photo of the debris in the employee parking lot in the Butler Building area marking the edge of the highest floodwater elevation on January 3, 2026, at 10:36 AM when the TWL was 8.73 feet NAVD88 (NOAA 2025b). Figure 22 shows a very good correlation between the flooded area according to the NOAA DEM and the extent of flooding from the interpretation of the District's photo; the edge of the floodwater is close to the entrance of the Butler Building and covers a significant area of the employee parking lot.



**Figure 21. Debris in the employee parking lot in the Butler Building area marking the edge of the highest floodwater elevation on January 3, 2026, at 10:36 AM, TWL = 8.73 feet NAVD88 (NOAA 2025b)**



**Figure 22. Flooded area in the Butler Building area and southern section of the Larkspur Ferry Terminal access road according to the NOAA DEM on January 3, 2026, at 10:36 AM, TWL = 8.73 feet NAVD88 (NOAA 2025b)**

Figure 23 (same as Figure 21) shows the edge of the floodwater and flooded area in the employee parking lot in the Butler Building area on January 4, 2026, at 12:09 PM when the TWL was 8.23 feet NAVD88 (NOAA 2025b). Figure 24 shows the flooded area in the southern section of the LFT access road. Figure 25 shows a very good correlation between the flooded area according to the NOAA DEM and the extent of flooding from the interpretation of the District's photos; the edge of the floodwater is close to the entrance of the Butler Building, and the HazMat Locker is above water. Furthermore, the southern section of the LFT access road is partially flooded due to the intrusion of seawater through the outfall under the bike path and vegetated berm and drain along the road.



**Figure 23. Edge of the floodwater and flooded area in the employee parking lot in the Butler Building area on January 4, 2026, at 12:09 PM, TWL was 8.23 feet NAVD88 (NOAA 2025b)**



**Figure 24. Flooded area in the southern section of the Larkspur Ferry Terminal access road on January 4, 2026, at 12:12 PM, TWL = 8.23 feet NAVD88 (NOAA 2025b)**



**Figure 25. Flooded area in the Butler Building area and southern section of the Larkspur Ferry Terminal access road according to the NOAA DEM on January 4, 2026, at 12:12 PM, TWL = 8.23 feet NAVD88 (NOAA 2025b)**

The NOAA DEM showed good agreement with the measurements performed during the site visit and the flooded areas derived from the District's photos of the extreme high tide event of January 2 to 4, 2026. Therefore, the NOAA DEM was adopted for the identification of potential floodwater breaching points and pathways and flooding areas for the different SLR projections selected.

## 4. Hazard Identification

Hazards can affect the LFT in diverse ways. For example, there may be physical, operational, business, and environmental impacts. In this assessment, only physical and operational impacts were considered such as flooding of terminal facilities, damage to structures and mechanical or electrical equipment, and service interruptions.

Hazard identification involves describing the coastal processes and conditions that may adversely affect the LFT's assets and operations. SLR is understood as a long-term driver that increases baseline water levels and amplifies the effects of coastal hazards.

The primary hazard affecting the LFT is coastal flooding, which can occur in two forms. In the short term, episodic flooding may occur during extreme water levels caused by the combined effects of tides, storm surge, waves, tsunamis, and large-scale climate and oceanographic phenomena such as El Niño. The TWL is the water level resulting from the combination of these effects. Over the long term, SLR may result in permanent inundation of low-lying areas. Elevated water levels reduce the freeboard of coastal features and waterfront structures, thereby increasing the likelihood, frequency, depth and extent of flooding across the LFT.

Wave runup and overtopping represent additional coastal hazards. These processes occur when wave action reaches or exceeds the elevation of the shoreline, coastal defenses, or waterfront structures. Wave runup and overtopping can result in localized, short-duration flooding and impose hydraulic loads on infrastructure, particularly during storm conditions when still water levels may be elevated.

Although less frequent, tsunamis represent a potential high-impact hazard. Tsunamis can cause rapid increases in water level and flow velocity, leading to overtopping of coastal defenses and waterfront structures and resulting in significant, though typically short-duration, flooding.

In addition to these primary hazards, SLR can influence several secondary and interacting processes. As sea levels rise, coastal groundwater levels may also increase, potentially leading to groundwater emergence in low-lying areas and reduced stormwater drainage capacity. This can cause surface flooding independent of direct waterside overtopping or shoreline inundation and may affect buried utilities, pavements, foundations, and other subsurface infrastructure. Furthermore, higher groundwater levels can increase soil saturation, thereby increasing the susceptibility of certain soils to liquefaction during seismic events.

### 4.1 Wave Runup and Overtopping

Wave and current conditions in the vicinity of the LFT are mild. Vessels, consisting mostly of pleasure boats in the Corte Madera Creek and the District ferries arriving and departing the LFT, transit at relatively low speeds and produce minimal or no wakes.

Wind records at NOAA station TIBC1 Tiburon Pier (NOAA 2025c) for May 1, 2006, to October 3, 2024, include 595,323 15-minute observations. Of these, 29,552 observations (about 5%) are winds from the LFT's most exposed direction (120 to 130 degrees), which has an approximately 12-mile fetch to the southeast. Within this sector, winds are less than 12 knots in 27,277 observations (92%) and greater than 12 knots in 2,275 observations (8%). Winds of less than 12 knots generate waves at the LFT smaller than 1 foot high and negligible wind setup. Wave and vessel wake conditions will not change with rising sea levels, and considering that these are negligible, resulting wave runup and overtopping can also be considered negligible and not a hazard to the LFT.

## 4.2 Water Levels

High water levels would result in a higher likelihood of flooding due to overtopping of waterfront structures, higher groundwater levels, and higher likelihood of soil liquefaction in seismic events. Consequently, water levels are considered a hazard to the LFT.

Table 2 lists the water level datums and extreme measured (high and low) TWLs relevant to the LFT. Because future extreme TWLs due to SLR are typically estimated by combining the current 100-year TWL (1% annual chance of exceedance) with SLR projections, accurate knowledge of the current 100-year TWL is required.

Water level measurements at NOAA station 9414863 Richmond span just over 20 years (NOAA 2025b), which is insufficient to reliably estimate the 100-year TWL. Therefore, the 8.60 feet NAVD88 100-year TWL derived from the longer NOAA station 9414290 San Francisco record was adopted (NOAA 2025b).

**Table 2. Water level datums at NOAA station 9414863 Richmond**

| Datums and TWLs                            | Elevation<br>(feet NAVD88) |
|--------------------------------------------|----------------------------|
| Maximum TWL (measured on January 3, 2026)  | 8.73                       |
| 100-year TWL <sup>[a]</sup>                | 8.60                       |
| Mean Higher High Water                     | 6.06                       |
| MSL                                        | 3.27                       |
| NAVD88                                     | 0.00                       |
| Mean Lower Low Water                       | 0.02                       |
| Minimum TWL (measured on November 1, 2009) | -2.51                      |

<sup>[a]</sup> NOAA station 9414290 San Francisco (NOAA 2025b)

MSL = mean sea level

## 4.3 Tsunamis

In addition to astronomic tides and weather effects such as storm surges and the El Niño mean sea level anomaly (both of which are less than 1 foot in California), water levels can rise due to tsunamis. Because the historical record for tsunamis in California is relatively short, and no anecdotal evidence or measurements are available at the LFT, the impact of tsunamis is unknown.

The most recent record is the measured water levels at NOAA station 9414863 Richmond (NOAA 2025b) due to the Tohoku Oki tsunami in Japan on March 11, 2011. Figure 26 shows the time history of the measured TWL at NOAA station 9414863 Richmond (NOAA 2025b) a couple of days after the tsunami occurred. Also shown is the residual, which is the difference between the measured TWL and the predicted astronomical tide. At its peak, the tsunami wave produced an elevation of the water level of about 1 foot above the predicted astronomical tide, however, during low tide. Considering that this is of the same order of magnitude as what storm surges and El Niño mean sea level anomalies could produce in California, and that the simultaneous occurrence of tsunamis with extreme high water levels (i.e., 100-year TWL) is unlikely, remote tsunamis are not considered a potential hazard for the LFT.

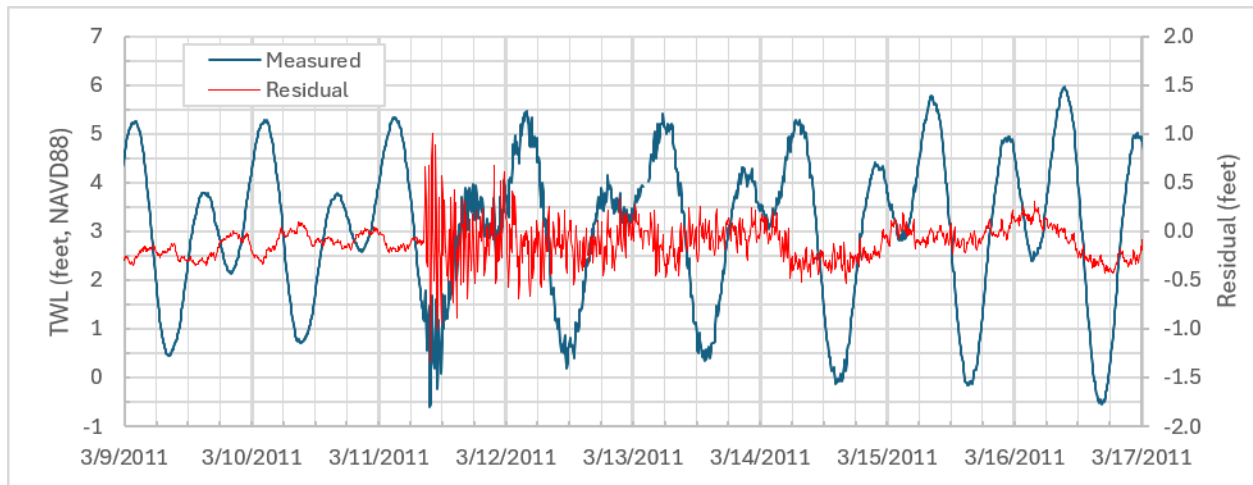


Figure 26. Time history of measured TWL at NOAA station 9414863 Richmond during the arrival of the Tohoku Oki tsunami and residual (measured TWL - predicted astronomical tide) (NOAA 2025b)

## 4.4 Sea Level Rise

A relevant hazard to the LFT is the future extreme TWLs resulting from SLR. These are typically estimated by combining the current 100-year TWL with SLR projections for time frames and risk aversion scenarios.

Table 3 lists the SLR projections (OPC 2024) for San Francisco, assumed representative for the LFT due to its proximity, for five different risk aversion scenarios for years 2020 through 2100. Figure 27 shows the TWLs, which combine the 100-year TWL (8.60 feet NAVD88) with the SLR projections, for years 2020 through 2100 for the five risk aversion scenarios.

Table 3. SLR projections for San Francisco (feet) (OPC 2024)

| Year | Low | Intermediate Low | Intermediate | Intermediate High | High |
|------|-----|------------------|--------------|-------------------|------|
| 2020 | 0.1 | 0.2              | 0.2          | 0.2               | 0.2  |
| 2030 | 0.2 | 0.3              | 0.3          | 0.4               | 0.4  |
| 2040 | 0.3 | 0.4              | 0.5          | 0.6               | 0.7  |
| 2050 | 0.4 | 0.5              | 0.7          | 0.9               | 1.1  |
| 2060 | 0.4 | 0.6              | 0.9          | 1.4               | 1.8  |
| 2070 | 0.5 | 0.8              | 1.2          | 2.1               | 2.7  |
| 2080 | 0.5 | 0.9              | 1.6          | 2.8               | 3.8  |
| 2090 | 0.6 | 1.1              | 2.2          | 3.6               | 5.0  |
| 2100 | 0.6 | 1.3              | 2.8          | 4.5               | 6.3  |

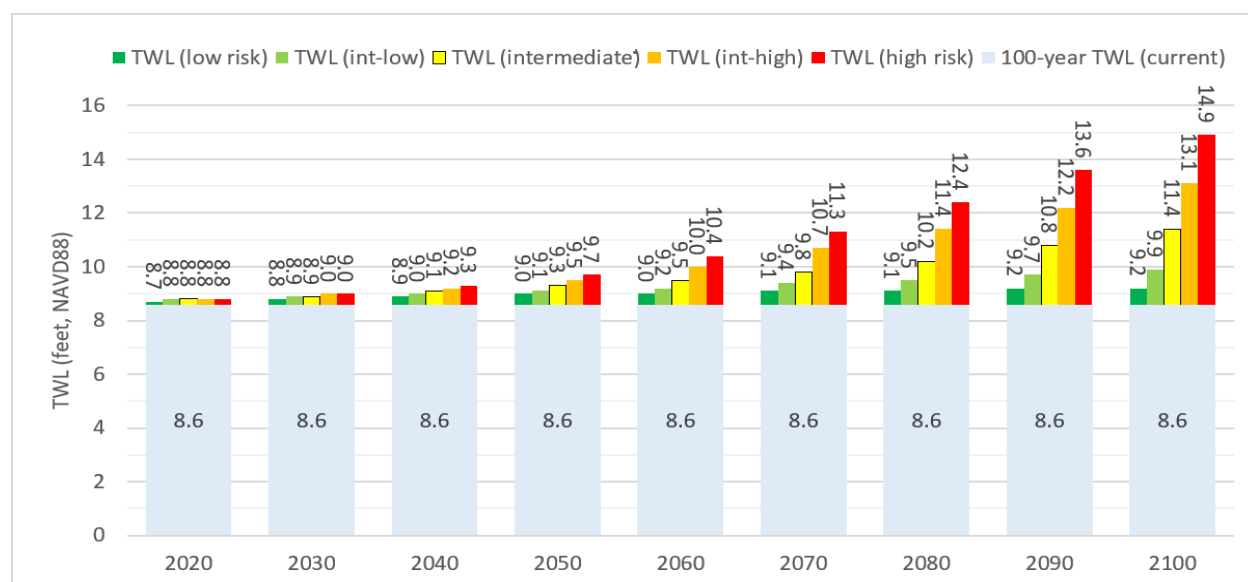


Figure 27. TWLs for the five risk aversion scenarios for years 2020 through 2100

## 4.5 Groundwater Emergence

Since the LFT is bordered by the Corte Madera Creek along its waterfront, long-term groundwater emergence is expected to be primarily controlled by the MSL, rising progressively in response to SLR.

Due to the direct hydraulic connection and the LFT's proximity to the Corte Madera Creek, coupled with the absence of cut-off walls or other subsurface barriers, the LFT soils are not expected to significantly impede landward groundwater flows. As a result, and in the long term, groundwater levels (GLs) are anticipated to track changes in MSL closely, with negligible lag attributable to soil hydraulic conductivity. In the short term, however, transient events such as extreme high tides and intense rainfall may temporarily elevate GLs above the MSL. But these elevated GLs are expected to dissipate relatively quickly, returning to pre-event conditions as these transient events recede.

Therefore, flooding due to long-term GL induced by SLR constitutes a hazard. It can be estimated combining the current MSL at NOAA station 9414863 Richmond (3.3 feet NAVD88, see Table 2) (NOAA 2025b) with the SLR projections for San Francisco (see Table 3). This approach is supported by Befus et al. (2020). Figure 28 shows the GLs for the low, intermediate, and high-risk aversion scenarios for years 2020 through 2100.

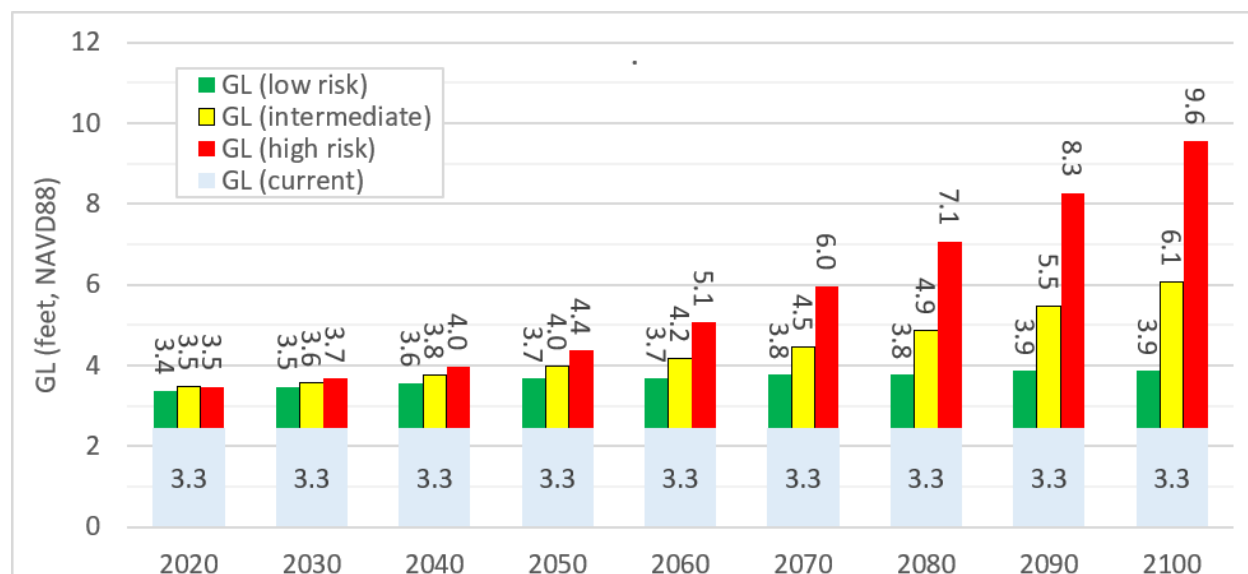


Figure 28. GLs for the low, intermediate, and high risk aversion scenarios for years 2020 through 2100

## 5. Vulnerability Assessment

Waterfronts like the LFT's typically comprise areas with different physical and operational conditions, asset types, levels of criticality, and varying adaptive capacities. For example, differences in elevation mean that areas of the waterfront will be overtopped by high TWLs at different times as the SLRs. As a result, analyzing the LFT's waterfront as a single uniform system can hide important spatial and temporal variations in vulnerability, while assessing it at an overly fine scale is often impractical. A balanced, areas-based approach is therefore more appropriate for a realistic and practical assessment.

The LFT was divided into eight areas, where each area shares similar physical and operational conditions, asset types, levels of criticality, and adaptive capacities. Figure 29 shows the eight areas selected for the assessment.

Despite not being on the waterfront, SFD Boulevard is vulnerable to high TWL flooding and is a pathway to LFT flooding. The Paved (i.e., asphalt- and concrete-surfaced) area, including the main parking lot, roadways, pathways, bike paths, and walkways and the planned Main Lot Parking Garage (Main Lot Garage), would be vulnerable to flooding due to groundwater emergence. Groundwater may emerge through pavement cracks, edges, drainage structures, utility vaults, and other subsurface pathways, making conventional prevention or control measures largely ineffective.



**Figure 29. Areas selected for the assessment (Google Earth Vexcel Imaging US Inc. n.d.)**

For the identified high TWL flooding and groundwater-emergence flooding hazards, the vulnerability of each area was assessed using the following methodology:

- High TWL flooding:
  - Identify floodwater breaching point elevation in the NOAA DEM, i.e., the lowest elevation in the area.
  - Select risk aversion scenario to define SLR projection based on site conditions, consequences of flooding, adaptive capacity, exposure to high TWL, LFT lifespan, and other criteria.
  - Delineate floodwater pathways and flood map derived from the NOAA DEM.
  - Cross-reference breaching point elevation with the sum of the current 100-year TWL and the projected SLR for the selected risk aversion scenario. This determined the ultimate horizon year by which adaptation measures must be fully operational, establishing a reverse-engineered timeline for project planning, design, permitting, funding and construction.
- Groundwater emergence flooding:
  - Select risk aversion scenario to define SLR projection based on site conditions, consequences of flooding, adaptive capacity, exposure to groundwater emergence, LFT lifespan, and other criteria.
  - Define projected long-term GL due to SLR combining the current MSL at NOAA station 9414863 Richmond (NOAA 2025b) with the risk aversion scenario SLR projection (Befus et al. 2020)

- Define groundwater emergence by subtracting the projected long-term GL from the ground elevations in the NOAA DEM.

## 5.1 Floodwater Breaching Points

### 5.1.1 Larkspur Ferry Terminal Buildings Area

The lowest elevation, and potential floodwater breaching point, in the LFT Buildings area is **11.2 feet NAVD88** at the northern end Berth 3. Figure 30 shows the location of the floodwater breaching point and the elevations in the vicinity.



Figure 30. Location and elevation of the floodwater breaching point (■) in the Larkspur Ferry Terminal Buildings area at the northern end of Berth 3 and elevations in the vicinity

### 5.1.2 Undeveloped Area

The lowest elevation, and potential floodwater breaching point, in the Undeveloped area is **8.5 feet NAVD88** at the northwest corner of the LFT basin. Figure 31 shows the location of the floodwater breaching point and the elevations in the vicinity.



Figure 31. Location and elevation of the floodwater breaching point (■) in the Undeveloped area at the northwest corner of the Larkspur Ferry Terminal basin and elevations in the vicinity

### 5.1.3 East Sir Francis Drake Boulevard Area

The lowest elevation, and potential floodwater breaching point, in the SFD Boulevard area is **9.8 feet NAVD88** at the eastern end of SFD Boulevard by the pedestrian bridge. Figure 32 shows the location of the floodwater breaching point and the elevations in the vicinity.



Figure 32. Location and elevation of the floodwater breaching point (■) in Sir Francis Drake Boulevard area at the eastern end of Sir Francis Drake Boulevard by the pedestrian bridge and elevations in the vicinity

#### 5.1.4 Creek Area

The lowest elevation, and potential floodwater breaching point, in the Creek area is **8.4 feet NAVD88** near the northern end of the Creek. Figure 33 shows the location of the floodwater breaching point and the elevations in the vicinity.



Figure 33. Location and elevation of the floodwater breaching point (■) in the Creek area near the northern end of the Creek and elevations in the vicinity

#### 5.1.5 Fuel Tanks Area

The lowest elevation, and potential floodwater breaching section, in the Fuel Tanks area is **9.7 feet NAVD88** on the top of the western side of the levee. The levee is generally level so floodwaters will breach that side of the levee at the same time. Figure 34 shows the location of the floodwater breaching section and the elevations in the vicinity.



Figure 34. Location and elevation of the floodwater breaching section (red line) in the Fuel Tanks area on the top of the west side of the levee and elevations in the vicinity

### 5.1.6 Butler Building Area

The lowest elevation, and potential floodwater breaching point, in the Butler Building area is **7.7 feet NAVD88** at the western landward edge of the marsh close to the Butler Building. The location corresponds well with floodwater breaching area observed during the high tides of January 2 to 4, 2026. Figure 35 shows the location of the floodwater breaching point and the elevations in the vicinity.



Figure 35. Location and elevation of the floodwater breaching point (7.7) in the Butler Building area at the western landward edge of the marsh close to the Butler Building and elevations in the vicinity.

### 5.1.7 Marsh Area

The lowest elevation, and potential floodwater breaching point, in the Marsh area is **9.3 feet NAVD88** at the eastern landward edge of the marsh close to the Administration Building. Figure 36 shows the location of the floodwater breaching point and the elevations in the vicinity.

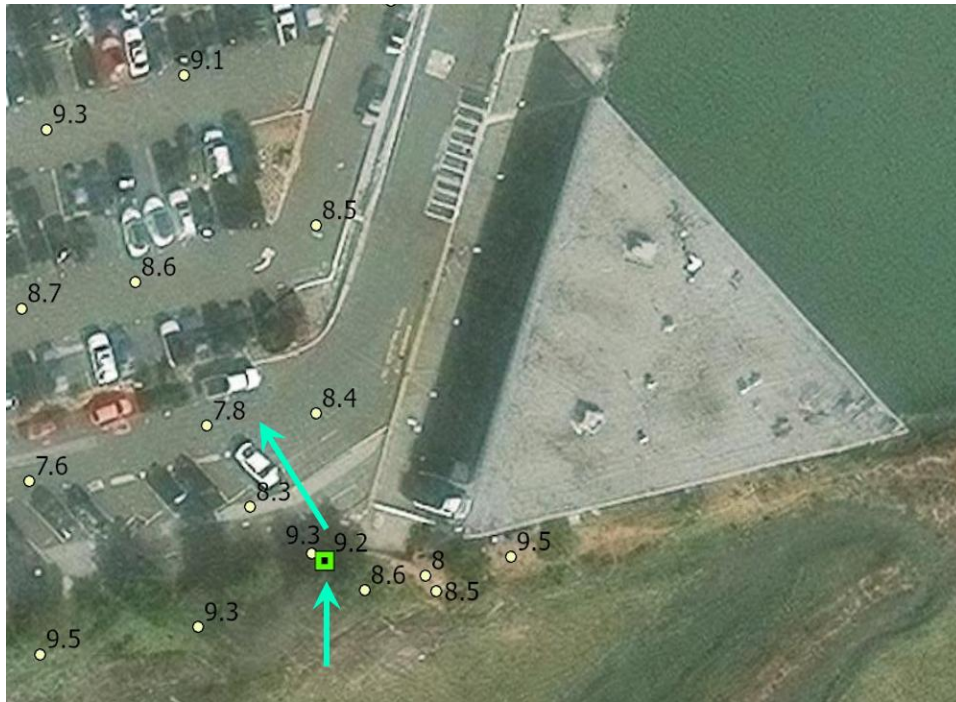


Figure 36. Location and elevation of the floodwater breaching point (■) in the Marsh area at the eastern landward edge of the marsh close to the Administration Building and elevations in the vicinity

## 5.2 Risk Aversion Scenarios

Considering the site visit observations, criteria such as consequences of flooding, adaptive capacity, exposure to high TWLs and groundwater emergence, a LFT lifespan of 75 years, and according to the following rationale, the risk-aversion scenarios were selected.

Except for the LFT Buildings area, which is vulnerable to high TWL flooding, all other areas are vulnerable to flooding from both high TWLs and groundwater emergence. In the Paved (i.e., asphalt- and concrete-surfaced) area, including parking lots, roadways, pathways, bike paths, and walkways, flooding caused by groundwater emergence would be difficult to prevent or control. Groundwater may emerge through pavement cracks, edges, drainage structures, utility vaults, and other subsurface pathways, making conventional prevention or control measures largely ineffective.

**LFT Buildings Area:** The LFT Buildings area includes critical assets like buildings, berths, utilities, walkways and ancillary structures and facilities for passenger loading/offloading and ferry berthing. It is largely built overwater and built on pile-supported concrete decks which would be very difficult to adapt to high TWL flooding. In the event of flooding, damage could be significant and impair the LFT operations. Therefore, a **high** risk aversion scenario was selected for this area.

**Undeveloped Area:** There are no critical assets in this area and mainly a barren lowland. However, there is a pedestrian pathway, a power transformer, and a couple of utility vaults, all of which can be relocated or adapted to high TWL flooding. To the west of the pathway, the approximately 5-foot-high above-grade vegetated berm that separates the pathway from the main parking lot can be adapted to high TWL flooding, for example, by elevating it or building a floodwall. In the event of flooding, damage would be inconsequential provided that mitigation measures are in place for the utilities. Therefore, a **low** risk aversion scenario was selected for this area.

**East SFD Boulevard Area:** SFD Boulevard is not part of the LFT, but it provides the only pedestrian and vehicular access to it. No critical assets are in this area. The one-lane main parking lot exit, the three-lane exit and the two-lane entrance that connect SFD Boulevard to the LFT access road can be adapted to high TWL flooding, for example, with ramps or gates to prevent main parking lot flooding. The several utility vaults that are scattered in the vicinity in the main parking lot could be relocated or adapted to high TWL flooding. In the event of flooding, access to the LFT and parking could be impaired and damage would be inconsequential provided that mitigation measures are in place for the utilities. Therefore, an **intermediate** risk aversion scenario was selected for this area.

**Creek Area:** There are no critical assets in this area. The east bank of the Creek slopes up to the bike path that runs along the western boundary of the LFT and the main parking lot. The bike path is generally level and has an elevation consistent with the adjacent main parking lot. The several utility vaults that are scattered in the vicinity in the main parking lot could be relocated or adapted to high TWL flooding. In the event of flooding, access to the main parking lot and parking could be impaired and damage would be inconsequential provided that mitigation measures are in place for the utilities. This area could be adapted to high TWL flooding, for example, by building a floodwall or a levee with the bike path running on top. Therefore, an **intermediate** risk aversion scenario was selected for this area.

**Fuel Tanks Area:** The fuel tanks, pipelines and pump station are critical assets. These assets are surrounded by a 4-foot-high engineered concrete levee that encloses a containment area which protects the LFT and Creek from accidental spills and the tanks from flooding. The levee can be raised to prevent high TWL flooding. It is unknown whether the concrete slab (containment area floor) supporting the tanks is impermeable and capable of preventing groundwater emergence flooding. In any case, perhaps given the relatively small area, the concrete slab could be impermeabilized. Therefore, an **intermediate** risk aversion scenario was selected for this area.

**Butler Building Area:** Assets in this area include the employee parking lot, and the Butler Building where the IT server room is housed and mooring equipment and hardware are stored, the HazMat (oil, paint, etc.) Locker, and the Backup Generator. While the employee parking lot, the mooring equipment and hardware storage are not critical, the IT server room, the Backup Generator and the HazMat Locker are. The employee parking lot is generally level and has an elevation consistent with the adjacent main parking lot. In the event of flooding, access to the employee parking lot and parking will be impaired (as observed during the high tides of January 2 to 4, 2026) and damage would be generally inconsequential. The Butler Building (and the IT server room), HazMat Locker and the Backup Generator can be relocated or adapted to high TWL flooding by raising them. Therefore, an **intermediate** risk aversion scenario was selected for this area.

**Marsh Area:** There are no critical assets in this area. The bike path borders the marsh. A low, vegetated 3-foot-high above-grade berm separates the bike path from the marsh and Corte Madera Creek. Stormwater collected in an approximately 120-foot-long drain in the LFT access road adjacent to the bike path is conveyed through an underground outfall to the Corte Madera Creek. The outfall provides a path for the Corte Madera Creek to flood the main parking lot in high water events (as observed during the high tides of January 2 to 4, 2026) and impair access to the main parking lot and parking; however, damage would be generally inconsequential provided that mitigation measures are in place for the utilities. This area could be adapted to high TWL flooding, for example, by building a floodwall or raising the berm. The outfall can be removed or plugged so that high TWL flooding of the main parking lot is prevented. Therefore, an **intermediate** risk aversion scenario was selected for this area.

**Paved Area:** This area, which includes the existing main and employee parking lots, roadways, pathways, bike paths, and walkways, is critical to LFT operations. Several adaptation measures can be implemented to reduce the risk of flooding from high TWLs. However, no practical or cost-effective solutions are

available to prevent flooding caused by groundwater emergence. Groundwater can surface through pavement cracks and edges, drainage structures, utility vaults, and other subsurface pathways, rendering conventional flood prevention and control measures largely ineffective. Given these limitations and the operational importance of this area, a **high** risk aversion scenario was selected.

Table 4 lists the risk aversion scenarios selected for each area.

**Table 4. Larkspur Ferry Terminal areas and selected risk aversion scenarios**

| Area               | Risk Aversion Scenario |
|--------------------|------------------------|
| LFT Buildings      | High                   |
| Undeveloped        | Low                    |
| East SFD Boulevard | Intermediate           |
| Creek              | Intermediate           |
| Fuel Tanks         | Intermediate           |
| Butler Building    | Intermediate           |
| Marsh              | Intermediate           |
| Paved              | High                   |

### 5.3 Floodwater Pathways

Figure 37 shows the projected TWLs as function of time, obtained by combining the current 100-year TWL and the projected SLR for the low risk aversion scenario, and the breaching point elevation of the Undeveloped area. Figure 38 shows the same for the intermediate risk aversion scenario and the breaching point elevations of the SFD Boulevard, Creek, Fuel Tanks, Butler Building and Marsh areas and Figure 39 for the high risk aversion scenario and the LFT Buildings area.

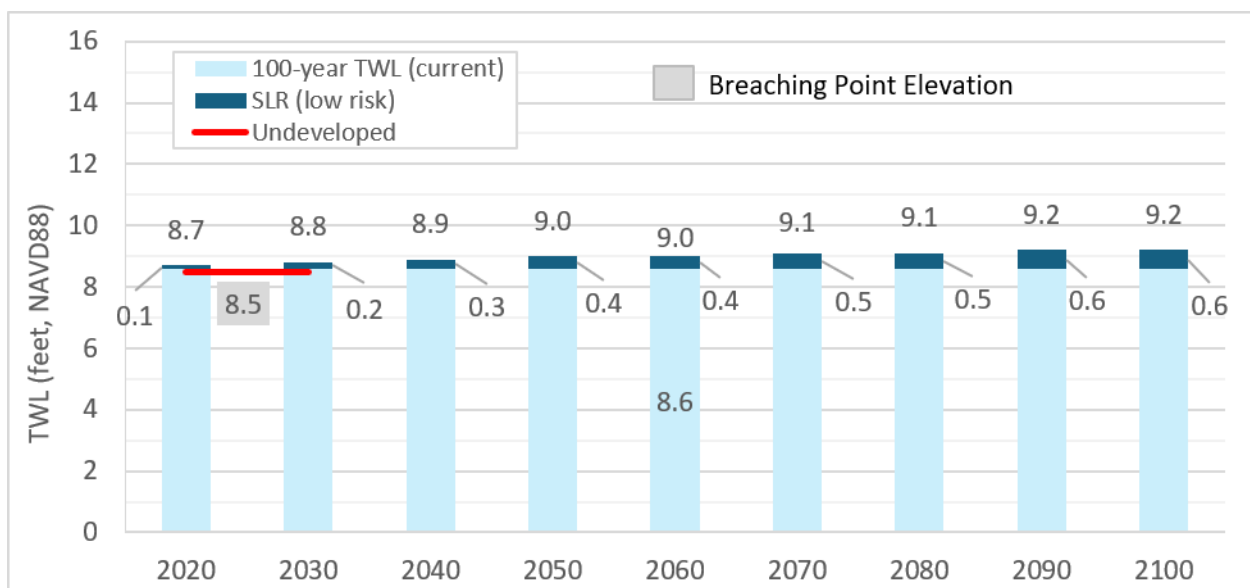


**Figure 37. Projected TWLs for the low risk aversion scenario and breaching point elevation of the Undeveloped area**

# Larkspur Ferry Terminal Sea Level Rise Impact Assessment

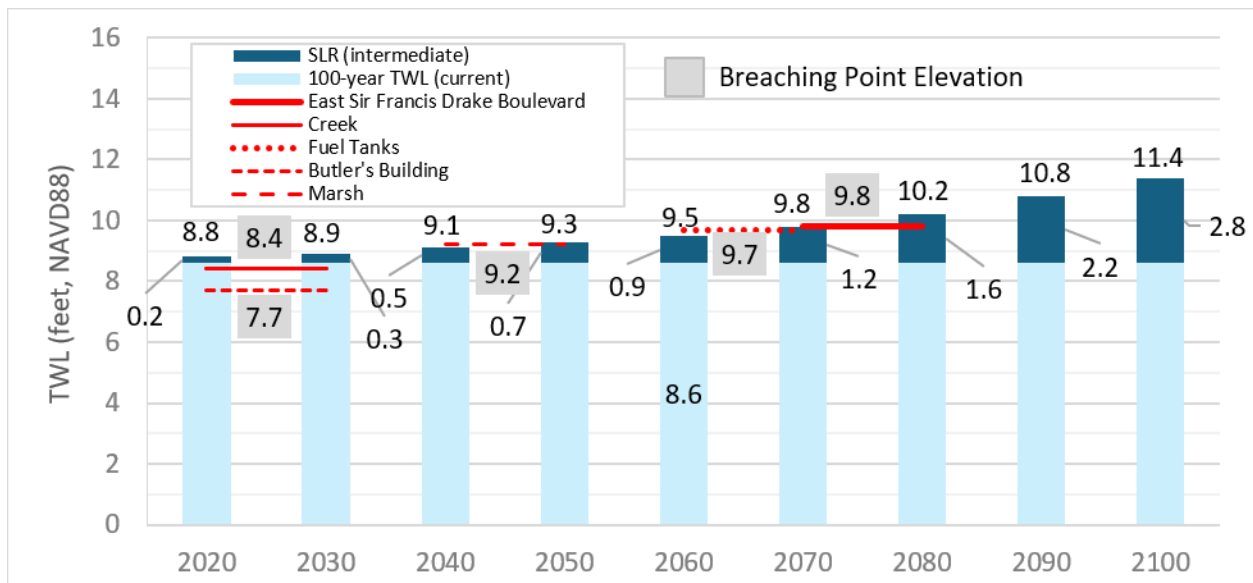


Figure 38. Projected TWLs for the intermediate risk aversion scenario and breaching point elevations of the Sir Francis Drake Boulevard, Creek, Fuel Tanks, Butler Building, and Marsh areas

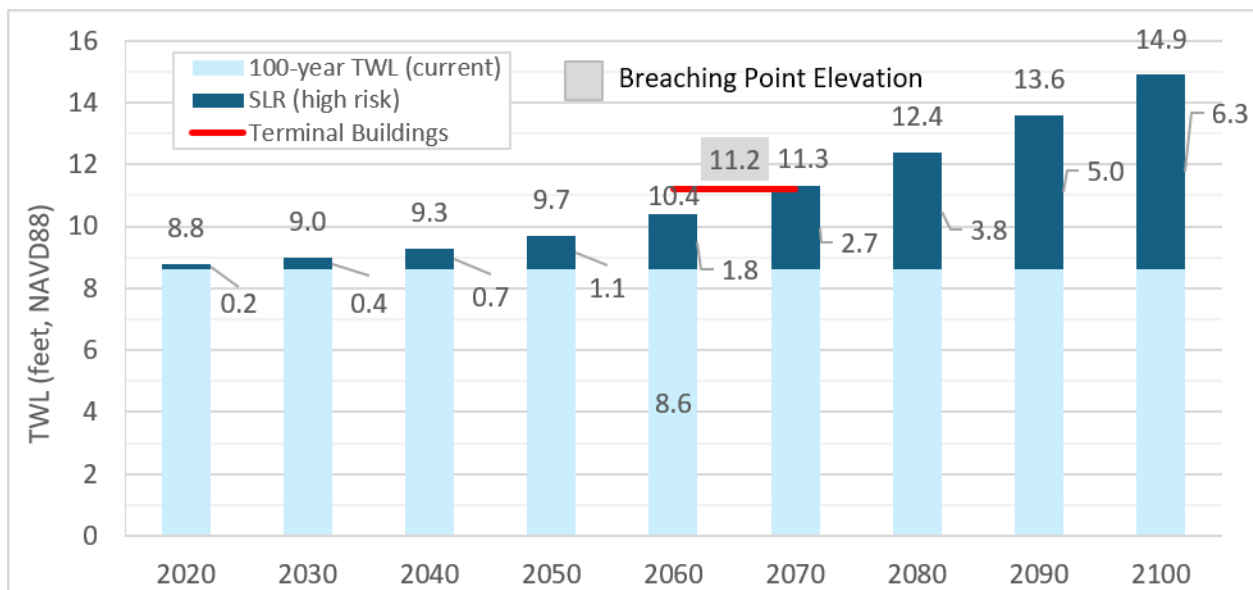


Figure 39. Projected TWLs for the high risk aversion scenario and breaching point elevation of the Larkspur Ferry Terminal Buildings area

Table 5 lists the areas ordered from the earliest to the latest, when the breaching points in each area are expected to be exceeded by the projected TWLs for the selected risk aversion scenarios.

**Table 5. Years when the projected TWLs for the selected risk aversion scenarios would exceed the breaching points in each area**

| Years     | Area               | Breaching Point Elevation (feet NAVD88) | Risk Aversion Scenario | Projected TWL (feet NAVD88) |
|-----------|--------------------|-----------------------------------------|------------------------|-----------------------------|
| 2020-2030 | Butler Building    | 7.7                                     | Intermediate           | 8.8 – 8.9                   |
| 2020-2030 | Creek              | 8.4                                     | Intermediate           | 8.8 – 8.9                   |
| 2020-2030 | Undeveloped        | 8.5                                     | Low                    | 8.7 – 8.8                   |
| 2040-2050 | Marsh              | 9.2                                     | Intermediate           | 9.1 – 9.3                   |
| 2060-2070 | Fuel Tanks         | 9.7                                     | Intermediate           | 9.5 – 9.8                   |
| 2060-2070 | LFT Buildings      | 11.2                                    | High                   | 10.4 – 11.3                 |
| 2070-2080 | East SFD Boulevard | 9.8                                     | Intermediate           | 9.8 – 10.2                  |
|           |                    |                                         |                        |                             |

### 5.3.1 Butler Building Area

In the Butler Building area, the TWL for the intermediate risk aversion scenario is projected to reach 8.9 feet NAVD88 by 2030 (see Figure 38). Once the projected TWL exceeds the breaching point elevation of 7.7 feet NAVD88, the employee parking lot and adjacent areas will be flooded. The impact of similar extreme high TWLs was observed on January 2 to 4, 2026 when the peak TWL reached 8.73 feet NAVD88. That event could be used as a proxy for this area.

Figure 40 shows a schematic of the potential floodwater pathways in the Butler Building area for the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 7.7 feet NAVD88 breaching point.

Figure 41 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtops the breaching point and adjacent low-lying areas for an infinite duration. This extent of flooding is unlikely to occur, as the duration of the TWL above the breaching point elevation and adjacent low-lying areas will be limited. Furthermore, the extent of flooding will be controlled not only by the duration of the overtopping but also by site-specific factors affecting floodwater propagation, such as topography, surface permeability, existing structures, flow pathways, and drainage characteristics. Hydrodynamic flood modeling accounting for these factors would be needed to accurately quantify the spatial extent and depth of flooding.

To illustrate the importance of duration, Figure 42 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 0.2 foot to account for SLR by 2030 (intermediate risk aversion). If such event would occur by 2030, the Butler Building area waterfront would be overtopped for approximately 15 hours over the five-day period.



Figure 40. Schematic of potential floodwater pathways in the Butler Building area for the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 7.7 feet NAVD88 breaching point

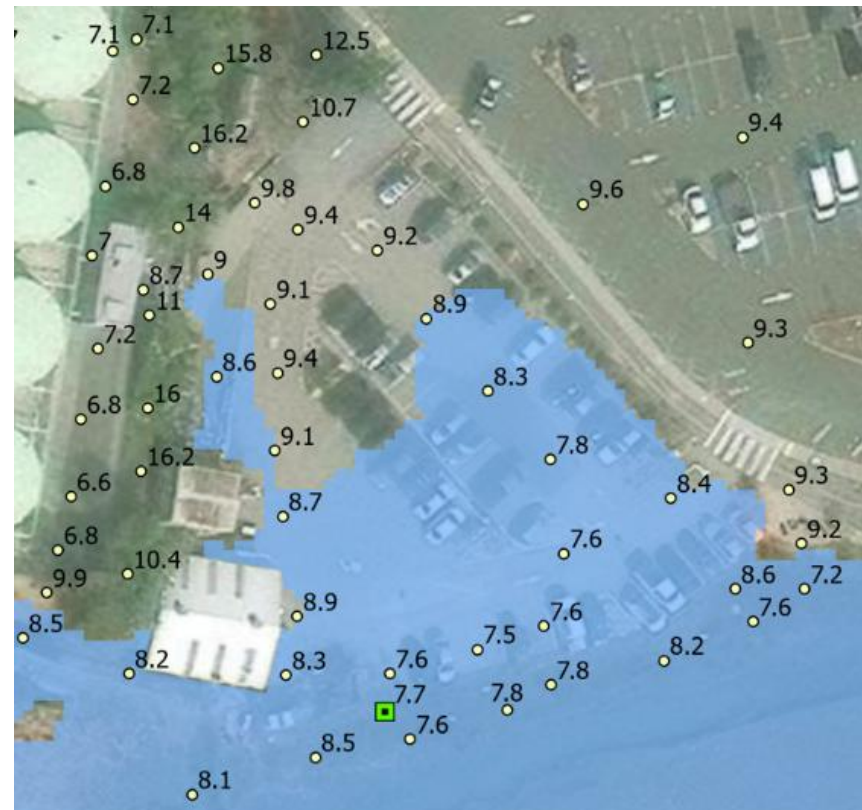


Figure 41. Potential extent of flooding in the Butler Building area assuming infinite duration of the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 7.7 feet NAVD88 breaching point and low-lying areas

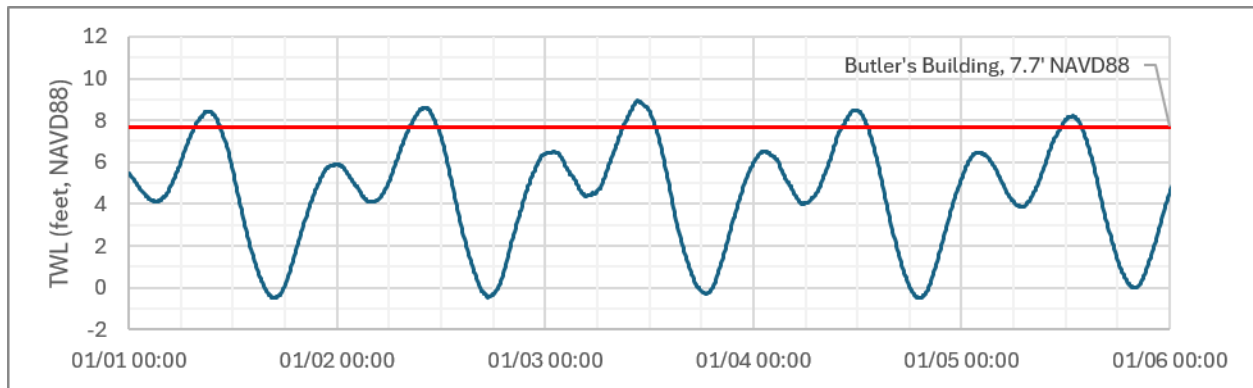


**Figure 42.** TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 0.2 feet to represent the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 7.7 feet NAVD88 breaching point (NOAA 2025b)

### 5.3.2 Creek Area

In the Creek area, the TWL for the intermediate risk aversion scenario is projected to reach 8.9 feet NAVD88 by 2030 (see Figure 38). Once the projected TWL exceeds the breaching point elevation of 8.4 feet NAVD88, the bike path, main parking lot and adjacent areas in the northwest corner of the LFT will be flooded.

Figure 43 shows a schematic of the potential floodwater pathways in the Creek area for the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 8.4 feet NAVD88 breaching point.

Figure 44 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtops the breaching point and adjacent low-lying areas for an infinite duration. This extent of flooding is unlikely to occur, as the duration of the TWL above the breaching point elevation and adjacent low-lying areas will be limited. Furthermore, the extent of flooding will be controlled not only by the duration of overtopping but also by site-specific factors affecting floodwater propagation, such as topography, surface permeability, existing structures, flow pathways, and drainage characteristics. Hydrodynamic flood modeling accounting for these factors would be needed to accurately quantify the spatial extent and depth of flooding.

To illustrate the importance of duration, Figure 45 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 0.3 foot to account for SLR by 2030 (intermediate risk aversion). If such event would occur by 2030, the Creek area waterfront would be overtopped for approximately 6.5 hours over the five-day period.



Figure 43. Schematic of potential floodwater pathways in the Creek area for the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 8.4 feet NAVD88 breaching point



Figure 44. Potential extent of flooding in the Creek area assuming infinite duration of the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 8.4 feet NAVD88 breaching point and adjacent low-lying areas

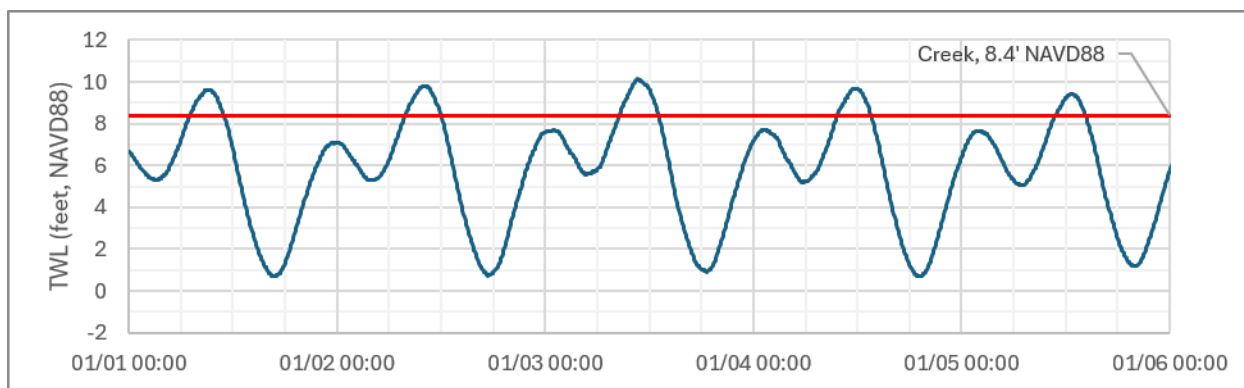


**Figure 45.** TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 0.3 feet to represent the projected 8.9 feet NAVD88 TWL by 2030 (intermediate risk aversion) overtopping the 8.4 feet NAVD88 breaching point (NOAA 2025b)

### 5.3.3 Undeveloped Area

In the Undeveloped area, the TWL for the low risk aversion scenario is projected to reach 8.8 feet NAVD88 by 2030 (see Figure 37). Once the projected TWL exceeds the breaching point elevation of 8.5 feet NAVD88, the low-lying areas at the north end of the LFT basin will be flooded.

Figure 46 shows a schematic of the potential floodwater pathways in the Undeveloped area for the projected 8.8 feet NAVD88 TWL by 2030 (low risk aversion) overtopping the 8.5 feet NAVD88 breaching point.

Figure 47 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 8.8 feet NAVD88 TWL by 2030 (low risk aversion) overtops the breaching point and adjacent low-lying areas for an infinite duration. This extent of flooding is unlikely to occur, as the duration of the TWL above the breaching point elevation and adjacent low-lying areas will be limited. Furthermore, the extent of flooding will be controlled not only by the duration of overtopping but also by site-specific factors affecting floodwater propagation, such as topography, surface permeability, existing structures, flow pathways, and drainage characteristics. Hydrodynamic flood modeling accounting for these factors would be needed to accurately quantify the spatial extent and depth of flooding.

To illustrate the importance of duration, Figure 48 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 0.1 foot to account for SLR by 2030 (low risk aversion). If such event would occur by 2030, the Undeveloped area would be overtopped for approximately 2 hours over the five-day period.



Figure 46. Schematic of potential floodwater pathways in the Undeveloped area for the projected 8.8 feet NAVD88 TWL by 2030 (low risk aversion) overtopping the 8.5 feet NAVD88 breaching point

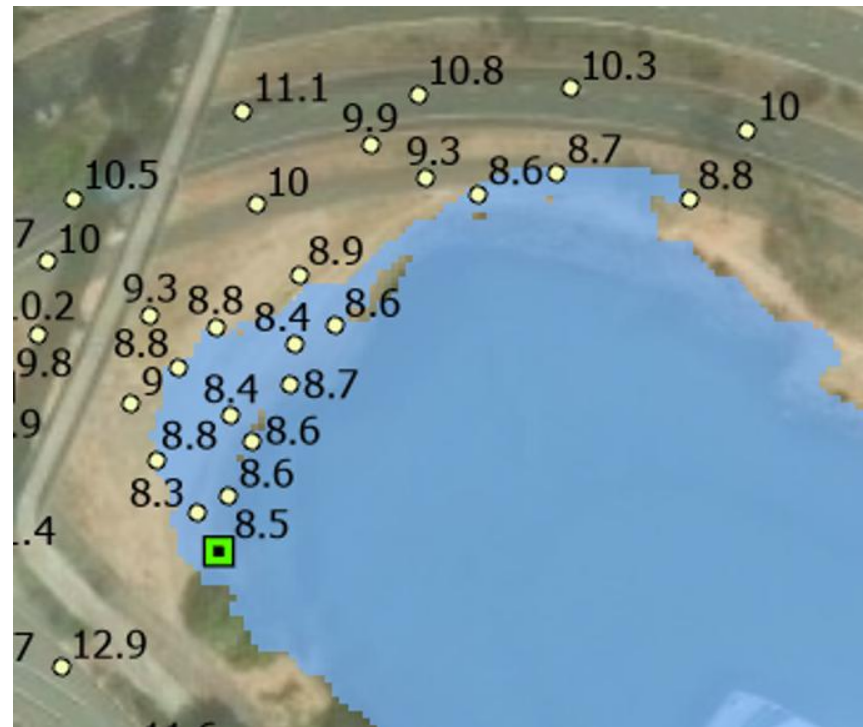


Figure 47. Potential extent of flooding in the Undeveloped area assuming infinite duration of the projected 8.8 feet NAVD88 TWL by 2030 (low risk aversion) overtopping the 8.5 feet NAVD88 breaching point and adjacent low-lying areas

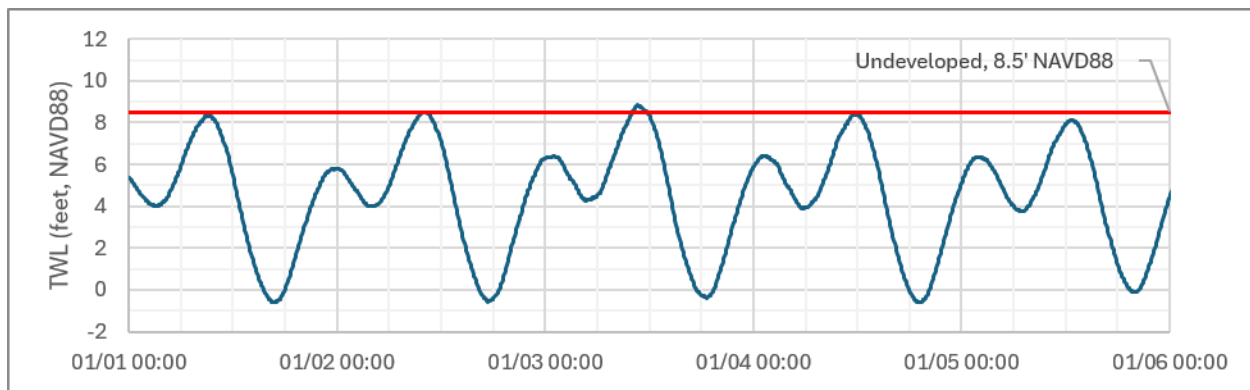


**Figure 48.** TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 0.1 feet to represent the projected 8.8 feet NAVD88 TWL by 2030 (low risk aversion) overtopping the 8.5 feet NAVD88 breaching point (NOAA 2025b)

### 5.3.4 Marsh Area

In the Marsh area, the TWL for the intermediate risk aversion scenario is projected to reach 9.3 feet NAVD88 by 2050 (see Figure 38). Once the projected TWL exceeds the breaching point elevation of 9.2 feet NAVD88, the bike path, adjacent access road and main parking lot in the southern area of the LFT will be flooded.

Figure 49 shows a schematic of the potential floodwater pathways in the Marsh area for the projected 9.3 feet NAVD88 TWL by 2050 (intermediate risk aversion) overtopping the 9.2 feet NAVD88 breaching point.

Figure 50 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 9.3 feet NAVD88 TWL by 2050 (intermediate risk aversion) overtops the breaching point and adjacent low-lying areas for an infinite duration. This extent of flooding is unlikely to occur, as the duration of the TWL above the breaching point elevation and adjacent low-lying areas will be limited. Furthermore, the extent of flooding will be controlled not only by the duration of overtopping but also by site-specific factors affecting floodwater propagation, such as topography, surface permeability, existing structures, flow pathways, and drainage characteristics. Hydrodynamic flood modeling accounting for these factors would be needed to accurately quantify the spatial extent and depth of flooding.

To illustrate the importance of duration, Figure 51 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 0.6 foot to account for SLR by 2050 (intermediate risk aversion). If such event would occur by 2050, the Marsh area would be overtopped for approximately 1 hour over the five-day period



Figure 49. Schematic of potential floodwater pathways in the Marsh area for the projected 9.3 feet NAVD88 TWL by 2050 (intermediate risk aversion) overtopping the 9.2 feet NAVD88 breaching point

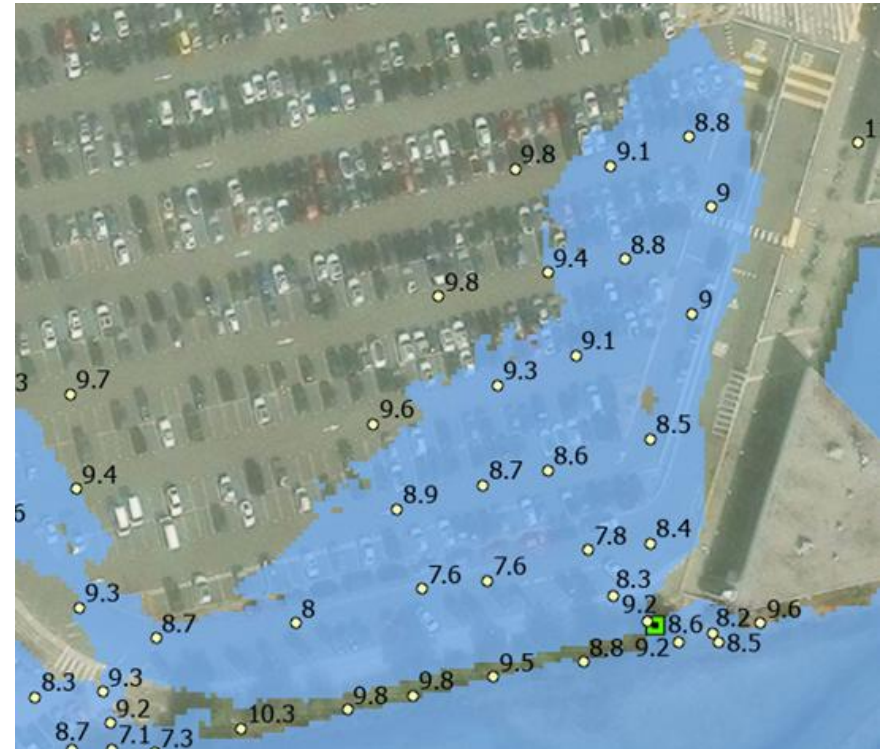


Figure 50. Potential extent of flooding in the Marsh area assuming infinite duration of the projected 9.3 feet NAVD88 TWL by 2050 (intermediate risk aversion) overtopping the 9.2 feet NAVD88 breaching point and adjacent low-lying areas

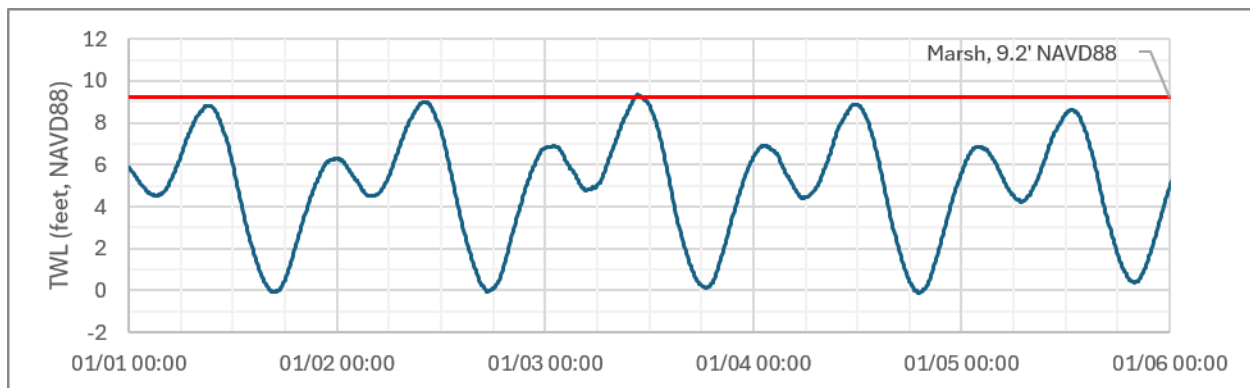


**Figure 51.** TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 0.6 feet to represent the projected 9.3 feet NAVD88 TWL by 2050 (intermediate risk aversion) overtopping the 9.2 feet NAVD88 breaching point (NOAA 2025b)

### 5.3.5 Fuel Tanks Area

In the Fuel Tanks area, the TWL for the intermediate risk aversion scenario is projected to reach 9.8 feet NAVD88 by 2070 (see Figure 38). Once the projected TWL exceeds the breaching point elevation of 9.7 feet NAVD88 (top of the engineered levee), the tanks containment area will be flooded.

Figure 52 shows a schematic of the potential floodwater pathways in the Fuel Tanks area for the projected 9.8 feet NAVD88 TWL by 2070 (intermediate risk aversion) overtopping the 9.7-foot NAVD88 high engineered levee.

Figure 53 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 9.8 feet NAVD88 TWL by 2070 (intermediate risk aversion) overtops the engineered levee. Hydrodynamic flood modeling would be needed to determine the volume and depth of floodwater in the containment area.

To illustrate the importance of duration, Figure 54 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 1.1 feet to account for SLR by 2070 (intermediate risk aversion). If such event would occur by 2070, the Fuel Tanks area would be overtopped for approximately 1 hour over the five-day period.



Figure 52. Schematic of potential floodwater pathways in the Fuel Tanks area for the projected 9.8 feet NAVD88 TWL by 2070 (intermediate risk aversion) overtopping the 9.7-foot NAVD88 high engineered levee

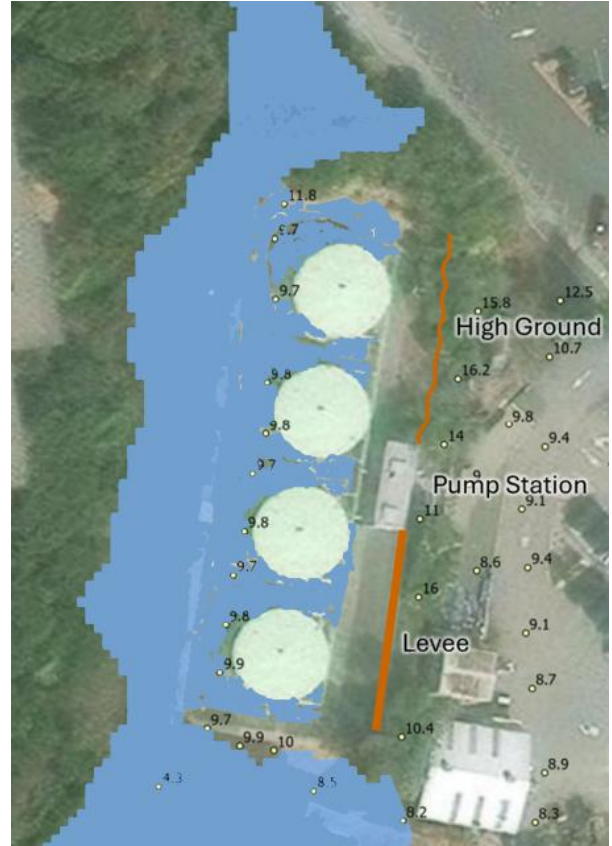


Figure 53. Potential extent of flooding of the Fuel Tanks area and tanks containment area assuming infinite duration of the projected 9.8 feet NAVD88 TWL by 2070 (intermediate risk aversion) overtopping the 9.7-foot NAVD88 high engineered levee and adjacent low-lying areas

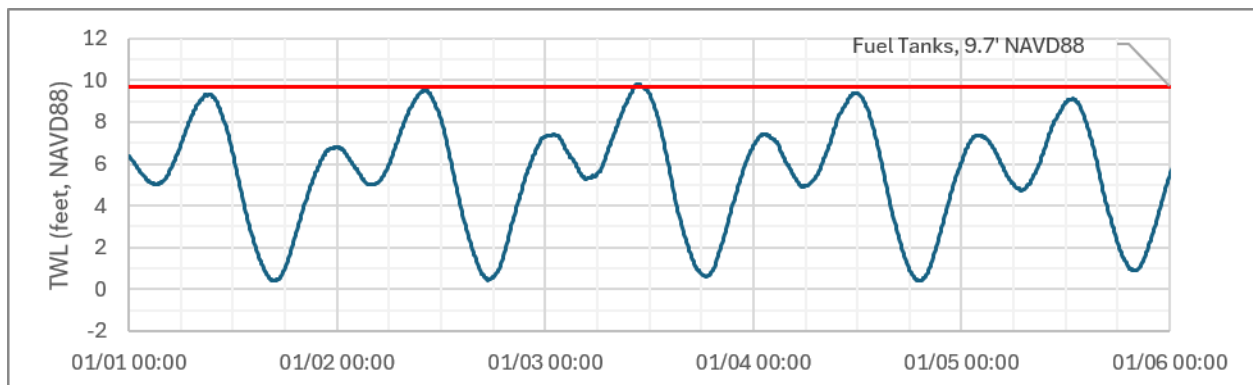


Figure 54. TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 1.1 feet to represent the projected 9.8 feet NAVD88 TWL by 2070 (intermediate risk aversion) overtopping the 9.7-foot NAVD88 high engineered levee (NOAA 2025b)

### 5.3.6 Larkspur Ferry Terminal Buildings Area

In the LFT Buildings area, the TWL for the high risk aversion scenario is projected to reach 11.3 feet NAVD88 by 2070 (see Figure 39). Once the projected TWL exceeds the breaching point elevation of 11.2 feet NAVD88 at Berth 3, the landside areas to the north and south, including the access road and main parking lot, will be flooded.

Figure 55 shows a schematic of the potential floodwater pathways in the Berth 3 area for the projected 11.3 feet NAVD88 TWL by 2070 (high risk aversion) overtopping the 11.2 feet NAVD88 breaching point.

Figure 56 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 11.3 feet NAVD88 TWL by 2070 (high risk aversion) overtops the breaching point and adjacent low-lying areas for an infinite duration. This extent of flooding is unlikely to occur, as the duration of the TWL above the breaching point elevation and adjacent low-lying areas will be limited. Furthermore, the extent of flooding will be controlled not only by the duration of the overtopping but also by site-specific factors affecting floodwater propagation, such as topography, surface permeability, existing structures, flow pathways, and drainage characteristics. Hydrodynamic flood modeling accounting for these factors would be needed to accurately quantify the spatial extent and depth of flooding.

To illustrate the importance of duration, Figure 57 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 2.6 feet to account for SLR by 2070 (high risk aversion). If such event would occur by 2070, the Berth 3 area would be overtopped for approximately 1 hour over the five-day period.

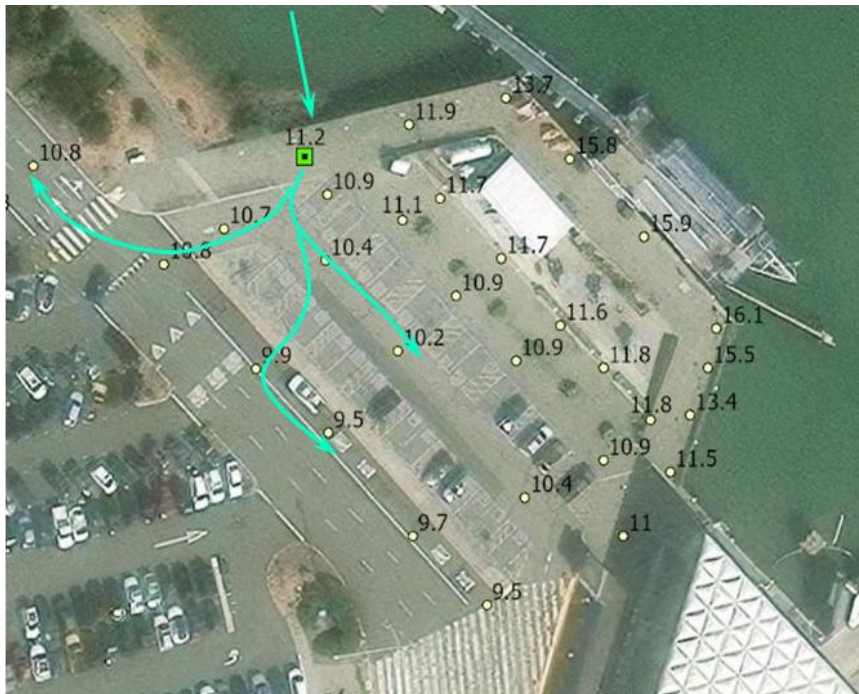


Figure 55. Schematic of potential floodwater pathways in the Larkspur Ferry Terminal Buildings Berth 3 for the projected 11.3 feet NAVD88 TWL by 2070 (high risk aversion) overtopping the 11.2 feet NAVD88 breaching point

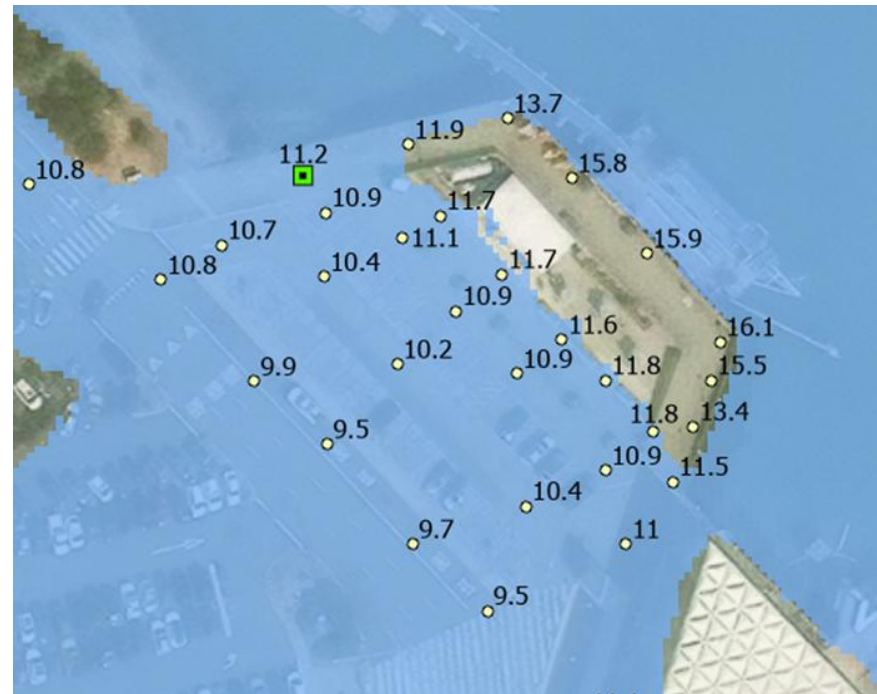


Figure 56. Potential extent of flooding in the Larkspur Ferry Terminal Buildings Berth 3 assuming infinite duration of the projected 11.3 feet NAVD88 TWL by 2070 (high risk aversion) overtopping the 11.2 feet NAVD88 breaching point and low-lying areas

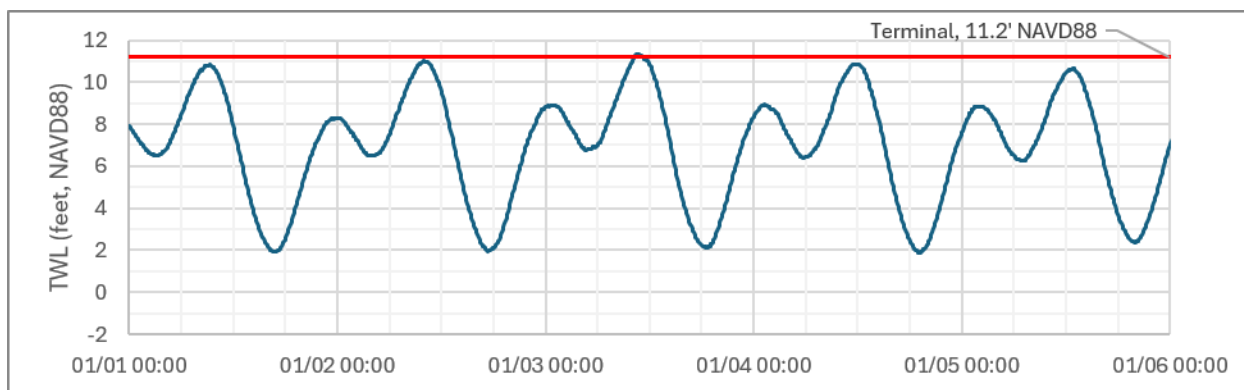


**Figure 57.** TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 2.6 feet to represent the projected 11.3 feet NAVD88 TWL by 2070 (high risk aversion) overtopping the 11.2 feet NAVD88 breaching point (NOAA 2025b)

### 5.3.7 East Sir Francis Drake Boulevard Area

In the SFD Boulevard area, the TWL for the intermediate risk aversion scenario is projected to reach 10.2 feet NAVD88 by 2080 (see Figure 38). Once the projected TWL exceeds the breaching point elevation of 9.8 feet NAVD88, the LFT access/exit roads lot will be flooded.

Figure 58 shows a schematic of the potential floodwater pathways in the SFD Boulevard area for the projected 10.2 feet NAVD88 TWL by 2080 (intermediate risk aversion) overtopping the 9.8 feet NAVD88 breaching point.

Figure 59 shows the potential extent of flooding (i.e., the area with elevations below the projected TWL) when the 10.2 feet NAVD88 TWL by 2080 (intermediate risk aversion) overtops the breaching point and adjacent low-lying areas for an infinite duration. This extent of flooding is unlikely to occur, as the duration of the TWL above the breaching point elevation and adjacent low-lying areas will be limited. Furthermore, the extent of flooding will be controlled not only by the duration of overtopping but also by site-specific factors affecting floodwater propagation, such as topography, surface permeability, existing structures, flow pathways, and drainage characteristics. Hydrodynamic flood modeling accounting for these factors would be needed to accurately quantify the spatial extent and depth of flooding.

To illustrate the importance of duration, Figure 60 shows the TWLs measured at NOAA station 9414863 Richmond (NOAA 2025b) between January 1 and 6, 2026 (the highest on record and representative of the 100-year TWL) augmented by 1.5 feet to account for SLR by 2080 (intermediate risk aversion). If such event would occur by 2080, the SFD Boulevard area would be overtopped for approximately 3 hours over the five-day period



**Figure 58. Schematic of potential floodwater pathways in the Sir Francis Drake Boulevard area for the projected 10.2 feet NAVD88 TWL by 2080 (intermediate risk aversion) overtopping the 9.8 feet NAVD88 breaching point**



**Figure 59. Potential extent of flooding in the Sir Francis Drake Boulevard area assuming infinite duration of the projected 10.2 feet NAVD88 TWL by 2080 (intermediate risk aversion) overtopping the 9.8 feet NAVD88 breaching point and adjacent low-lying areas**

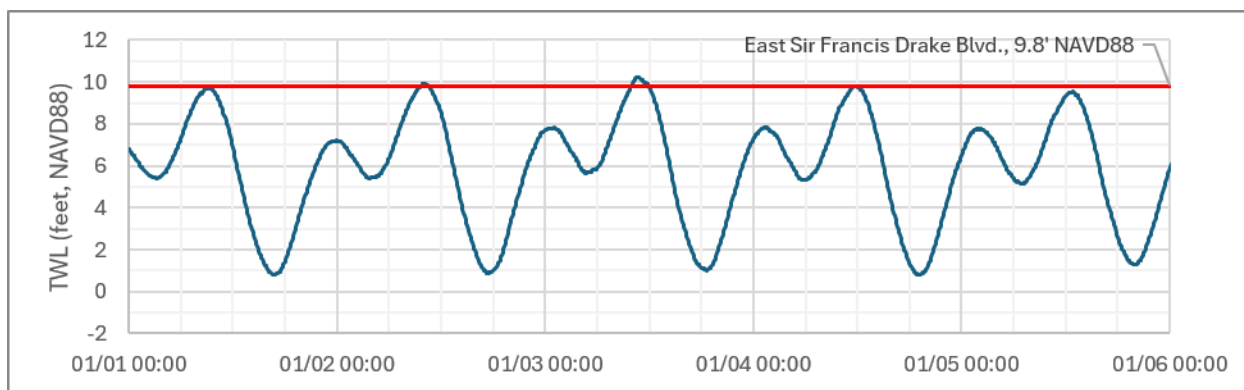


**Figure 60.** TWL measured at NOAA station 9414863 Richmond between January 1 and 6, 2026, augmented by SLR = 1.5 feet to represent the projected 10.2 feet NAVD88 TWL by 2080 (intermediate risk aversion) overtopping the 9.8 feet NAVD88 breaching point (NOAA 2025b)

## 5.4 Groundwater Emergence

The Paved area is vulnerable to groundwater emergence flooding. Due to the LFT's proximity and its direct hydraulic connection to the Corte Madera Creek, coupled with the absence of cut-off walls or other subsurface barriers, the LFT soils are not expected to significantly impede landward groundwater flows. As a result, and in the long term, GLs are anticipated to track changes in MSL closely, with negligible lag attributable to soil hydraulic conductivity.

Therefore, projected long-term GLs due to SLR were estimated combining the current MSL at NOAA station 9414863 Richmond (NOAA 2025b) (3.3 feet NAVD88, see Table 2) with the high risk scenario SLR projections (see Table 3). Groundwater emergence was estimated by subtracting the projected long-term GLs from the ground elevations in the NOAA DEM.

The assessment showed that, in the Paved area and for the high risk scenario, no groundwater would emerge before the year 2080. However, groundwater is expected to emerge within the fuel tank containment area between 2070 and 2080, as the elevation of the containment area floor (approximately 6 to 7 feet NAVD88) is lower than the projected groundwater elevation of 7.1 feet NAVD88 in 2080.

Table 6 lists the GLs for years 2080 through 2100 for the high risk aversion scenario. Figure 61 and Figure 62 show the perimeter of the planned Main Lot Garage and the GLs in feet below ground level (BGL) for years 2080, 2090 and 2100 for the high risk aversion scenario. Within the Main Lot Garage perimeter, Figure 61 shows the GLs when the first floor of the Main Lot Garage is at the current ground elevation, which ranges between 8.4 and 14 feet NAVD88 and averages 10.5 feet NAVD88. Figure 62 shows the GLs when the first floor of the Main Lot Garage is built at 11.4 feet NAVD88.

If the first floor of the Main Lot Garage is built at the current ground elevation, Figure 61 shows that by 2080, the GLs within the perimeter of the Main Lot Garage would be 1 to 2 feet BGL in the southern area of the Main Lot Garage and within 1 foot or at the ground level by 2090, and groundwater would emerge by 2100. However, it is important to note that the GLs shown are long-term averages and that the temporary increases in GL due to extreme high TWLs would result in episodic groundwater emergence. Figure 62 shows that if the first floor of the Main Lot Garage is built at 11.4 feet NAVD88 the groundwater emergence could be prevented but only within the Main Lot Garage perimeter.

Additionally, both figures show that by 2080 and beyond, groundwater would emerge in the fuel tanks containment area.

**Table 6. Current MSL, high risk aversion scenario SLR projections and GLs for years 2080 through 2100**

| Year | MSL<br>(feet NAVD88) | SLR<br>(feet NAVD88) | Groundwater Level<br>(feet NAVD88) |
|------|----------------------|----------------------|------------------------------------|
| 2080 | 3.3                  | 3.8                  | 7.1                                |
| 2090 | 3.3                  | 5.0                  | 8.3                                |
| 2100 | 3.3                  | 6.3                  | 9.6                                |

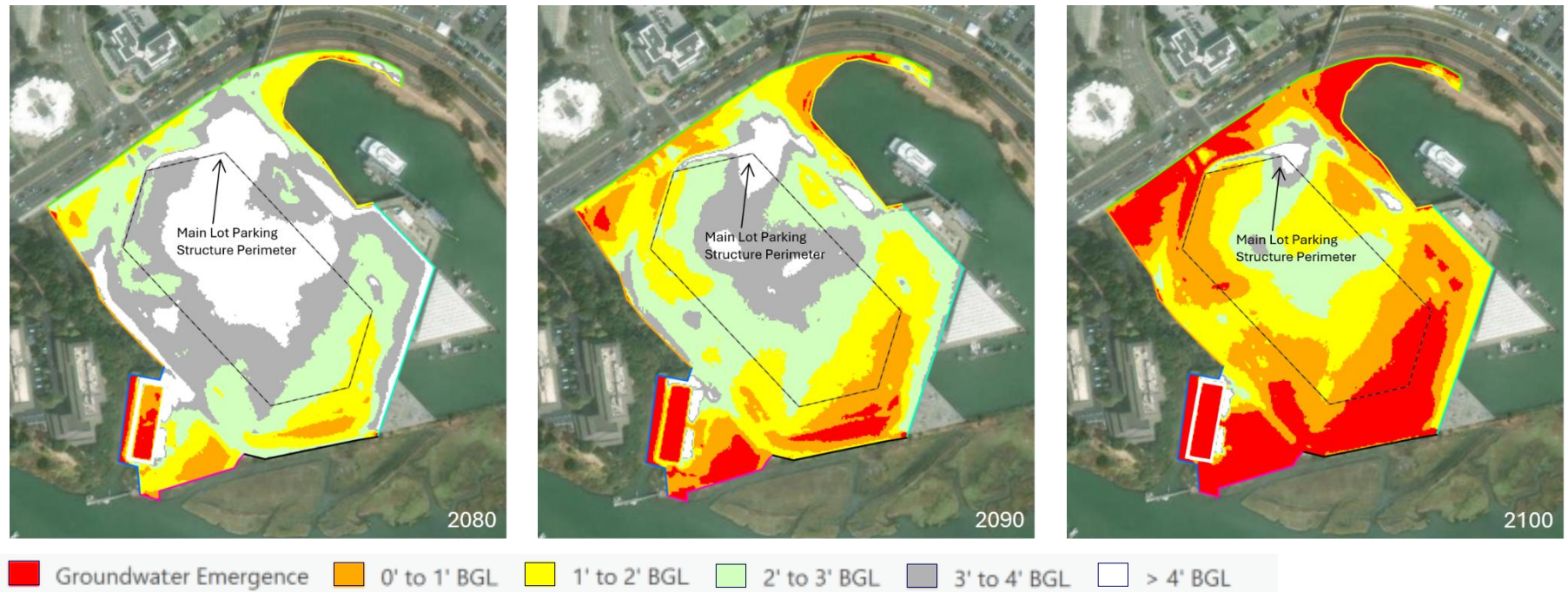


Figure 61. Depth of groundwater (feet, BGL) for years 2080 (left), 2090 (center) and 2100 (right) for the high risk aversion scenario, first floor of the Main Lot Parking Garage built at the ground elevation

Larkspur Ferry Terminal  
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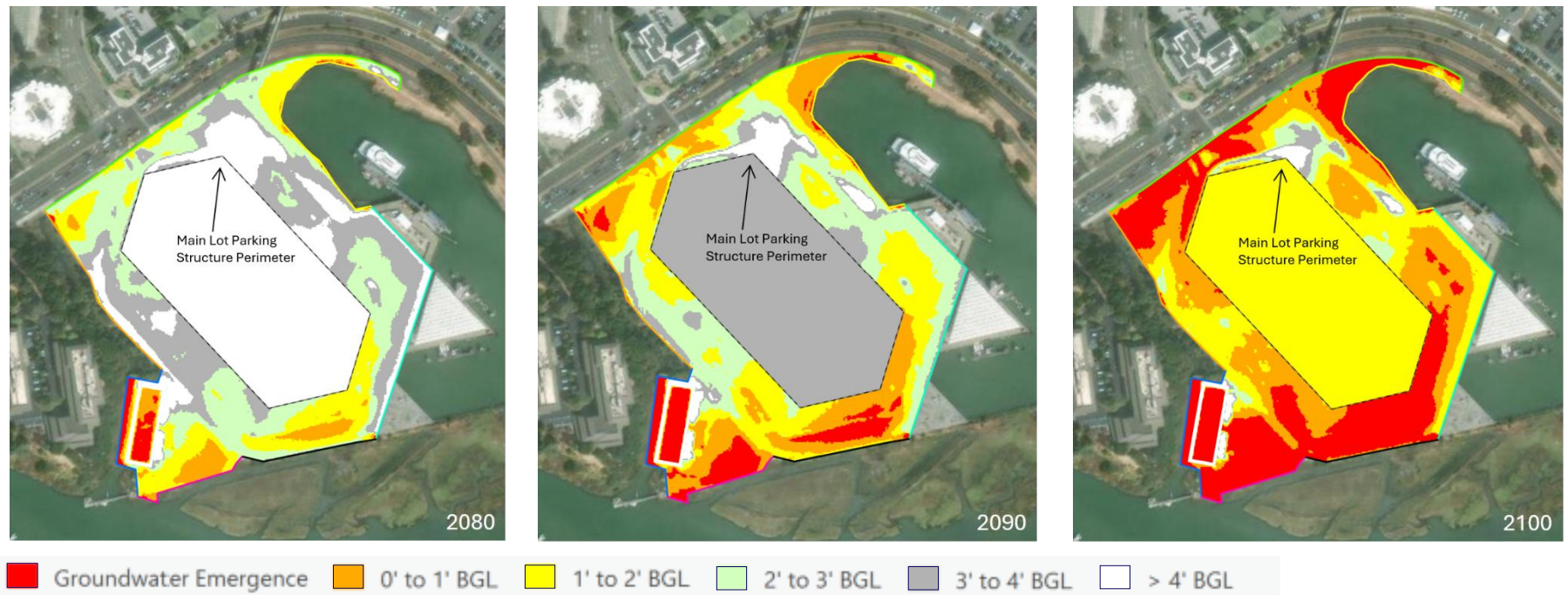


Figure 62. Depth of groundwater (feet, BGL) for years 2080 (left), 2090 (center) and 2100 (right) for the high risk aversion scenario, first floor of the Main Lot Parking Garage built at 11.4 feet NAVD88

## 5.5 Summary

Table 7 presents a summary of the vulnerability assessment. Figure 63 shows the breaching points at each area selected for the assessment and potential extent of high TWL flooding from 2030 to 2080. The potential areas extent of groundwater emergence flooding is shown in Figure 62. Hydrodynamic flood modeling accounting for factors such as floodwater overtopping duration, topography, surface permeability, existing structures, flow pathways, and drainage characteristics would be needed to accurately determine flooding pathways and quantify spatial extent and depth of flooding.

**Table 7. Summary of vulnerability assessment**

| Years                                                                                                                                                          | Area                          | Hazard                | Breaching Point Elevation (feet NAVD88) | Projected TWL (feet NAVD88) | Vulnerable Assets                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------------------|-----------------------------------------|-----------------------------|-----------------------------------------------------------------------------|
| 2020-2030                                                                                                                                                      | Butler Building               | High TWL              | 7.7                                     | 8.8 – 8.9                   | Employee parking lot                                                        |
| 2020-2030                                                                                                                                                      | Creek                         | High TWL              | 8.4                                     | 8.8 - 8.9                   | Northwest corner of the LFT: bike path, main parking lot and utility vaults |
| 2020-2030                                                                                                                                                      | Undeveloped                   | High TWL              | 8.5                                     | 8.7 – 8.8                   | None                                                                        |
| 2040-2050                                                                                                                                                      | Marsh                         | High TWL              | 9.2                                     | 9.1 - 9.3                   | Southern area of the LFT: main parking lot, road and utility vaults         |
| 2060-2070                                                                                                                                                      | Fuel Tanks                    | High TWL              | 9.7                                     | 9.5 – 9.8                   | Fuel tanks, pipelines                                                       |
| 2060-2070                                                                                                                                                      | LFT Buildings                 | High TWL              | 11.2                                    | 10.4 – 11.3                 | Buildings, passenger and ferry boarding areas, utility vaults               |
| 2070-2080                                                                                                                                                      | East SFD Boulevard            | High TWL              | 9.8                                     | 9.8 – 10.2                  | Roads, main parking lot and utility vaults                                  |
| 2080                                                                                                                                                           | Fuel Tanks                    | Groundwater Emergence | N/A                                     | N/A                         | Containment area                                                            |
| 2090                                                                                                                                                           | Butler Building, Marsh, Paved | Groundwater Emergence | N/A                                     | N/A                         | Employee and main (south) parking lots, bike path, utility vaults           |
| 2100                                                                                                                                                           | Paved                         | Groundwater Emergence | N/A                                     | N/A                         | Main parking lot (north) and Main Lot Garage <sup>[a]</sup>                 |
| <sup>[a]</sup> Groundwater emergence flooding if first floor of Main Lot Garage is built at existing ground level, not vulnerable if built at 11.4 feet NAVD88 |                               |                       |                                         |                             |                                                                             |

# Larkspur Ferry Terminal Sea Level Rise Impact Assessment



Year 2030, TWL = 8.9 feet NAVD88



Year 2050, TWL = 9.3 feet NAVD88



Year 2070, TWL = 9.8 feet NAVD88



Year 2080, TWL = 10.2 feet NAVD88



Year 2070, TWL = 11.3 feet NAVD88

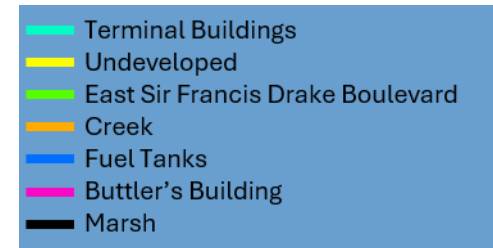


Figure 63. Breaching points and potential extent of flooding from 2030 to 2080 assuming no adaptation measures are implemented, year 2030 low and intermediate risk aversion scenarios, years 2050 and 2070 intermediate, and year 2080 high risk aversion scenario

## 6. Risk Assessment and Adaptation Plan

### 6.1 Risk Assessment

The vulnerability assessment identified the LFT's vulnerabilities and established, for the selected risk aversion scenarios and associated SLR projections, the timeline by which adaptation measures must be operational. The risk assessment complemented the vulnerability assessment by evaluating the significance of those vulnerabilities based on the likelihood of the flood hazards and their potential consequences, providing a basis for prioritizing areas and adaptation measures and allocating resources.

The likelihood of a hazard is inversely related to the level of risk aversion of the selected scenario. For example, SLR projections for a high-risk aversion scenario are based on highly conservative assumptions intended to reflect extreme, very low probability conditions. Within a standard risk framework, where risk is assessed as a function of both the likelihood of occurrence and the consequences of the hazard, the very low likelihood associated with the high-risk aversion scenario means that the overall risk will remain relatively low, even though the potential consequences may be severe.

The risk assessment was based on qualitative ratings of likelihood and consequences. Table 8 lists the qualitative levels of likelihood, corresponding risk aversion scenarios and ratings, and Table 9 lists the qualitative levels of consequence and ratings. Table 10 shows the risk assessment matrix (per PIANC 2020) used to derive the qualitative risk levels for each LFT area. Table 11 describes recommended adaptation actions for each risk level.

**Table 8. Qualitative levels of likelihood, risk aversion scenarios and ratings**

| Likelihood                             | Risk Aversion Scenario | Rating |
|----------------------------------------|------------------------|--------|
| Rare, very unlikely                    | High                   | 1      |
| Unlikely, could occur but not expected | Intermediate high      | 2      |
| Possible, might occur                  | Intermediate           | 3      |
| Likely, expected to occur              | Intermediate low       | 4      |
| Almost certain, will occur             | Low                    | 5      |

**Table 9. Qualitative levels of consequence and ratings**

| Consequence   | Description                                            | Rating |
|---------------|--------------------------------------------------------|--------|
| Insignificant | Negligible operational disruption, no damage           | 1      |
| Minor         | Limited operational disruption, minor repairs          | 2      |
| Moderate      | Noticeable operational disruption, moderate damage     | 3      |
| Major         | Significant operational disruption, substantial damage | 4      |
| Severe        | Operations shutdown, major damage/loss                 | 5      |

**Table 10. Typical risk assessment matrix, risk level = likelihood x consequence (PIANC 2020)**

| <b>Likelihood →</b><br><b>Consequence ↓</b> | <b>Rare<br/>(1)</b> | <b>Unlikely<br/>(2)</b> | <b>Possible<br/>(3)</b> | <b>Likely<br/>(4)</b> | <b>Almost<br/>Certain<br/>(5)</b> |
|---------------------------------------------|---------------------|-------------------------|-------------------------|-----------------------|-----------------------------------|
| Insignificant(1)                            | 1                   | 2                       | 3                       | 4                     | 5                                 |
| Minor (2)                                   | 2                   | 4                       | 6                       | 8                     | 10                                |
| Moderate (3)                                | 3                   | 6                       | 9                       | 12                    | 15                                |
| Major (4)                                   | 4                   | 8                       | 12                      | 16                    | 20                                |
| Severe (5)                                  | 5                   | 10                      | 15                      | 20                    | 25                                |
| <b>Risk Level</b>                           | <b>low</b>          | <b>moderate</b>         | <b>high</b>             | <b>very high</b>      |                                   |

**Table 11. Risk levels and recommended actions**

| <b>Risk Level</b> | <b>Recommended Action</b>                                   |
|-------------------|-------------------------------------------------------------|
| <b>Low</b>        | Monitoring and management                                   |
| <b>Moderate</b>   | Adaptation required within existing asset management cycles |
| <b>High</b>       | Adaptation required as high priority                        |
| <b>Very High</b>  | Immediate adaptation required                               |

Table 12 presents the risk assessment for the selected LFT areas. The likelihood rankings due to high TWL and groundwater emergence flooding were determined based on the criteria presented in Table 4 and Table 8. Consequences were assessed by considering the presence of critical assets and the potential impacts of flooding on LFT operations, including service disruptions and damage to assets (infrastructure, utilities). According to the risk assessment, the following actions are recommended:

- High Risk Level: East SFD Boulevard, Fuel Tanks and Butler Building areas: adaptation required as a high priority.
- Moderate Risk Level: LFT Buildings, Undeveloped, Creek, Marsh and Paved areas: adaptation required within existing asset management (maintenance, repair, rehabilitation, and replacement) cycles.

Table 12. Larkspur Ferry Terminal Risk Assessment Summary

| Area                                                                                                                                                                                                                    | Risk Aversion Scenario | Likelihood Rating | Consequence                                                                                            | Risk Level |    |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------|--------------------------------------------------------------------------------------------------------|------------|----|----------|
| <b>LFT Buildings:</b> includes critical assets: buildings, berths, utilities, walkways, structures and facilities for passenger loading/offloading and ferry berthing, built overwater on pile-supported concrete decks | High                   | 1                 | Operations shutdown, major damage/loss to structures and utilities                                     | 5          | 5  | Moderate |
| <b>Undeveloped:</b> no critical assets, mainly a barren lowland.                                                                                                                                                        | Low                    | 5                 | None                                                                                                   | 1          | 5  | Moderate |
| <b>East SFD Boulevard:</b> no critical assets, but the only pedestrian and vehicular (cars, buses, bikes, etc.) access to the LFT                                                                                       | Intermediate           | 3                 | Significant operational disruption due to impaired access and parking, substantial damage to utilities | 4          | 12 | High     |
| <b>Creek:</b> no critical assets, but pedestrian and bike access at the northwest corner of the LFT, and small parking area                                                                                             | Intermediate           | 3                 | Limited operational disruption, minor repairs                                                          | 2          | 6  | Moderate |
| <b>Fuel Tanks:</b> includes critical assets: fuel tanks, pipelines and pump station                                                                                                                                     | Intermediate           | 3                 | Operations shutdown, major damage/loss                                                                 | 5          | 15 | High     |
| <b>Butler Building:</b> includes critical assets: IT server room, backup generator and HazMat locker                                                                                                                    | Intermediate           | 3                 | Operations shutdown, major damage/loss, potential hazmat leaks                                         | 5          | 15 | High     |
| <b>Marsh:</b> no critical assets, but pedestrian and vehicular access at the southern boundary of the LFT, and small parking area                                                                                       | Intermediate           | 3                 | Limited operational disruption, minor repairs                                                          | 2          | 6  | Moderate |
| <b>Paved:</b> includes critical assets: main and employee parking lots, roadways, pathways, bike paths, walkways and the planned Main Lot Garage                                                                        | High                   | 1                 | Operations shutdown, major damage/loss to structures and utilities                                     | 5          | 5  | Moderate |

## 6.2 Adaptation Plan

The vulnerability and risk assessments serve complementary but distinct purposes in supporting SLR adaptation planning for the LFT. The vulnerability assessment identified when specific areas of the LFT will become susceptible to flooding under the selected SLR projections and risk aversion scenarios. By comparing projected high TWLs to the waterfront breaching point elevations and GLs to the existing ground elevations, the ultimate horizon years by which adaptation measures must be fully operational were established. This approach effectively created a reverse-engineered timeline, working backward from the time flooding is expected to occur to determine when planning, design, permitting, funding, and construction work must begin.

The emphasis on a reverse-engineered timeline is particularly important when the implementation of adaptation measures will require lengthy design, environmental review and permitting processes, funding and construction. In order for an adaptation measure to be recognized as meeting the minimum standards under the National Flood Insurance Program, coordination with the Federal Emergency Management Agency for accreditation under Code of Federal Regulations 44 §65.10 will be required. This together with review by agencies such as the California Coastal Commission, the U.S. Army Corps of Engineers, and local permitting authorities can easily require five to ten years (or longer) from project inception to completion.

Consequently, the vulnerability assessment does more than identify future flooding thresholds; it provides the engineering justification necessary to trigger decisions and work well before floodwaters are expected to reach critical elevations. In this sense, the vulnerability assessment defines not only when a vulnerability may be realized, but also when work must commence to ensure the adaptation measures are operational on time.

The risk assessment adds another layer of information by evaluating the significance of the identified vulnerabilities based on both the likelihood of future flooding and the consequences if flooding would occur. While a vulnerability assessment may indicate that an asset will not be exposed until a time far into the future, the risk assessment may identify that asset as a high priority because of its critical physical and operational characteristics, the severe consequences if impacted by the hazard, and/or the long lead time required to develop the adaptation measure. This does not necessarily imply that a particular adaptation measure should be implemented immediately. Rather, it indicates that immediate actions (planning, design, etc.) are warranted to ensure that the measure can be delivered before the identified vulnerability threshold is reached. Therefore, the vulnerability assessment defines the adaptation measure operational deadline, whereas the risk assessment helps determine the urgency and prioritization of actions needed to meet that deadline.

The need for prioritization is particularly important because the LFT waterfront contains a wide range of elevations, asset types and criticalities, and operational functions. Combined with the progressive nature of SLR, these differences result in varying vulnerability timeframes across the LFT. As shown in Table 7, some areas may require adaptation measures immediately, while others may not face significant exposure until mid- or end of the century. As a result, adaptation measures will not all need to be implemented at the same time, nor will doing so be practical or cost-effective.

This reality supports the adoption of a phased approach to SLR adaptation planning. A phased approach ensures that adaptation measures are implemented in a timely, cost-effective, and flexible manner while reducing uncertainty and avoiding premature investment. Rather than attempting to protect the entire LFT at once, adaptation actions can be sequenced according to the projected vulnerability timelines and risk priorities.

A phased approach offers the following important advantages:

- It aligns adaptation investments with projected vulnerability timeframes, avoiding over-investment too early before it is needed while also reducing the risk of delayed action.
- Implementing all adaptation measures upfront can be prohibitively expensive, particularly when some impacts may not materialize for many decades and future conditions remain uncertain.
- Allows costs to be distributed over time, improving affordability and providing flexibility as conditions evolve.
- Incorporates adaptive management principles. SLR projections are subject to inherent uncertainty, and scientific understanding continues to evolve. A phased approach allows decisions to be revisited as new climate information becomes available, SLR projections are updated, and monitoring data provides greater confidence regarding future conditions. This flexibility can reduce the risk of either under-designing or over-designing adaptation measures.
- Allows early actions to focus on lower-cost or temporary measures while preserving the opportunity to implement larger and more expensive measures later if conditions warrant.
- Provides opportunities to integrate adaptation measures with existing asset management (maintenance, repair, rehabilitation, and replacement) cycles. By coordinating adaptation investments with planned upgrades, disruption to LFT operations can be minimized and overall project costs reduced.

Table 7 and Table 12 provide the basis for the adaptation plan. The analysis of alternatives, selection of preferred and design of adaptation measures is not within the scope of the assessment. However, in principle and except for the LFT Buildings area, the use of floodwalls (I or T-type walls), gates and ramps, and elevating existing levees and ground appear as feasible alternatives. Measures requiring encroaching into the Corte Madera Creek will not be permitted under the McAtteer-Petris Act.

In alignment with a phased approach, the following is recommended.

- Perform hydrodynamic flood modeling to determine the duration of high TWLs exceeding the breaching point elevations, and to determine flooding pathways and quantify spatial extent and depth of flooding. This would assist in the definition of adaptation measures.
- Decommission (plug, remove) the underground outfall that conveys the stormwater collected by the approximately 120-foot-long drain in the southern area of the main parking lot to the Corte Madera Creek. The outfall constitutes a path for the Corte Madera Creek seawater to flood the main parking lot in high TWLs.
- Given that it does not have adaptation capacity, design and build the **Main Lot Garage** (planned to be in operation by 2040) so that its first floor is at the 11.4 feet NAVD88 elevation to prevent groundwater emergence flooding by 2100.
- **Butler Building** is a high risk area; commence work toward the immediate implementation of an adaptation measure for high TWL flooding by 2030 and for groundwater emergence flooding by 2090.
- **Creek and Undeveloped** are moderate risk areas; within an existing asset management cycle, commence work toward implementing adaptation measures for high TWL flooding by 2030.
- **Marsh** is a moderate risk area; within an existing asset management cycle, commence work toward implementing an adaptation measure for high TWL flooding by 2040 - 2050 and for groundwater emergence flooding by 2090.

- **Fuel Tanks** is a high risk area; commence work toward the implementation of an adaptation measure for high TWL flooding by 2060 – 2070 and for groundwater emergence flooding by 2080.
- **LFT Buildings** is a moderate risk area; within an existing asset management cycle, commence work toward implementing an adaptation measure for high TWL flooding by 2060 – 2070.
- **East SFD Boulevard** is a high risk area; commence work toward the implementation of an adaptation measure for high TWL flooding by 2070 – 2080.
- **Paved** is a moderate risk area; within an existing asset management cycle, commence work toward implementing an adaptation measure for groundwater emergence flooding by 2090.

## 7. Conclusions and Recommendations

The following conclusions and recommendations were made:

1. The site visit was very beneficial. It allowed for gaining first-hand knowledge about the characteristics and condition of the LFT waterfront and the impact of the high TWLs of January 2 to 4, 2026, and allowed the team to perform spot elevation measurements to verify the NOAA DEM.
2. The NOAA DEM showed good agreement with the spot elevation measurements and was adopted for the identification of potential floodwater breaching points and pathways and flooding areas for the different SLR projections selected.
3. High TWLs flooding and groundwater emergence flooding were identified as the principal hazards.
4. The LFT was divided into eight areas, where each area shares similar physical and operational conditions, asset types, levels of criticality, and adaptive capacities. These were the LFT Buildings, Undeveloped, East SFD Boulevard, Creek, Fuel Tanks, Butler Building, Marsh and Paved.
5. For the waterfront areas, floodwater breaching points (lowest) elevations were identified, risk aversion scenarios and SLR projections were selected, floodwater pathways and flood maps delineated and ultimate horizon years by which adaptation measures must be fully operational were determined.
6. For the Paved area within the LFT, a risk aversion scenario and SLR projections were selected, projected long-term GLs and groundwater emergence locations and years were defined.
7. The vulnerability assessment showed that:
  - a. The Butler Building and the Undeveloped and Marsh areas are currently vulnerable to high TWL flooding.
  - b. Adaptation measures for high TWL flooding will be needed in the:
    - i. Marsh area by 2040 – 2050 (southern area of the LFT: main parking lot, road and utility vaults)
    - ii. Fuel Tanks area by 2060 – 2070 (fuel tanks, pipelines)
    - iii. LFT Buildings area by 2060 – 2070 (buildings, passenger and ferry boarding areas, utility vaults)
    - iv. East SFD Boulevard area by 2070 – 2080 (roads, main parking lot and utility vaults)
  - c. Adaptation measures for groundwater emergence flooding will be needed in the:

- i. Fuel Tanks area by 2080 (containment area)
  - ii. Butler Building, Marsh, Paved areas by 2090 (employee and main (south) parking lots, bike path, utility vaults)
  - iii. Paved area by 2100 (main parking lot (north), Main Lot Garage)
8. The risk assessment complemented the vulnerability assessment by evaluating the significance of the vulnerabilities based on the likelihood of the flood hazards and their potential consequences, providing a basis for prioritizing areas and adaptation measures and allocating resources.
9. Based on qualitative ratings of likelihood and consequences, the risk assessment showed that:
  - a. The East SFD Boulevard, Fuel Tanks and Butler Building are areas at high risk and adaptation is recommended as a high priority.
  - b. The LFT Buildings, Undeveloped, Creek, Marsh and Paved are areas at moderate risk and adaptation within existing asset management cycles is recommended.
10. While a vulnerability assessment may indicate that an asset will not be exposed until a time far into the future, the risk assessment may identify that asset as a high priority because of its critical physical and operational characteristics, the severe consequences if impacted by the hazard, and/or the long lead time required to develop the adaptation measure. This does not necessarily imply that a particular adaptation measure should be implemented immediately. Rather, it indicates that immediate actions (planning, design, etc.) are warranted to ensure that the measure can be delivered before the identified vulnerability threshold is reached.
11. A phased approach to adaptation is recommended. A phased approach recognizes both the long implementation timelines associated with waterfront adaptation measures and the varying vulnerability timeframes across the LFT. It enables proactive, cost-effective, and adaptive decision-making, ensuring that adaptation measures are delivered when needed while maintaining flexibility in the face of future uncertainty.
12. In alignment with a phased approach, the following is recommended:
  - a. Perform hydrodynamic flood modeling to determine the duration of high TWLs exceeding the breaching point elevations, and to determine flooding pathways and quantify spatial extent and depth of flooding. This would assist in the definition of adaptation measures.
  - b. Decommission (plug, remove) the underground outfall that conveys the stormwater collected by the approximately 120-foot-long drain in the southern area of the main parking lot to the Corte Madera Creek. The outfall constitutes a path for the Corte Madera Creek seawater to flood the main parking lot in high TWLs.
  - c. Given that it does not have adaptation capacity, design and build the Main Lot Garage (planned to be in operation by 2040) so that its first floor is at the 11.4 feet NAVD88 elevation to prevent groundwater emergence flooding by 2100.
  - d. Butler Building is a high risk area; commence work toward the immediate implementation of an adaptation measure for high TWL flooding by 2030 and for groundwater emergence flooding by 2090.
  - e. Creek and Undeveloped are moderate risk areas; within an existing asset management cycle, commence work toward implementing adaptation measures for high TWL flooding by 2030.

- f. Marsh is a moderate risk area; within an existing asset management cycle, commence work toward implementing an adaptation measure for high TWL flooding by 2040 - 2050 and for groundwater emergence flooding by 2090.
- g. Fuel Tanks is a high risk area; commence work toward the implementation of an adaptation measure for high TWL flooding by 2060 - 2070 and for groundwater emergence flooding by 2080.
- h. LFT Buildings is a moderate risk area; within an existing asset management cycle, commence work toward implementing an adaptation measure for high TWL flooding by 2060 - 2070.
- i. East Sir SFD Boulevard is a high risk area; commence work toward the implementation of an adaptation measure for high TWL flooding by 2070 - 2080.
- j. Paved is a is a moderate risk area; within an existing asset management cycle, commence work toward implementing an adaptation measure for groundwater emergence flooding by 2090.

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