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September 5, 2018
Job No.: 2355-010

M E M O R A N D U M

TO: Sean Murphy – Alameda Marina

FROM: Angelo J. Obertello, P.E., LEED AP, QSD, Principal

SUBJECT: Sea Level Risk Assessment and Strategy
Alameda Marina
Alameda, California

The following provides a summary of the coastal flooding and sea level rise risk assessment for the Alameda Marina project. Also, this includes a summary of the proposed project improvements to provide long term protection from rising sea levels.

BACKGROUND

Alameda Marina is located along the northern waterfront of Alameda, California and adjacent to the Oakland / Alameda Estuary. The site is bound by Clement Avenue to the south, Oakland / Alameda Estuary to the north, Navy Operation Support Center to the east and Grand Avenue to the west. The project location is depicted on Figure 1. The site has functioned as working waterfront for the past 70 years. There is an active marina with approximately 530 boat slips. The land side areas currently contain approximately 250,000 square feet of maritime supporting buildings. The majority of the land side areas are paved in asphalt to facilitate circulation and dry storage of boats. The site existing infrastructure, including the shoreline seawalls, buildings and utilities were constructed in the 1940's and are beyond their useful life. Specifically, the majority of the over 4,000 linear feet of existing seawall is failing and must be replaced. Also, the waterfront within the site is currently not accessible to the public.

The existing elevations of the land portions of the site range from 9 to 15 (NAVD 88). The low-lying areas within the site are generally located in the northwest portion of the site. Additionally, there are existing structures and a wharf along the waterfront that are intended to be preserved and are at the following existing elevations. See Figure 2 depicting the locations of these structures.

- Building 13 = Elevation 12.3 +/-
- Building 14 = Elevation 11.4 +/-
- Building 18 = Elevation 12.1 +/-
- Building 19 = Elevation 12.1 +/-
- Building 16 and 21 = Elevation 11.5 +/-
- Building 25 and 26 (Harbormaster Office) = Elevation 10.6 +/-
- Building 27 = Elevation 11 +/-
- Wood Wharf = Elevation 12 +/-

The proposed project will redevelop this existing marina site into a mixed-use waterfront community that enhances and improves the maritime uses with also integrating public recreation areas and residential uses. The project proposes public access corridors along the waterfront and connecting to Clement Avenue, providing direct access to the waterfront for the surrounding community. The proposed buildings will include a mix of residential, commercial, maritime and retail uses. The project is designed to have resiliency including built-in protection from sea level rise and planned adaptive capacity strategies.

VULNERABILITY ASSESSMENT

In accordance with BCDC's sea level rise policies, a risk assessment has been conducted for the Alameda Marina project. The areas within the project site vulnerable to coastal flooding at various levels of future sea level rise have been evaluated. These areas of potential inundation are depicted on the enclosed Figures 3 and 4.

Tidal Water Levels

The following table outlines the tidal water levels at the project site. These are based upon nearest tidal station which is located at the Park Street Bridge (National Oceanic and Atmospheric Administration Datum 9414746) and FEMA preliminary Flood Insurance Rate Maps, dated December 21, 2017.

Water Level	Elevation (NAVD 88)
100-Year Tide (Base Flood Elevation per FEMA)	10.0
King Tide	7.5
MHHW	6.4
MHW	5.7
MSL	3.3

The site experiences negligible wave or wind run-up because of the protected nature of the Oakland / Alameda Estuary. The wave wind run-up is estimated to be 1-foot or less and is accounted for in the 100-Year Base Flood Elevation (BFE) stated above.

Sea Level Rise Projections

This risk assessment utilizes the best available science for sea level rise projections. In March 2018, the California Ocean Protection Council published an update to its sea level rise guidance. The updated report provides the scientific foundation for a decision-making process to select which sea level rise projection is appropriate for a specific project. This approach considers many factors, including project location, lifespan of the project, degree of sea level rise exposure, risk tolerance and adaptive capacity of the project. The updated guidance provides sea level rise projected values for low risk aversion, medium-high risk aversion, and extreme risk aversion. The Council's updated report estimates the likely range of sea level rise at 2100 for low risk aversion sites to be 2.4-3.4 feet, medium-high risk aversion to be 5.7-6.9 feet and extreme risk aversion to be 10.2 feet.

The areas within the project site that would be inundated, if left unprotected, at the various amounts of sea level rise projection are depicted on the enclosed Figures 3 and 4.

Risk Assessment

The Alameda Marina has been planned with a practical approach to provide long term protection to the public access areas, future buildings and maritime uses. The proposed shoreline and land side improvements are planned to be constructed at a minimum elevation that provides built-in protection from the projected sea levels at 2100 for a medium-high risk aversion. Additionally, the shoreline improvements, including seawalls and revetments, are planned with adaptive capacity to accommodate being raised in the future if necessary in the case that sea level rise exceeds projections.

PROJECT DESIGN

Built-in Protection

The proposed project will be designed such that the proposed public access areas, streets and building sites will be raised to a minimum elevation of 13.5, providing built-in protection from 6 feet of sea level rise above the typical year king tides, which only occur 2 to 6 times per year. This also provides built-in protection from 3.5 feet of future sea level rise above the 100-year coastal flood elevation. More specifically, the following improvements are planned to provide protection from sea level rise:

- The public access corridor and recreation areas along the project shoreline will be elevated to a minimum elevation of 13.5.

- The proposed buildings will be raised to establish the minimum habitable floor elevation at 14.0.
- The proposed streets within the interior of the project site will be raised to a minimum elevation of 13.5.
- Existing buildings interior to the project site, such as 16, 18, 19, 21 & 27 will be protected from future flooding by the surrounding proposed improvements being constructed at an elevation of 13.5. There will be transitions from these surrounding improvements to the existing entries of the structures with acceptable ramps for universal access and/or steps. Also, additional storm drain facilities will be provided to address the interior drainage of the low-lying areas directly adjacent to the structures. This may include a local sump pump.
- The existing wharf will be rehabilitated, extending the useful life approximately 40-50 years. The projected sea level rise at 2060-2070 ranges from 1.3-3.5 feet. The existing elevation of the wharf, 12, is above the projected amount of sea level rise for the wharf's lifespan. At the end of the wharf's lifespan it will be reconstructed at higher elevation providing protection from additional sea level rise projected for the lifespan of the new structures.
- Existing buildings directly along the waterfront are near the end of their useful life and will be evaluated over time to determine if they will either be:
    - Demolished as the frequency of inundation by rising sea levels increases or when they are no longer useful.
    - Retrofitted with flood proofing or raising of the structure to an elevation above the projected sea levels for the extended life of the structure.

Figures 3 and 4 demonstrates that with the proposed improvements outlined above implemented, there are no areas of inundation within the project area.

Adaptive Strategies

The proposed project is planned to include adaptive capacity for future adaptive measures to be implemented providing protection from higher amounts of sea level rise. The adaptive strategies would include implementation of floodwalls, earthen berms, elevated wharves and other storm drain system enhancements. The project has been designed to accommodate these adaptive measures without requiring fill within the Bay. This will provide protection of the public access and recreation areas from the periodic inundation that would occur in extreme tide events as the sea levels rise beyond elevation 13.5. The adaptive measures would also provide protection for the interior development areas, including the buildings and streets.

The project will establish a community facilities district and / or owners association that will be responsible for monitoring sea level rise. This will include monitoring scientific guidance and updates on sea level rise, as well as commissioning periodic shoreline condition assessments by a coastal engineer to document the physical effects of sea level rise and life expectancy of the shoreline protection measures. The district or association will also be responsible for collecting and managing reserve funds from the project to implement the adaptive measures in the future when they are determined to be necessary.

ALAMEDA MARINA

FIGURE 1

EXISTING CONDITIONS

CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA

DATE: SEPTEMBER 6, 2018 SCALE: 1"=200'

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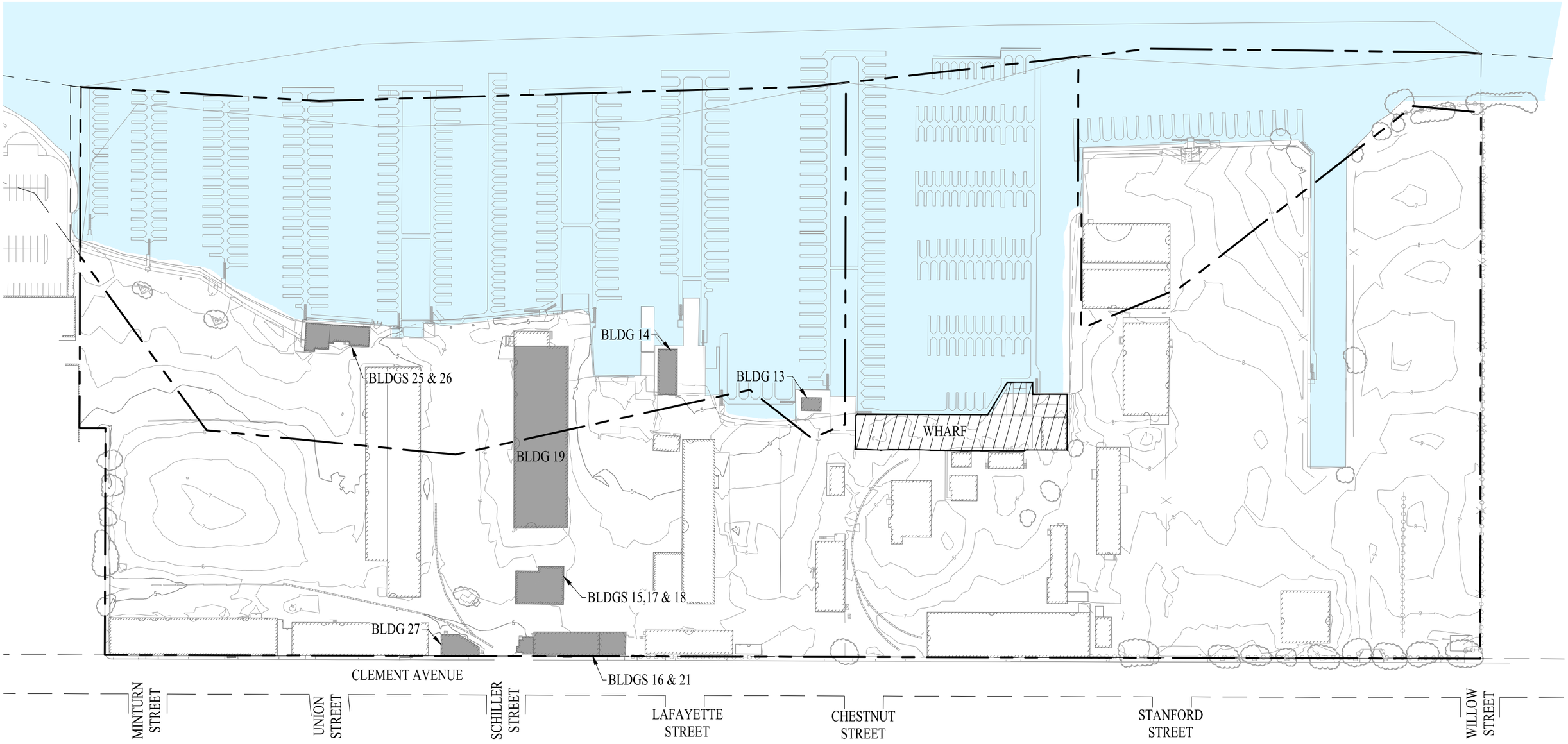
G:\2355-000\ACAD\EXHIBITS\XB_FIGURE 1-EXISTING CONDITIONS.DWG



ALAMEDA MARINA

FIGURE 2

EXISTING STRUCTURES

CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA

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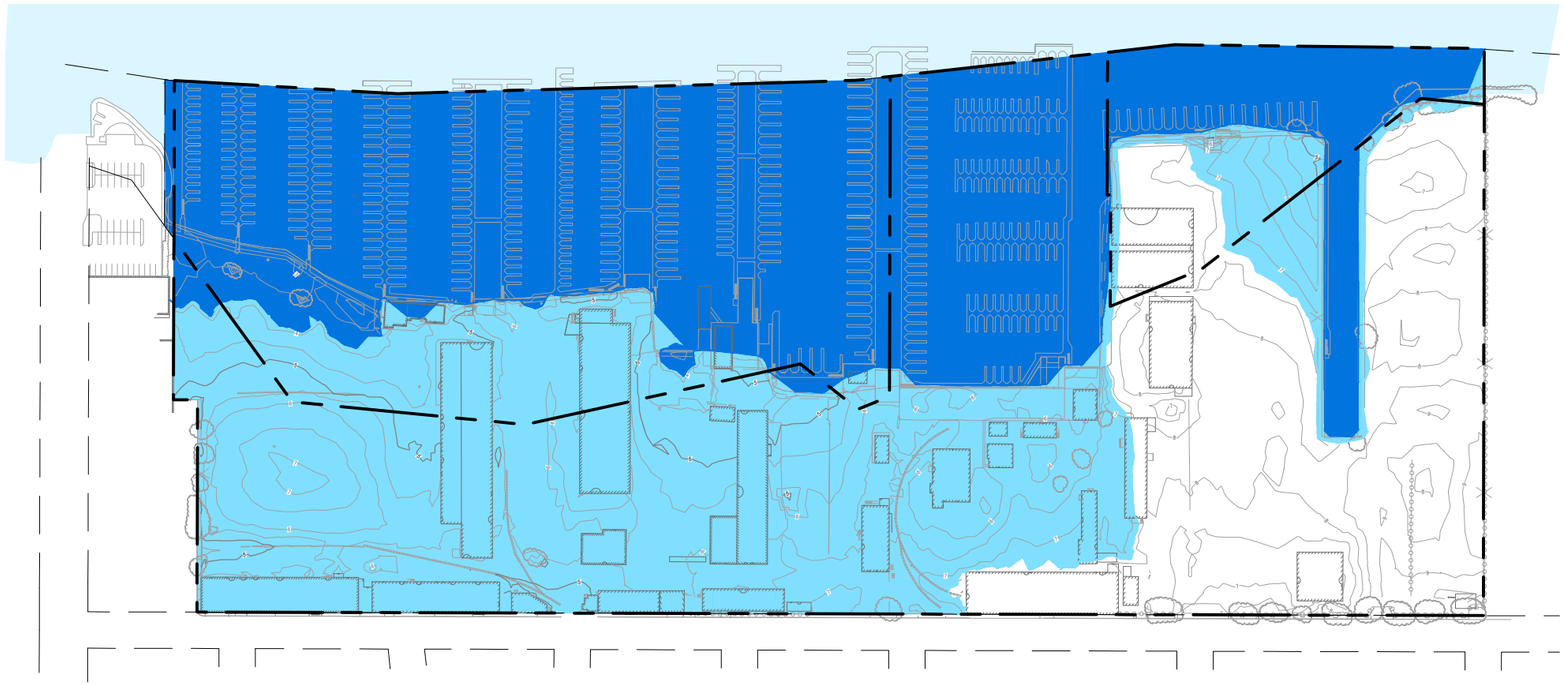
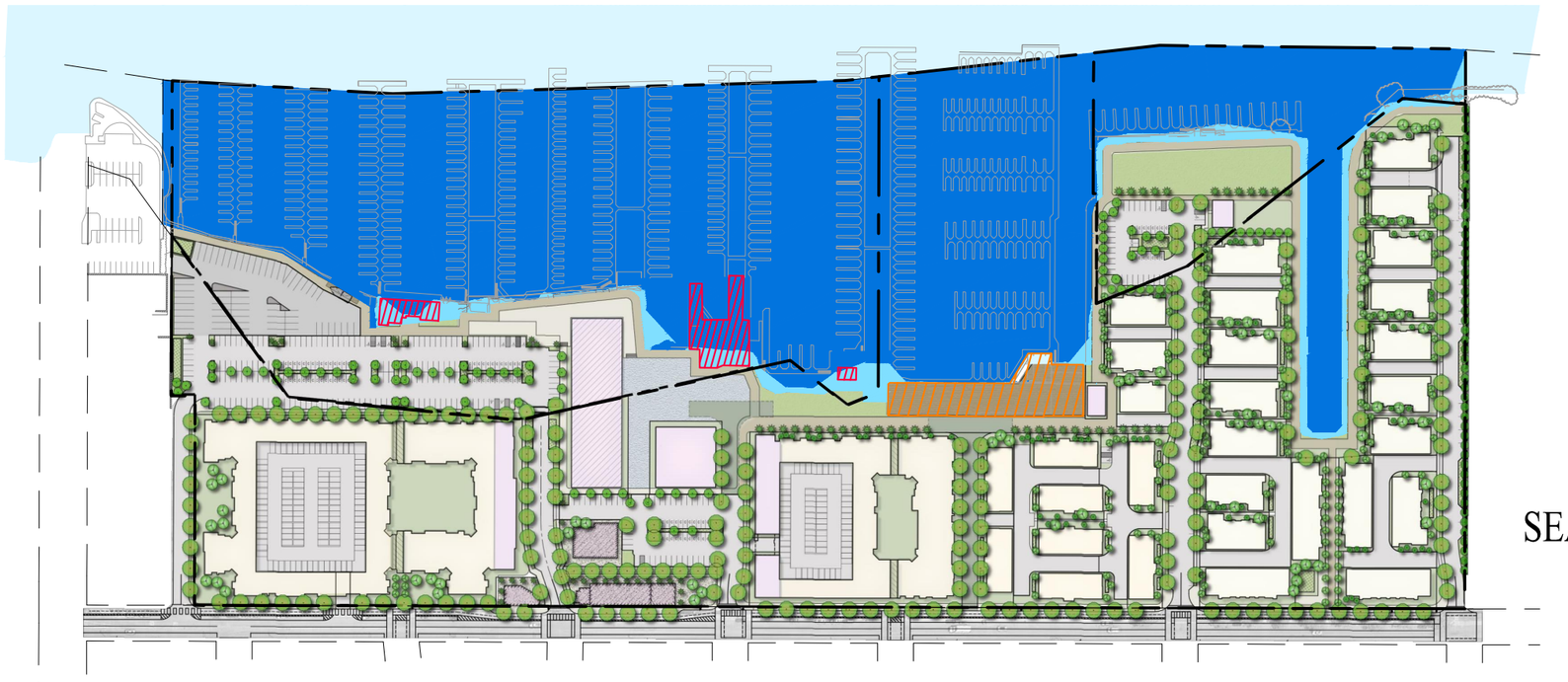
G:\2355-000\ACAD\EXHIBITS\XB_FIGURE 2-EXISTING STRUCTURES.DWG



EXISTING CONDITIONS



PROPOSED CONDITIONS

SEA LEVEL RISE CRITERIA

THE PROPOSED ELEVATION OF THE WATERFRONT PUBLIC ACCESS AREAS IS 13.5 WHICH EQUATES TO 7.1' ABOVE MHHW ELEVATION OF 6.4 AND 6' ABOVE THE KING TIDE ELEVATION OF 7.5.

HISTORICAL DATA FROM TIDAL STATIONS NEAR THE SITE REFLECTS A LIKELY PROJECTION THAT WATER LEVELS REACH ABOVE THE KING TIDE ONLY TWO TO SIX TIMES PER YEAR.

THE 2050 PROJECTION OF 1.9' SEA LEVEL RISE WOULD YIELD WATER LEVELS OF ELEVATION 9.4 TWO TO SIX TIMES PER YEAR, APPROXIMATELY 4' BELOW THE PROPOSED ELEVATION OF THE WATERFRONT PUBLIC ACCESS AREAS.

THE 2100 PROJECTION OF 5.7' SEA LEVEL RISE WOULD YIELD WATER LEVELS OF ELEVATION 13.2 TWO TO SIX TIMES PER YEAR, SLIGHTLY BELOW THE WATERFRONT PUBLIC ACCESS.

WITH 2070 SLR LEVELS NOT PRESENTING FLOOD RISK FOR THE WATERFRONT PUBLIC ACCESS AREAS, THERE ARE SEVERAL POTENTIAL ADAPTIVE MEASURES THAT MAY BE EMPLOYED IN THE FUTURE TO MITIGATE 2100 SLR AND SUPPORT MAINTAINING PUBLIC ACCESS. SOME OF THESE POTENTIAL MEASURES INCLUDE:

- IMPLEMENTATION OF FLOODWALLS, EARTHEN BERMS, ELEVATED WHARVES AND OTHER STORM DRAIN SYSTEM ENHANCEMENTS.
- THE WHARF WILL BE RECONSTRUCTED AT HIGHER ELEVATION PROVIDING PROTECTION FROM ADDITIONAL SEA LEVEL RISE PROJECTED FOR THE LIFE SPAN OF THE NEW STRUCTURE.

LEGEND

- 100 YEAR WATER SURFACE ELEVATION (10.0')
- BFE + 3.4' SEA LEVEL RISE (13.4')
- EXISTING STRUCTURE TO BE EITHER:
  - RAISED OR FLOOD PROTECTED, OR
  - DEMOLISHED
- EXISTING WHARF TO BE RECONSTRUCTED/ ADAPTED IN 2060–2070±

ALAMEDA MARINA

FIGURE 3

SEA LEVEL RISE INUNDATION - (BFE + 3.4')

CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA

DATE: SEPTEMBER 6, 2018 SCALE: 1"=250'

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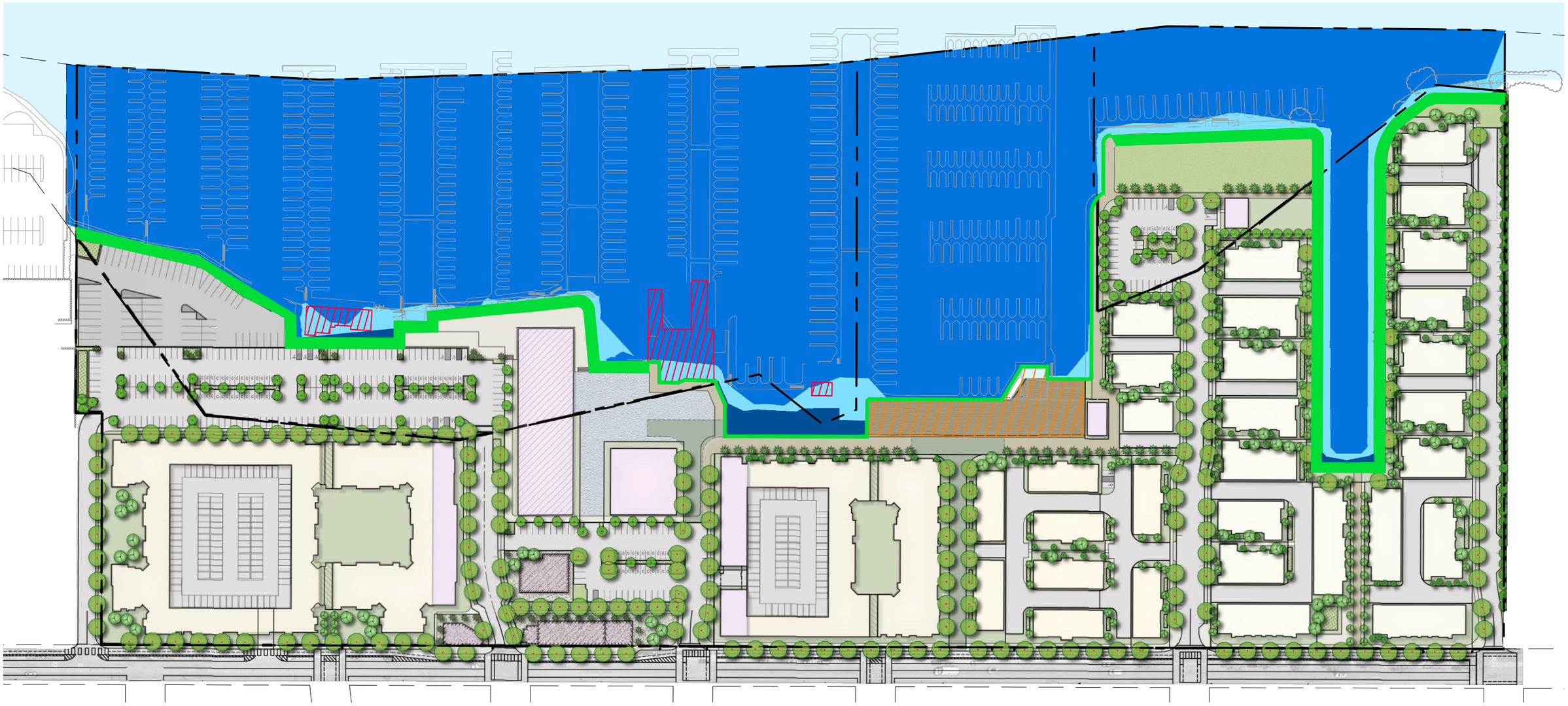
G:\2355-000\ACAD\EXHIBITS\XB_FIGURE 3-SEA LEVEL RISE.DWG



PROPOSED CONDITIONS WITH ADAPTIVE MEASURES

LEGEND

- 100 YEAR WATER SURFACE ELEVATION (10.0')
- BFE + 3.4' SEA LEVEL RISE (13.4')
- BFE + 5.7' SEA LEVEL RISE (15.7')
- EXISTING STRUCTURE TO BE EITHER:
  - RAISED OR FLOOD PROTECTED, OR
  - DEMOLISHED
- EXISTING WHARF TO BE RECONSTRUCTED/ ADAPTED IN 2060–2070±
- ADAPTIVE MEASURES

ALAMEDA MARINA

FIGURE 4

SEA LEVEL RISE INUNDATION - (BFE + 5.7')

CITY OF ALAMEDA ALAMEDA COUNTY CALIFORNIA

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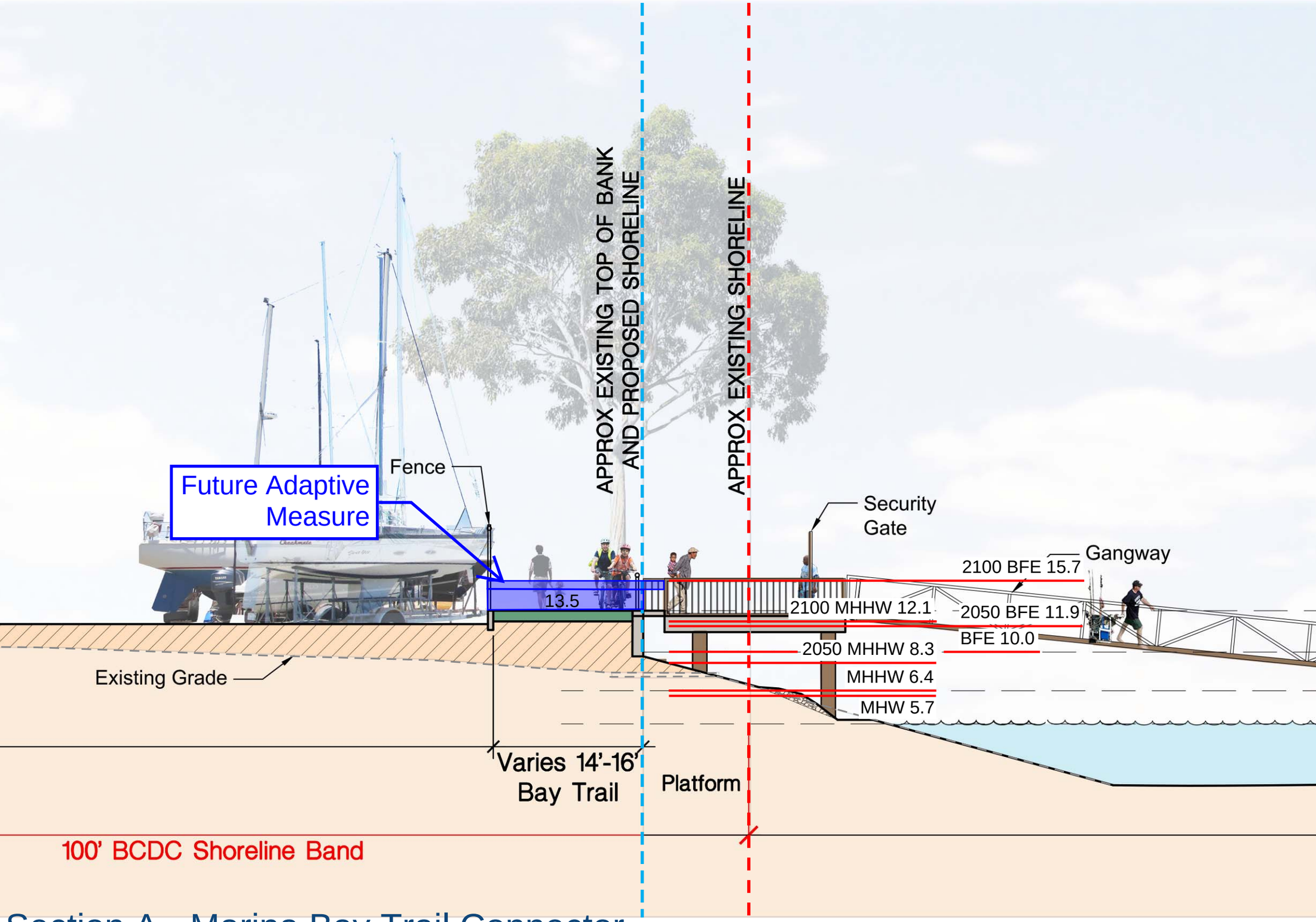
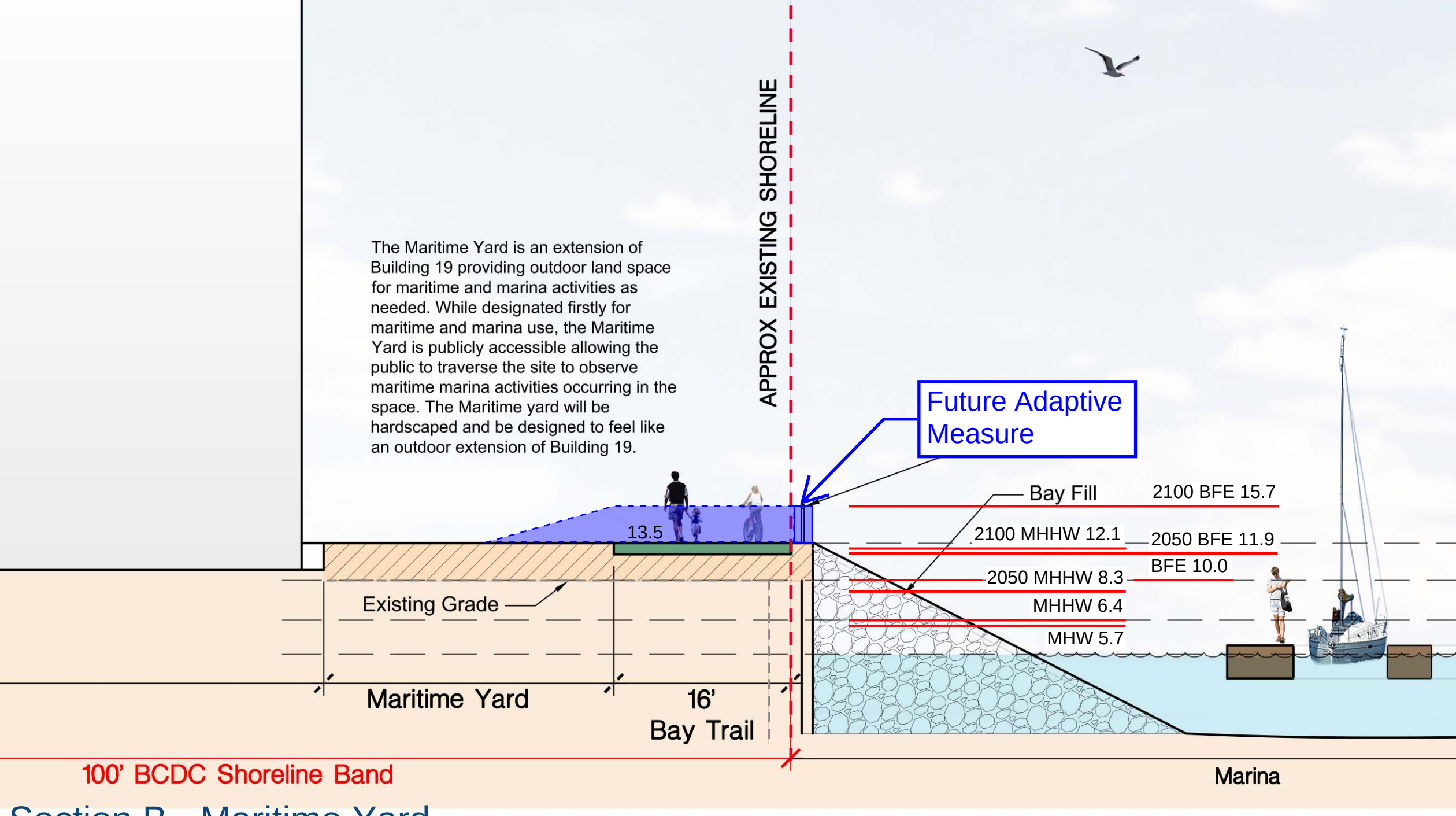
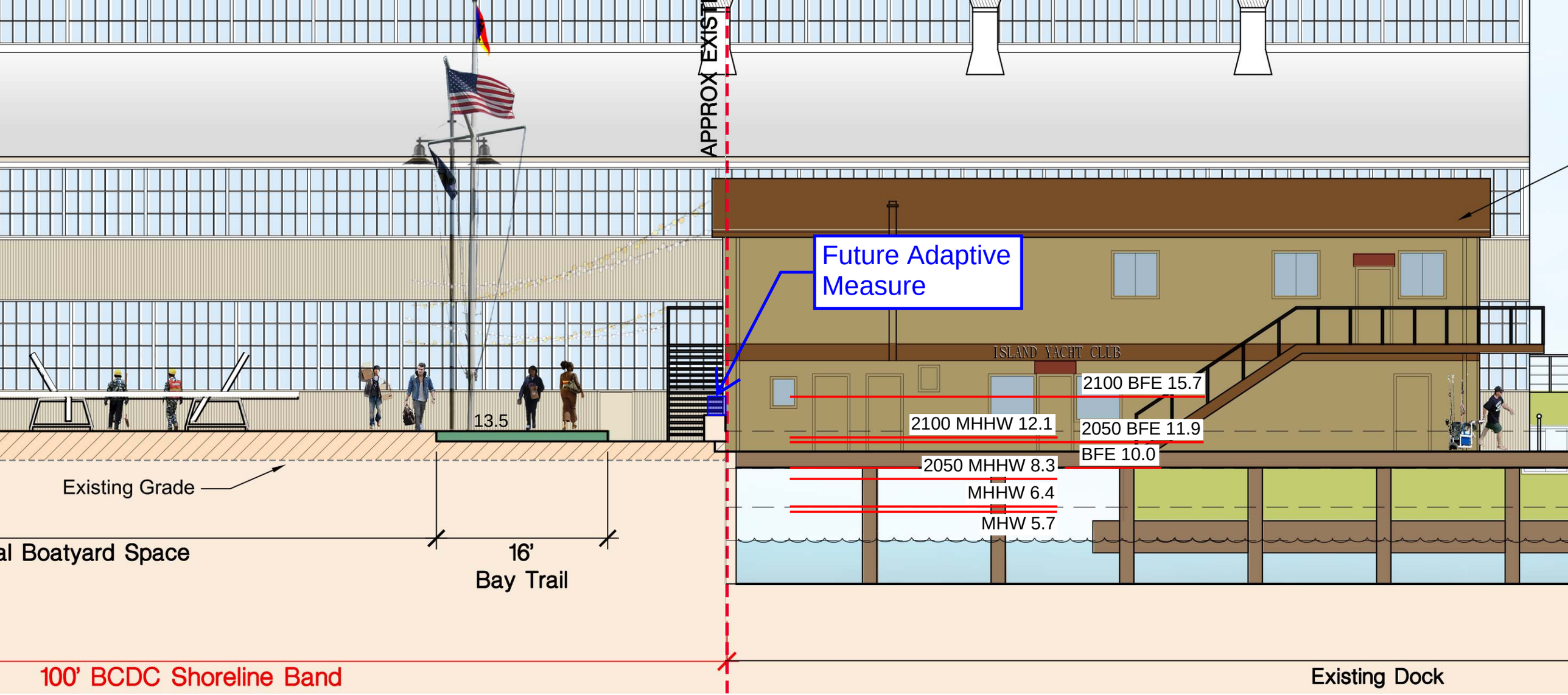
G:\2355-000\ACAD\EXHIBITS\XB_FIGURE 4-SEA LEVEL RISE.DWG



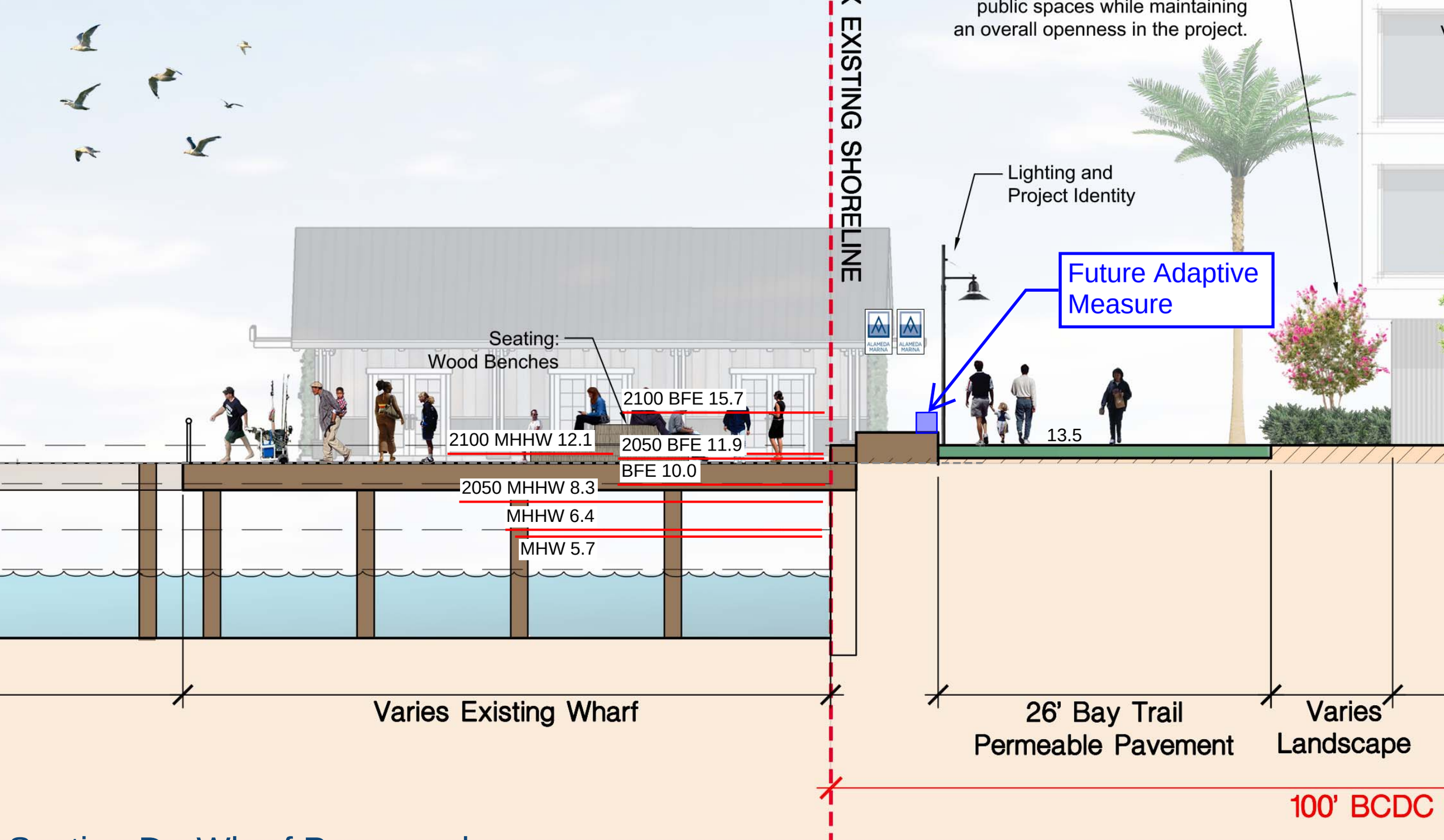
Section A - Marina Bay Trail Connector



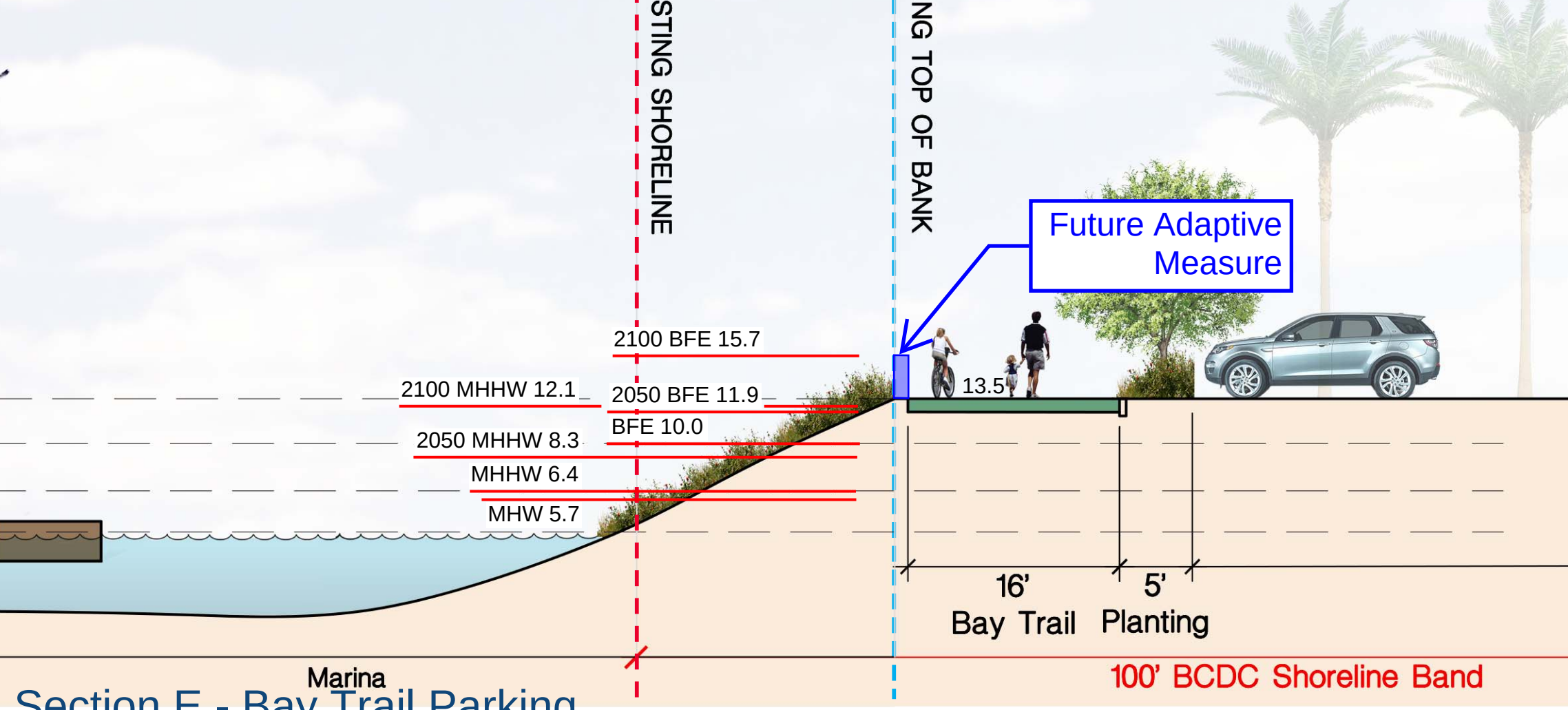
Section B - Maritime Yard



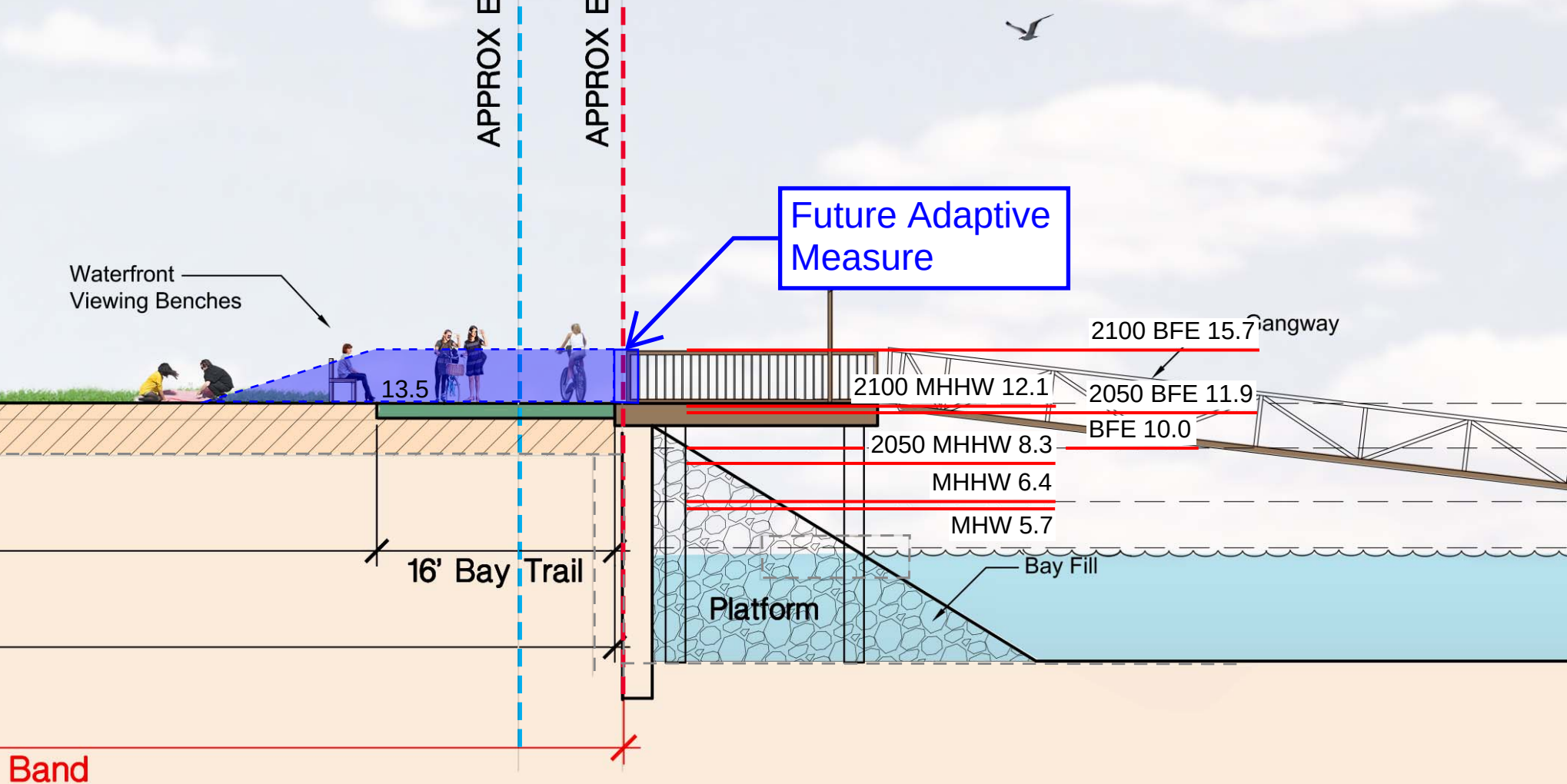
Section C - Maritime Commercial Core



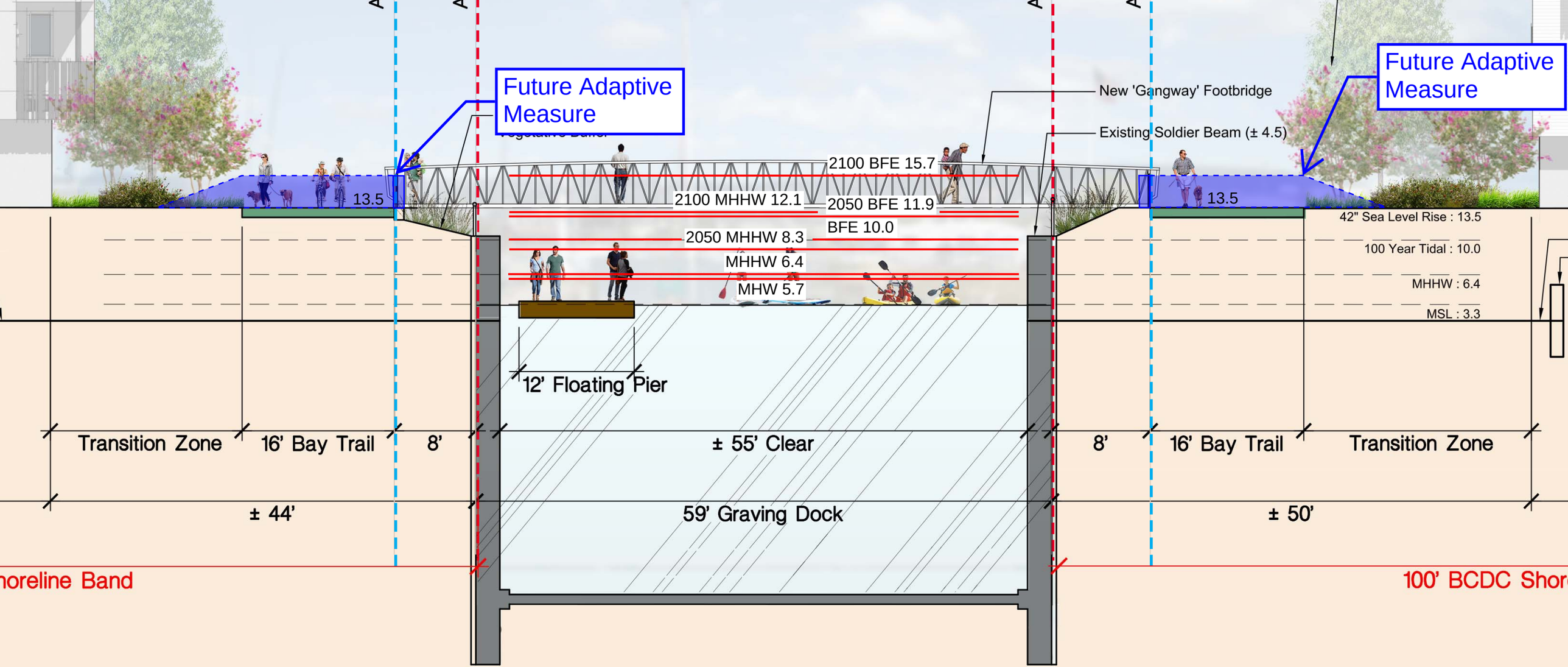
Section D - Wharf Promenade



Section E - Bay Trail Parking



Section F - Harbor View Park



Section G - Waterlife Park