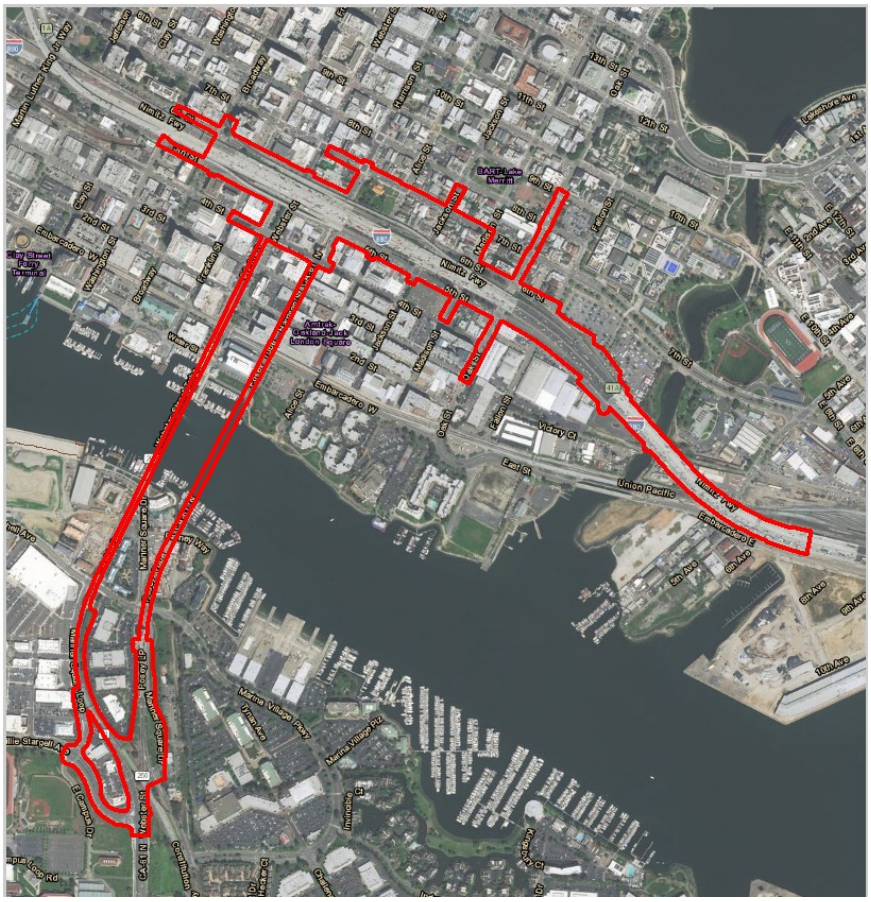
**Oakland Alameda Access Project**
**Alameda County, California**
**04-ALA-880 PM 30.47/31.61; 04-ALA-260 PM R0.78/R1.90**
**EA 04-0G360**

# Location Hydraulic Study Report



Prepared for:

June 2020

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June 2020

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# Location Hydraulic Study Report

Submitted to:
California Department of Transportation, District 4
Alameda County Transportation Commission

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

Analette A. Ochoa, P.E.
Registered Civil Engineer

6/24/2020
Date

June 2020

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June 2020

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# Executive Summary

The proposed Project (Project), the Oakland Alameda Access Project, is located in the cities of Oakland and Alameda in Alameda County, California. The Project would improve access along (I-880), the Posey and Webster Tubes, downtown Oakland, and the City of Alameda. The Build Alternative, also referred to as the proposed project, would improve access to northbound (NB) and southbound I-880 from the Posey Tube via a right-turn-only lane from the Posey Tube to 5th Street and a new horseshoe connector at Jackson Street below the I-880 viaduct that would connect to the existing NB I-880/Jackson Street on-ramp. The Project would also reconstruct and shift the existing westbound Interstate 980/Jackson Street off-ramp to the south.

The purpose of this *Location Hydraulic Study* is to examine and analyze the existing Federal Emergency Management Agency (FEMA) floodplains within the Project limits, document any potential impacts or encroachments upon these floodplains, and recommend mitigation that may be required. The Federal Highway Administration (FHWA) defines impacts to and significant encroachment on a floodplain using the following conditions:

1. Significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route,
2. Significant risk with change in land use, fill inside the floodplain, or change in water surface elevation, or
3. Significant adverse impact on the natural and beneficial floodplain values.

Runoff within the Oakland Project limits primarily collects along the roadway shoulders, conveys into underground storm drainage systems, and flows to the Oakland Estuary and Lake Merritt Channel. The Lake Merritt Channel connects Lake Merritt to the Oakland Estuary. A pump station and tide gate regulate the tidal exchanges between the channel and the estuary.

The Alameda Project limits are also in a completely urban setting. Runoff within the Alameda Project limits collects along the roadway shoulders, conveys into underground storm drainage systems, and flows to the Oakland Estuary.

The Project extends through FEMA Flood Insurance Rate Map (FIRM) number 06001C0067H. The maps identify a Zone AE floodplain area associated with the Project limits. Zone AE areas represent the 100-year floodplain.

There is minimal proposed fill within the base floodplain, and the Project would not impact or encroach on the base floodplain. No traffic interruptions from the base flood are expected at the Project site.

The Project would result in approximately 1 acre of net new impervious surface. However, because this area is small in comparison to the overall watershed (approximately 245 square miles), no change in the FEMA 100-year water surface elevation is expected as result of the Project. The Project would not support potentially incompatible floodplain development and does not represent a transverse or longitudinal encroachment. The Project would not impact land

use within the watershed because the area is predominantly developed and impervious. The Project is not expected to impact natural and beneficial floodplain values.

The Project is prone to potential inundations caused by the overtopping of the waterbodies in the Project vicinity due to sea-level rise (SLR). SLR at the Project site was estimated using the *State of California Sea-Level Rise Guidance, 2018 Update* (Coastal and Ocean Working Group of the California Action Team, 2018). A medium-to-high risk scenario SLR value of 4.3 feet (ft) was calculated using the Project's design life of 50 years. Using the 100-year storm surge as the base, the elevation of SLR is predicted to be 14.3 ft North American Vertical Datum of 1988 (NAVD 88) within the Project site. However, per the Project Design Team (PDT), the Project was evaluated for potential SLR impacts using the Mean Higher High Water (MHHW) as the base water level, which is a more frequent and lower water level than the 100-year storm event. Because this report evaluates the potential Project impacts associated with the 100-year storm event, the impacts and adaptive measures due to SLR are instead discussed in detail in the Project's SLR Memorandum.

The overall risk of this Project is low, because the Project would result in insignificant impacts to the base floodplain.

# Acronyms

| | |
|---|---|
| AASHTO | American Association of State highway and Transportation Officials |
| AB | aggregate base |
| ADT | average daily traffic |
| AS | aggregate subbase |
| BFE | base flood elevation |
| BMP | Best management Practice |
| Caltrans | California Department of transportation |
| CFR | Code of Federal Regulations |
| CFS | cubic feet per second |
| County | Alameda County |
| CIP | cast-in-place |
| CISS | cast-in-steel-shell |
| DOT | Department of Transportation |
| DWR | Department of Water Resources |
| ESRI | Environmental Systems Research Institute |
| FEMA | Federal Emergency Management Agency |
| FFRMS | Federal Flood Risk Management Standard |
| FHWA | Federal Highway Administration |
| FIRM | Flood Insurance Rate Map |
| FIS | Flood Insurance Study |
| HMA | hot mix asphalt |
| I-880 | Interstate 880 |
| MHHW | mean high higher water |
| NB | Northbound |
| NFIP | National Flood Insurance Program |
| NGVD 29 | National Geodetic Vertical Datum of 1929 |
| PDT | Project Design Team |
| Project | Oakland Alameda Access Project |
| PS&E | Plans, Specifications and Estimates |
| RS | river station |
| SB | Southbound |
| SFHA | Special Flood Hazard Area |
| SLR | sea level rise |
| sq. mi | square mile |
| Tubes | Posey and Webster Tubes |
| USACE | United States Army Corps of Engineers |
| USGS | United States Geological Survey |
| WB | Westbound |

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# Location Hydraulic Study Form

## LOCATION HYDRAULIC STUDY FORM

Dist. 4 Co. Alameda Rte. 04-ALA-260, 04-ALA-880 Project ID EA 04-0G360
Federal-Aid Project Number:

Floodplain Description: The existing floodplain within the Project limits is classified as Zone AE floodplain with elevation of 10 ft, NAVD, according to the FEMA FIS.

1. Description of Proposal *(include any physical barriers i.e. concrete barriers, sound walls, etc. and design elements to minimize floodplain impacts)*
The Oakland Alameda Access Project proposes arterial and freeway access improvements between I-880, I-980 and local Oakland streets; including access to and from the Posey/Webster Tubes which connect the cities of Oakland and Alameda.

2. ADT: Current N/A Projected N/A

3. Hydraulic Data:

| | | |
|---|---|---|
| Base Flood | Q100= N/A CFS | WSE100= 10.0 ft NAVD 88 |
| The flood of record, if greater than Q100: | Q= N/A CFS | WSE= N/A |
| Overtopping flood | Q= N/A CFS | WSE= N/A |

Are NFIP maps and studies available? NO ____ YES ✓

4. Is the highway location alternative within a regulatory floodway?
NO ✓ YES ____

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain.

Potential Q100 backwater damages:

| | | | |
|---|---|---|---|
| A. | Residences? | NO ____ | YES ✓ |
| B. | Other Bldgs? | NO ____ | YES ✓ |
| C. | Crops? | NO ✓ | YES ____ |
| D. | Natural and beneficial Floodplain values? | NO ____ | YES ✓ |

*"Natural and beneficial flood-plain values" shall include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.*

6. Type of Traffic:

| | | |
|---|---|---|
| A. Emergency supply or evacuation route? | NO ____ | YES ✓ |
| B. Emergency vehicle access? | NO ____ | YES ✓ |
| C. Practicable detour available? | NO ____ | YES ✓ |
| D. School bus or mail route? | NO ____ | YES ✓ |

7. Estimated duration of traffic interruption for 100-year event hours: N/A

8. Estimated value of Q100 flood damages (if any) – moderate risk level.

| | | |
|---|---|---|
| A. | Roadway | $ N/A |
| B | Property | $ N/A |
| | Total | $ N/A |

9. Assessment of Level of Risk
Low ✓
Moderate ____
High ____

For High Risk projects, during design phase, additional Design Study Risk Analysis may be necessary to determine design alternative.

## LOCATION HYDRAULIC STUDY FORM cont.

Dist. 4 Co. Alameda Rte. 04-ALA-260, 880 P.M. 0.78/1.90, 30.47/31.61
Federal-Aid Project Number:
Project ID EA 04-0G360 ID 0400000326 Bridge No.

**PREPARED BY:**

Signature:
*I certify that I have conducted a Location Hydraulic Study consistent with 23 CFR 650 and that the information summarized in items numbers 3, 4, 5, 7, and 9 of this form is accurate.*

Anabelle Ocba Date 6/24/2020
Local Agency/Consulting Hydraulic Engineer *(local assistance projects)*

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible Floodplain development? NO ✓ YES

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

*I certify that item numbers 1, 2, 6 and 8 of this Location Hydraulic Study Form are accurate and will ensure that Final PS&E reflects the information and recommendations of said report:*

Date
Local Agency/Consulting Project Engineer *(local assistance projects)*

**CONCURRED BY:**
*I have reviewed the quality and adequacy of the floodplain submittal consistent with the attached checklist, and concur that the submittal is adequate to meet the mandates of 23 CFR 650.*

Michael Nguyen Date 7/23/2020
District Project Manager *(capital and 'on' system projects)*

Date
Local Agency Project Manager *(Local Assistance projects)*

Craig Tomimatsu Date 07/23/2020
District Local Assistance Engineer *(or District Hydraulic Branch for very complex projects or when required expertise is unavailable. Note: District Hydraulic Branch review of local assistance projects shall be based on reasonableness and concurrence with the information provided).*

*I concur that the natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.*

Date 7/24/2020
District Senior Environmental Planner *(or Designee)*

*Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.*

## SUMMARY FLOODPLAIN ENCROACHMENT REPORT

Dist. 4 Co. Alameda Rte. 04-ALA-260, 880 K.P. N/A
Federal-Aid Project Number *(Local Assistance)*
Project No.: EA 04-0G360 Bridge No.
Limits: The Oakland Alameda Access Project proposes arterial and freeway access improvements between I-880, I-980 and local Oakland streets; including access to and from the Posey/Webster Tubes which connect the cities of Oakland and Alameda.
Floodplain Description: The existing floodplain within the Project limits is classified as Zone AE floodplain with elevation of 10 ft, NAVD, according to the FEMA FIS.

| | | No | Yes |
|---|---|---|---|
| 1. | Is the proposed action a longitudinal encroachment of the base floodplain? | ✓ | |
| 2. | Are the risks associated with the implementation of the proposed action significant? | ✓ | |
| 3. | Will the proposed action support probable incompatible floodplain development? | ✓ | |
| 4. | Are there any significant impacts on natural and beneficial floodplain values? | ✓ | |
| 5. | Routine construction procedures are required to minimize impacts on the floodplain. Are there any special mitigation measures necessary to minimize impacts or restore and preserve natural and beneficial floodplain values? If yes, explain. | ✓ | |
| 6. | Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR, Section 650.105(q). | ✓ | |
| 7. | Are Location Hydraulic Studies that document the above answers on file? If not explain. | | ✓ |

**PREPARED BY**:

_____ *Date* _____
Local Agency/Consulting Project Engineer *(capital and 'on' system projects)*

_____ *Date* _____
Local Agency/Consulting Hydraulic Engineer *(local assistance projects)*

**CONCURRED BY:**

_____ *Date* _____
District Project Manager *(capital and 'on' system projects)*

_____ *Date* _____
District Local Assistance Engineer/District Hydraulic Branch
*(District Hydraulic Branch for very complex projects or when required expertise is unavailable. Note: District Hydraulic Branch review of local assistance projects shall be based on reasonableness and concurrence with the information provided)*

*I concur that impacts to natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.*

_____ *Date* _____
District Senior Environmental Planner *(or Designee)*

***Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.***

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# 1 GENERAL DESCRIPTION

The proposed project, the Oakland Alameda Access Project (Project), is located in the cities of Oakland and Alameda in Alameda County, California. The Project proposes to improve access along Interstate 880 (I-880) and in and around the Posey and Webster Tubes (Tubes), downtown Oakland, and the City of Alameda. Within the approximately 1-mile-long project, I-880 (PM ALA 30.47 to PM 31.61) and State Route 260 (SR-260) (PM ALA R0.78 to R1.90) are major transportation corridors. Also, the I-880 freeway viaduct is a physical barrier, limiting bicycle and pedestrian connectivity between downtown Oakland and Chinatown to the north and the Jack London District and Oakland Estuary to the south. Existing local street patterns across I-880 are intertwined with on- and off-ramps and the Tubes connecting Oakland and Alameda affecting the cross-freeway circulation of motorists, bicyclists, and pedestrians.

## 1.1 Purpose and Need

The purpose of the Project is to:

- Improve multimodal safety and reduce conflicts between regional and local traffic;
- Enhance bicycle and pedestrian accessibility and connectivity within the project study area;
- Improve mobility and between I-880, SR-260 (Tubes), City of Oakland downtown neighborhoods, and City of Alameda;
- Reduce freeway-bound regional traffic and congestion on local roadways and in area neighborhoods.

Access between the freeway and the roadway networks between I-880 and the Tubes is limited and indirect, and access to/from the cities of Oakland and Alameda is circuitous. Existing access to I-880 from Alameda and the Jack London District requires loops through several local streets and intersections, routing vehicles through the downtown Oakland Chinatown neighborhood, which has the following operational impacts on local streets:

- Streets in and around the downtown Oakland Chinatown area have a high volume of pedestrian activity and experience substantial vehicle-pedestrian conflicts, and the I-880 viaduct limits bicycle and pedestrian connectivity between downtown Oakland and the Jack London District.
- SB I-880 traffic heading to Alameda must exit at the Broadway/Alameda off-ramp, then travel south along 5th Street for more than a mile — through nine signalized and unsignalized intersections — before reaching the Webster Tube at 5th Street/Broadway.
- WB I-980 traffic heading to Alameda must exit at the Jackson Street off-ramp and circle back through Chinatown through seven signalized and unsignalized intersections to reach the Webster Tube.
- NB I-880 traffic heading to Alameda must exit at the Broadway off-ramp and form a queue on Broadway between 5th and 6th streets, which backs up onto the ramp. Alternatively, drivers may loop through Chinatown to access the Webster Tube.

## 1.2 No-Build (No-Action) Alternative

Under the No-Build Alternative, there would be no improvements to bicycle or pedestrian connectivity or safety. Freeway traffic to/from the cities of Oakland and Alameda would continue to use city streets through Oakland and Chinatown, which are areas with a high volume of pedestrian activity. Vehicle-pedestrian or -bicycle conflicts from traffic traveling through city streets would continue. The I-880 viaduct would continue to impede connectivity between downtown Oakland and the Jack London District, and access would not be improved for bicycles and pedestrians traveling between Oakland and Alameda.

## 1.3 Build Alternative

Under the Build Alternative, Caltrans and ACTC propose to remove and modify the existing freeway ramps and to modify the Posey Tube exit in Oakland. The Build Alternative would improve access to NB and SB I-880 from the Posey Tube via a right-turn-only lane from the Posey Tube to 5th Street and a new horseshoe connector at Jackson Street below the I-880 viaduct that would connect to the existing NB I-880/Jackson Street on-ramp. The existing WB I-980/Jackson Street off-ramp would be reconstructed and shifted to the south.

The Webster Tube entrance at 5th Street and Broadway would be shifted to the east to create more space for trucks to make the turn from Broadway into the Webster Tube. A bulb-out would be constructed to extend the sidewalk, reducing the crossing distance and allowing improved visibility of pedestrians on the southeast corner.

The NB I-880/Broadway off-ramp would be removed and the NB I-880/Oak Street off-ramp to 6th Street would be widened. The NB I-880/Oak Street intersection would become the main NB I-880 off-ramp to downtown Oakland and to Alameda. 6th Street would become a one-way through street from Oak Street to Harrison Street and a two-way street from Harrison Street to Broadway.

The proposed Project would include the addition of a Class IV two-way cycle track on 6th Street between Oak and Washington streets and on Oak Street between 3rd and 9th streets. Bicycle and pedestrian improvements would be constructed at the Tubes' approaches in Oakland and Alameda, and the Webster Tube westside walkway would be opened to pedestrians. This would improve connectivity to existing and future planned bicycle paths in the City of Oakland and implement various "complete streets" improvements to create additional opportunities for non-motorized vehicles and pedestrians to cross under I-880 between downtown Oakland, the Jack London District, and Alameda. See Figure 1, Figure 2, Figure 3, and Figure 4 for proposed elements of the Build Alternative.

Additional details on the Build Alternative improvements:

1. **Construction of a new horseshoe connector under I-880 at Jackson Street.**

   Vehicles exiting the Posey Tube would have direct access to NB I-880 via the proposed horseshoe connector. Vehicles heading to NB and SB I-880 would use the right-turn-only lane at the Posey Tube exit to turn onto eastbound 5th Street. Access to a new horseshoe connector

would be provided from the left side of 5th Street and would loop below the I-880 viaduct to connect to the existing NB I-880/Jackson Street on-ramp. Traffic heading to SB I-880 would continue eastbound on 5th Street to the SB I-880/Oak Street on-ramp. Figure 2 shows the new horseshoe connector under I-880 at Jackson Street.

Construction of the new right-turn-only lane onto 5th Street would require new retaining walls along the right side of the Posey Tube exit replacing the historic Posey Tube wall. The horseshoe connector would provide a direct route between the Posey Tube and NB I-880/ EB I-980 and SB I-880, substantially improving connectivity and minimizing the need for freeway-bound vehicles to travel through Chinatown to access the ramps. This configuration would also reduce intersection and bicycle-pedestrian conflicts.

Posey Tube traffic heading to Chinatown and downtown Oakland would remain in the left lane and continue onto Harrison Street or turn left onto 6th Street to reach downtown via Broadway. A new left-turn pocket to accommodate the turn onto 6th Street would be constructed requiring removal of a section of the historic Posey Tube western exit wall.

**2. Reconstruction of the existing WB I-980/Jackson Street off-ramp.**

To provide space for unimpeded movement from the Posey Tube to the new horseshoe connector, the WB I-980/Jackson Street off-ramp would be realigned to the south. Figure 2 shows the relocated Jackson Street off-ramp. The realigned off-ramp would touch down at-grade on 5th Street at the Alice Street intersection. Off-ramp and 5th Street traffic would continue to be separated by a landscaped median past the condominium building at 428 Alice Street. 5th Street would be converted to a two-way street to accommodate condominium residents allowing vehicles to turn left or right onto 5th Street.

**3. Removal of the existing NB I-880/Broadway off-ramp viaduct structure including the bridge deck and supporting columns.**

Removing the NB I-880/Broadway off-ramp structure would provide the space for complete street improvements on 6th Street. It would also restore an element of the City of Oakland's street grid system by providing a continuous 6th Street between Oak Street and Broadway. Figure 2 shows where the existing NB I-880/Broadway off-ramp would be removed. This would provide for a more efficient street network, and it would allow traffic to be more evenly distributed on Oakland city streets. Also, it would improve traffic operations at the Broadway/6th Street and Broadway/5th Street intersections by eliminating the stream of traffic exiting the Broadway off-ramp and heading to the Webster Tube entrance. Instead, this traffic would use 6th Street and turn left at Webster Street to access the Webster Tube.

**4. Widening of the NB I-880/Oak Street off-ramp.**

The existing Oak Street off-ramp would be widened from a one- to a two-lane exit by restriping the NB I-880 mainline and reconfiguring the ramp terminus. Figure 3 shows the proposed widening at the NB I-880/Oak Street off-ramp and restriping on NB I-880. At the Oak Street intersection, the ramp would be further widened from one left-turn-only pocket

lane, one through and left-turn lane, and one through and right-turn lane to provide one left-turn-only (SB) pocket lane, one through westbound (WB) lane, one through (WB) and right-turn (NB) lane, and one right-turn-only (NB) lane. Two new retaining walls would be constructed along the widened ramp's new edge of the shoulder. In advance of the Oak Street exit, NB I-880 would be restriped from four to five lanes, including a standard 1,400-foot-long auxiliary lane to accommodate the additional traffic resulting from the Broadway off-ramp removal.

**5. Modification of 5th Street/Broadway access to the Webster Tube.**

The 5th Street/Broadway entrance to the Webster Tube would be moved slightly east (refer to Figure 2). Also, the 5th Street crosswalk on the east side of Broadway would be shifted east and considerably shortened, and the signal phasing would be modified to include a pedestrian-led signal phase for eastbound pedestrian traffic. This would improve safety by giving pedestrians priority over turning traffic. Also, this would improve truck access to the Webster Tube and minimize conflicts with other vehicular traffic.

**6. Construction of a new through 6th Street connecting Oak Street to Broadway.**

Improvements to 6th Street would be accomplished by turning the street into a one-way street in the westbound direction from Oak Street to Harrison Street and a two-way street from Harrison Street to Broadway (refer to Figure 2). The lanes would be a minimum of 11 feet wide. There would be a minimum of two through lanes with additional turn pockets at intersections in the westbound direction. There would be one lane in the eastbound direction from Harrison Street to Broadway.

A new sidewalk would be constructed along the south side between Broadway and Oak Street. Segments of the existing sidewalk along the north side between Oak Street and Broadway would be reconstructed to a minimum of 10 feet wide between Harrison and Alice streets to provide continuity for pedestrians. A continuous Class IV two-way cycle track would also be provided between Oak and Washington streets. Parking spaces would be provided along portions of this roadway.

**7. Construction of a two-way bicycle/pedestrian path and walkway from Webster Street in Alameda to 6th Street in Oakland through the Posey Tube and from 4th Street in Oakland through the Webster Tube to Mariner Square Loop in Alameda.**

The path would begin at Webster Street and Constitution Way in Alameda, would continue through the Posey Tube on the existing eastside walkway, and would exit the Tube via a new ramp with a hairpin turn at 5th Street. Figure 4 shows the proposed bicycle and pedestrian improvements. The path in Alameda connecting to the Posey Tube would be realigned and widened. The path in Oakland would wrap around the back of the Portal building on 4th Street and continue onto Harrison Street. It would continue onto a Class I two-way bicycle/pedestrian path under I-880 just west of Harrison Street and connect to the Class IV two-way cycle track on 6th Street between Oak and Washington streets. The new bicycle and

pedestrian ramp exit from the Posey Tube would require removal of the existing historic Posey Tube staircase to provide street level ADA-compliant access from the Tube.

The proposed Project would improve access between Oakland and Alameda by opening the Webster Tube maintenance walkway to bicycle and pedestrian travel. The walkway would connect to the proposed path under I-880 at 4th Street (near the Posey Tube Portal building).It would continue onto 4th Street to Webster Street, and it would turn north through the existing parking lot on the west side of the Webster Tube entrance before making a hairpin turn to connect to the westside walkway inside the Tube.

On the Alameda side, the walkway would connect to existing bicycle and pedestrian facilities at Mariner Square Loop and Willie Stargell Avenue. The existing sidewalk within Neptune Park would be widened to match the proposed sidewalk to the north. Improvements inside the Tube would include widening the existing walkway, upgrading the existing railings, and relocating call boxes and fire extinguishers.

**8. Modification of 5th, 7th, Madison, Jackson, Harrison, Webster, Oak, and Franklin streets.**

The street modifications (refer to Figure 2) would include replacing the dual right turns at the 7th Street/Harrison Street intersection with a single right-turn-only lane and removing the free right turn (where the island allows cars to turn right without stopping) at the 7th Street/ Jackson Street intersection. These would no longer be needed because Alameda traffic bound for NB/SB I-880 would be better served by the right turns from the Posey Tube to 5th Street. With the removal of the free right turns, vehicles would observe the traffic signal before turning right. With the curb extension proposed at this location, the pedestrian crossing distance would be shortened, which would decrease vehicle-pedestrian conflicts. In addition, a PHB beacon would be installed on 7th Street across the street from the Chinese Garden Park. There would also be restrictive right-turn movements to reduce bicycle and vehicle conflicts at the 5th/Broadway, 6th/Webster, 6th/Harrison, 6th/Jackson, 6th/Madison, 5th/Jackson, 8th/Oak, and 7th/Oak intersections.

A continuous sidewalk would be installed along the perimeter of Chinese Garden Park. Additional improvements, including landscaping modifications, could occur adjacent to the southern boundary of the park and would be coordinated through the City of Oakland.

Jackson Street between 5th and 6th streets would be converted from two- to one-way travel lanes in the northbound direction, and it would provide an emergency-only access lane.

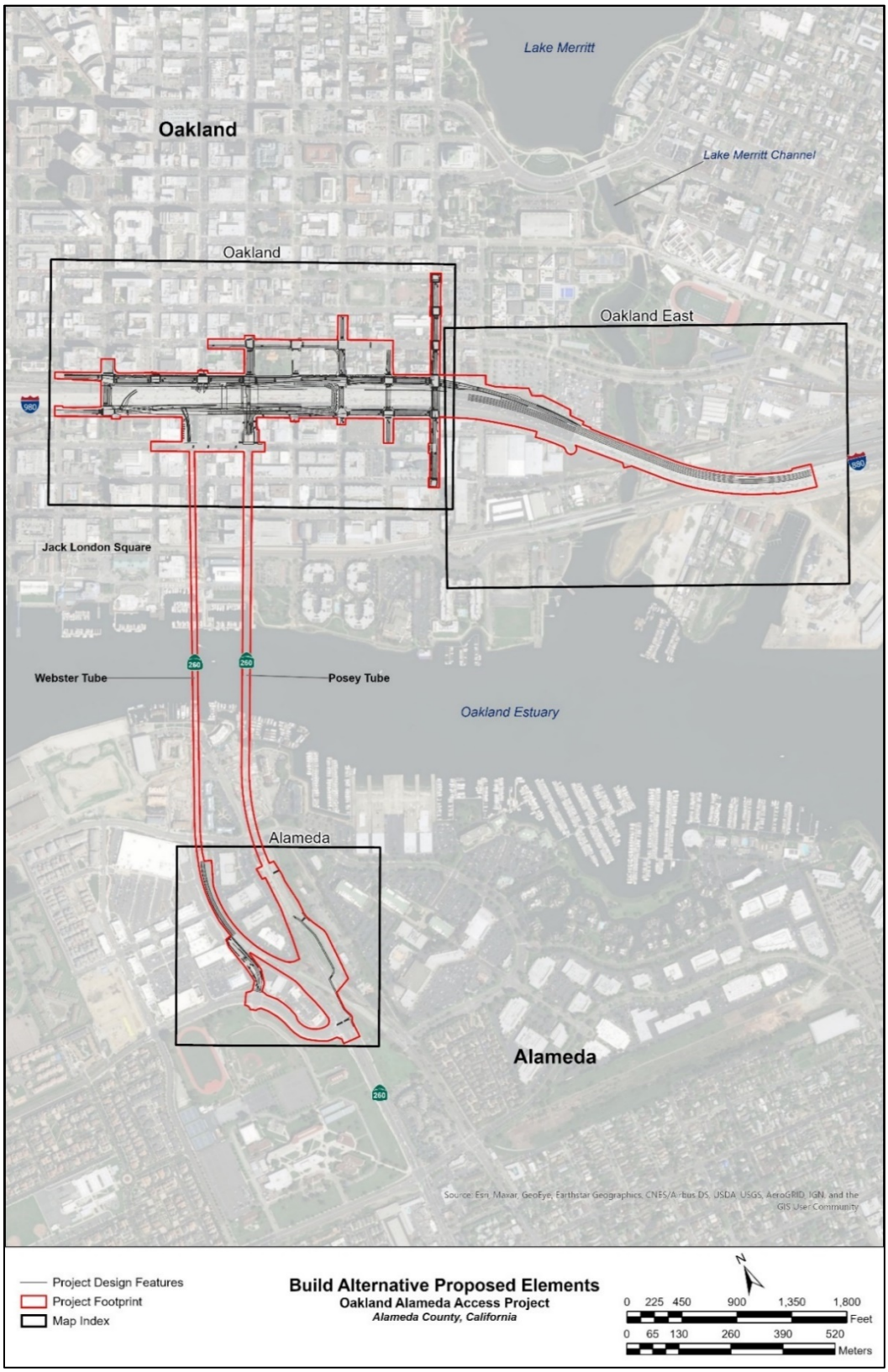


**Figure 1. Build Alternative Proposed Elements, Project Overview**

Source: HNTB

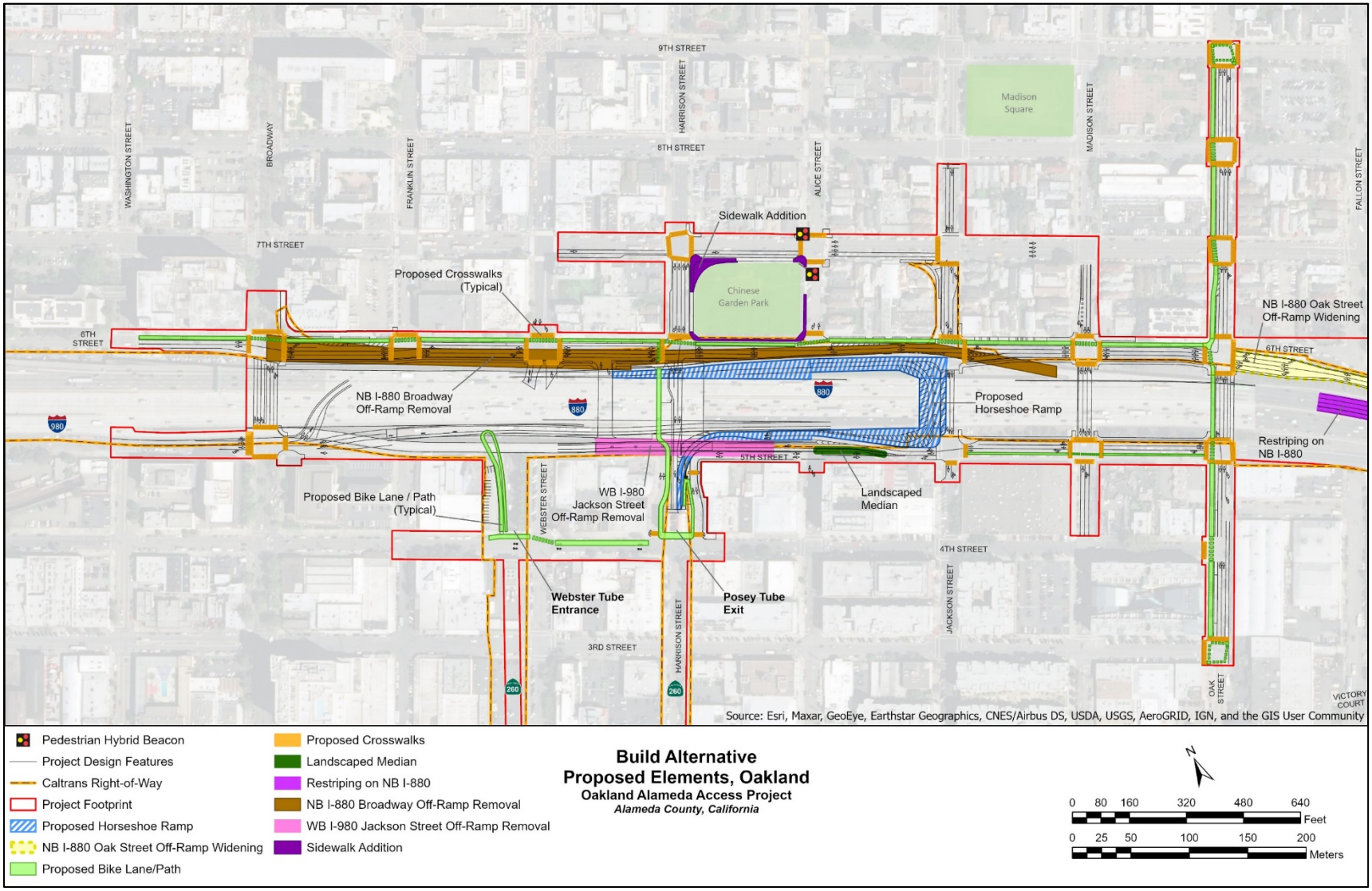


**Figure 2. Build Alternative Proposed Elements, Oakland**

Source: HNTB

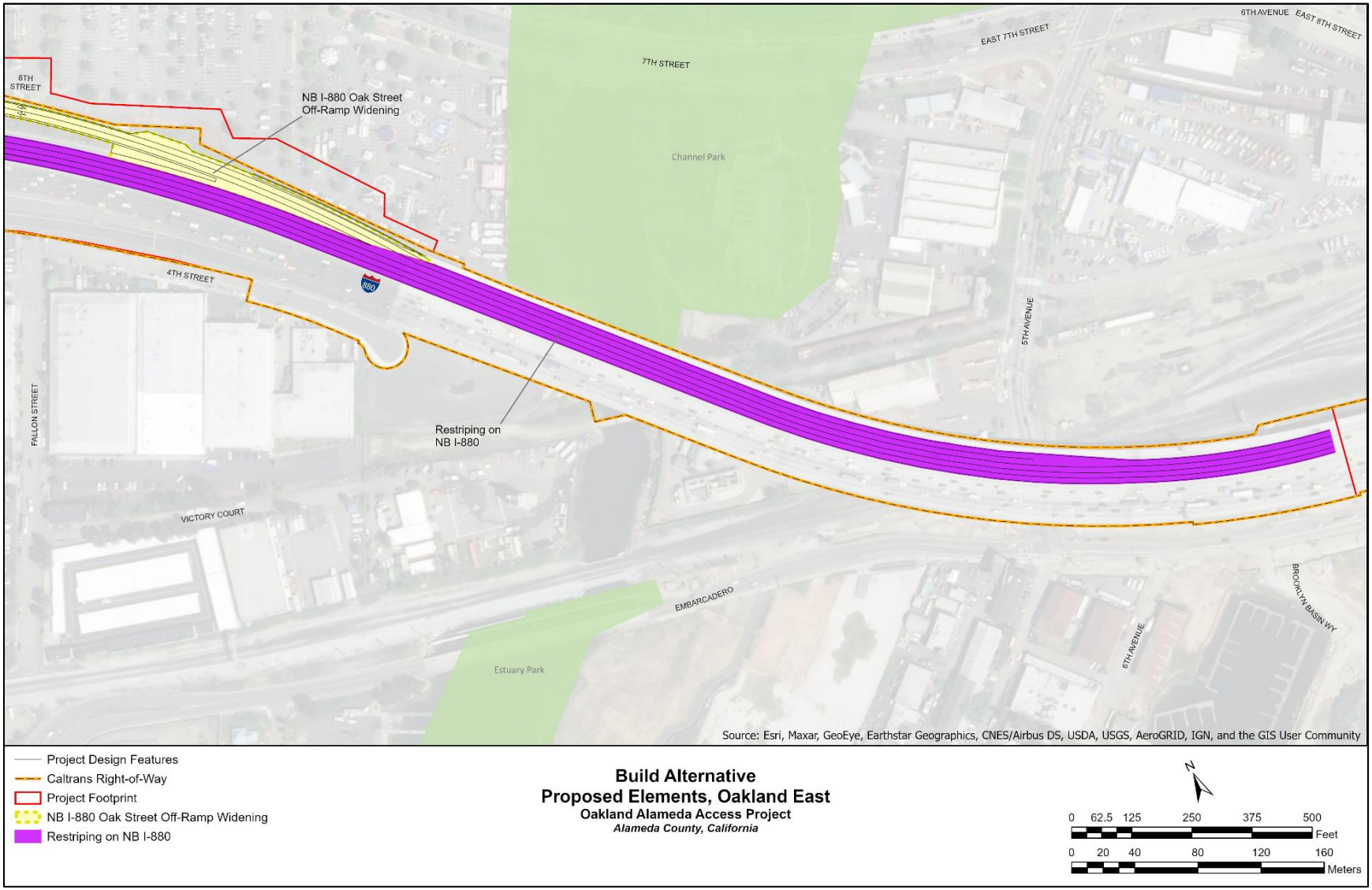


**Figure 3. Build Alternative Proposed Elements, Oakland East**

Source: HNTB

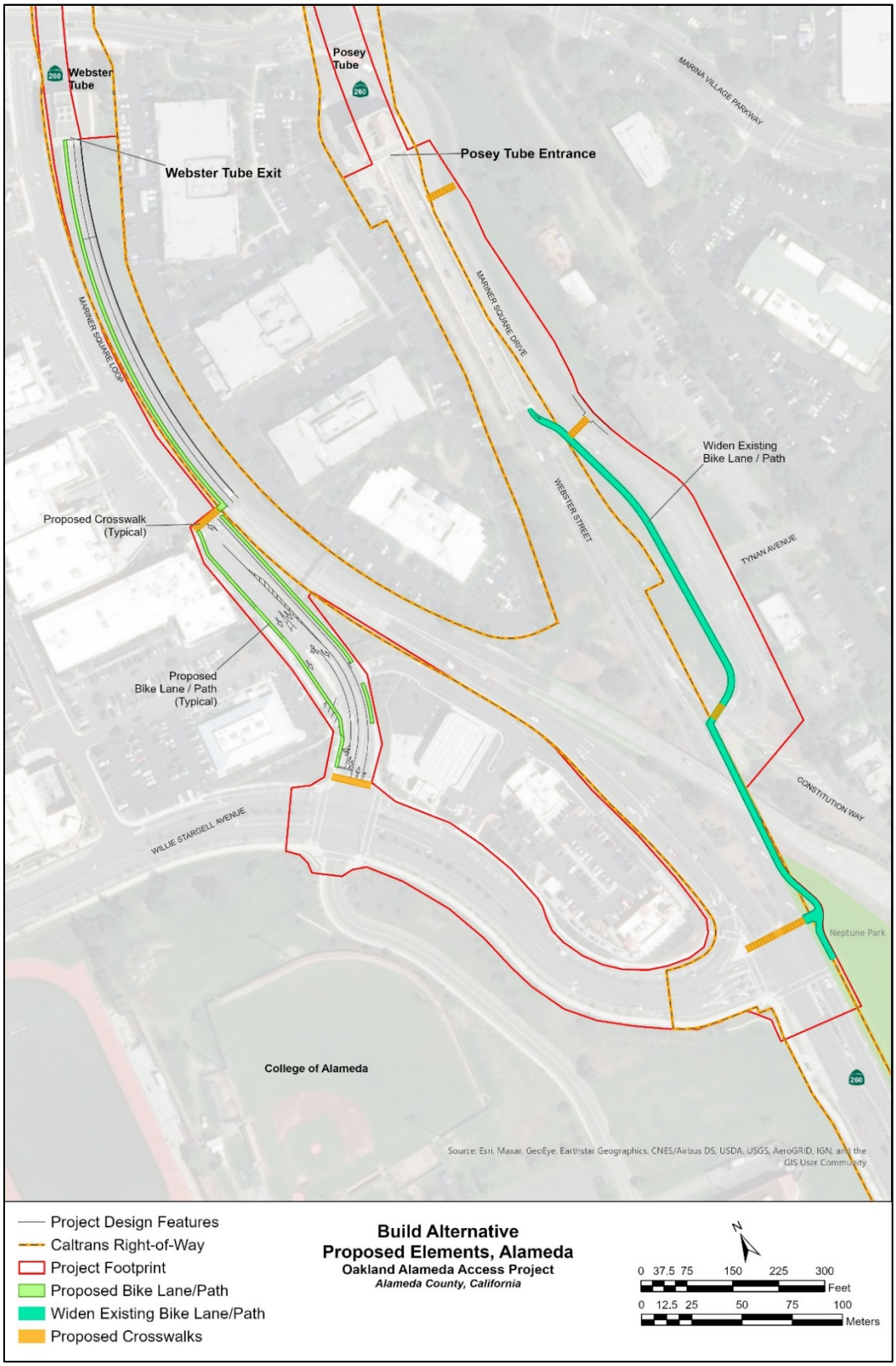


**Figure 4. Build Alternative Proposed Elements, Alameda**

Source: HNTB

## 1.4 Retaining Walls and Excavation

The proposed improvements would include construction of several new retaining walls along the NB I-880 Jackson Street on-ramp, WB I-980 Jackson Street off-ramp, NB I-880 Oak Street off-ramp, and new horseshoe connector. Retaining wall construction would minimize the need for right-of-way (ROW) acquisition. Table 1 lists the retaining walls needed for the proposed Project including their locations and approximate dimensions. Table 2 lists the excavation depths of other proposed Project features.

**Table 1. Locations and Dimensions of Retaining Walls**

| Wall Number | Location | Approx. Length (feet) | Height (feet) | Maximum Excavation Depth (feet) |
|---|---|---|---|---|
| **OAKLAND** | | | | |
| 1 | Supporting Harrison Street as Posey Tube right lane runs onto 5th Street | 215 | 8 to 12 | 36 |
| 2 | Supporting the existing fill in front of the existing abutment at Harrison Street | 65 | 8 to 30 | 13 |
| 3 | Supporting I-880 mainline | 410 | 24 to 32 | 28 |
| 4 | Supporting the Jackson Street abutment | 145 | 17 | 2 |
| 4A | Supporting the Jackson Street abutment | 60 | 10 | 20 |
| 4B | Supporting the Jackson Street abutment | 60 | 14 | 20 |
| 5 | Supporting cut slope south of 6th Street and parallel to existing NB I-880 Broadway off-ramp | 510 | 4 to 22 | 44 |
| 6 | Supporting Posey Tube bicycle/pedestrian switchback on the exit's east side | 105 | 10 | 32 |
| 7 | Support along the NB I-880 Oak Street off-ramp to accommodate an additional left-turn pocket | 215 | 4 to 10 | 6 |
| 8R | Supporting the reconstruction of the WB I-980 Jackson Street off-ramp (north wall) | 230 | 24 | 32 |
| 8L | Supporting the reconstruction of the WB I-980 Jackson Street off-ramp (south wall) | 225 | 22 | 6 |
| 9 | Supporting additional left-turn pocket for traffic from the Posey Tube at Harrison Street and 6th Street intersection | 95 | 8 | 12 |
| 10 | Supporting NB I-880 Oak Street off-ramp widening | 399 | 12 | 4 |

**Table 2. Excavation Depths**

| Feature | Description | Excavation Depth (feet) |
|---|---|---|
| **OAKLAND** | | |
| Bike Path | Assumed pavement depth = 0.5’ PCC, 0.5’ class 2 aggregate base (AB) | 1 |
| Roadway | Assumed pavement depth =0.75’ hot mix asphalt (HMA) (type A), 0.75’ class 2 AB, 1’ class 2 aggregate subbase (AS) | 2.5 |
| WB I-980 Jackson Street Off-ramp | New bents (columns) and an abutment | 50 |
| **ALAMEDA** | | |
| Bike Path | Assumed pavement depth = 0.5’ PCC, 0.5’ class 2 AB | 1 |
| Roadway | Assumed pavement depth =0.75’ HMA (type A), 0.75’ class 2 AB, 1’ class 2 AS | 2.5 |
| Overhead Sign Foundation | Truss single post Type V with assumed span length = 32’ | 20 |

### 1.4.1 Construction Schedule

Construction activities would last approximately 36 months. Construction is expected to begin in mid-2023. There would be two major stages with several phases in each. The first stage would include construction of the Jackson Street horseshoe and associated improvements on the southside of I-880 as well as the widening of the walkway in the Webster Tube. The second stage would include widening of the NB I-880/Oak Street off-ramp, removal of the Broadway NB I-880 off-ramp, and construct 6$^{th}$ Street improvements with associated elements on the northside of I-880.

Construction equipment would be staged in areas underneath I-880 that are owned by Caltrans and currently leased as parking lots. Construction activities would be completed during the day; however, nighttime work would be needed to minimize impacts to traffic, especially in the Webster Tube. Caltrans would continue to coordinate with the cities of Oakland and Alameda to develop and implement a Transportation Management Plan (TMP) and other measures to minimize construction impacts on the human and natural environment. As part of the TMP, a shuttle may be needed to transport bicyclists and pedestrians between Oakland and Alameda during construction. The proposed Project contains a number of standardized Project measures which are employed on most, if not all, Caltrans projects. They were not developed in response to any specific environmental impacts resulting from the proposed Project.

## 1.5 Regulatory Setting

### 1.5.1 Executive Order 11988 (Floodplain Management, 1977)

Executive Order 11988 (Floodplain Management) directs all federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development

wherever there is a practicable alternative. Requirements for compliance are outlined in Title 23, Code of Federal Regulations (CFR), Part 650, Subpart A (23 CFR 650A) titled "Location and Hydraulic Design of Encroachment on Floodplains" (2015).

If the preferred alternative involves significant encroachment onto the floodplain, the final environmental document (final Environmental Impact Statement or finding of no significant impact) must include:

- The reasons why the proposed action must be located in the floodplain,
- The alternatives considered and why they were not practicable, and
- A statement indicating whether the action conforms to applicable state or local floodplain protection standards.

### 1.5.2 California's National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) is the nationwide administrator of the National Flood Insurance Program (NFIP), which is a program that was established by the National Flood Insurance Act of 1968 to protect lives and property, and to reduce the financial burden of providing disaster assistance. Under the NFIP, FEMA has the lead responsibility for flood hazard assessment and mitigation, and it offers federally backed flood insurance to homeowners, renters, and business owners in communities that choose to participate in the program. FEMA has adopted the 100-year floodplain as the base flood standard for the NFIP. FEMA is also concerned with construction that would be within a 500-year floodplain for proposed projects that are considered "critical actions," which are defined as any activities where even a slight chance of flooding is too great. FEMA issues the Flood Insurance Rate Maps (FIRMs) for communities that participate in the NFIP. These FIRMs present delineations of flood hazard zones.

In California, nearly all of the State's flood-prone communities participate in the NFIP, which is locally administered by the California Department of Water Resources' (DWR) Division of Flood Management. Under California's NFIP, communities have a mutual agreement with the State and Federal government to regulate floodplain development according to certain criteria and standards, which is further detailed in the NFIP.

### 1.5.3 Alameda County Floodplain Data

As part of the NFIP, typically, each county (or community) has a Flood Insurance Study (FIS), which is used to locally develop FIRMs and Base Flood Elevations (BFEs). The FIS volumes for the Project limits are 06001CV001B, 06001CV002B, and 06001CV003B.

## 1.6 Design Standards

### 1.6.1 FEMA Standards

FEMA standards are employed for design, construction, and regulation to reduce flood loss and to protect resources. Two types of standards are often employed: design criteria and performance standards.

The design criteria dictates that a provision, practice, requirement, or limit must be met (e.g., using the 1%-annual-chance flood and establishing floodway boundaries so as not to cause more than a 1-foot increase in flood stages).

A performance standard dictates that a goal is to be achieved, leaving it to the individual application as to how to achieve the goal (e.g., providing protection to the regulatory flood, keeping post-development stormwater runoff the same as pre-development, or maintaining the present quantity and quality of water in a wetland).

The 1%-annual-chance flood and floodplain have been adopted as a common design and regulatory standard in the United States. The NFIP adopted it in the early 1970s as a standard for use by all federal agencies with the issuance of Executive Order 11988. States or local agencies are free to impose a more stringent standard within their jurisdiction.

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# 2 AFFECTED ENVIRONMENT

The Project site is located in the west region of Alameda County. The Project proposes work on both the City of Oakland and Alameda sides of the Oakland estuary (see Figure 5). The Project limits are located entirely within an urban setting and are covered with impervious surfaces, residential and commercial buildings, freeways and city roadways; and other urban development and infrastructure. Along the I-880 corridor, the Oakland Harbor owned by the Port of Oakland lies along the north western border of the Project limits. The remainder of the west side of I-880 and I-980 consists mostly of commercial complexes. The Oakland Inner Harbor, Oakland Estuary, and Estuary Park are situated west beyond the Project limits. The remainder of the western portion of the City of Oakland part of the Project limits consists mainly of residential and commercial complexes located on the east and west sides of I-880. Areas east of the I-880 and I-980 corridor are a mix of residential areas and businesses. The inlet of Lake Merritt is within the southern portion of the Project limits.

Similar to the City of Oakland portion of the Project limits, Oakland Estuary is situated along the northern portion of the Project limits on the City of Alameda side. The City of Alameda section of the Project consists primarily of commercial developments and business complexes.

## 2.1 Geographic Location

The Project is located in Alameda County at approximately 37°47'48.65” North latitude and 122°16'17.44" West longitude in the cities of Oakland and Alameda.

## 2.2 Vertical Datum

The elevations shown in the FEMA FIRMs and FIS for the County are referenced to the North American Vertical Datum of 1988 (NAVD 88).

## 2.3 Watershed Description

The proposed Project lies on either side of the Oakland Estuary, which is connected to San Francisco Bay. According to the Caltrans Water Quality Planning Tool, the Project limits are entirely within an undefined hydrologic sub-area (#204.20) of the East Bay Cities hydrologic area, South Bay hydrologic unit, and San Francisco Bay hydrologic region.

### 2.3.1 City of Oakland Project Limits

Runoff within the City of Oakland Project limits primarily collects along the roadway shoulders, conveys into underground storm drainage systems, and flows towards the Oakland Estuary and Lake Merritt Channel (Sowers 2000; Schaaf and Wheeler 2008).

The Lake Merritt Channel connects Lake Merritt to the Oakland Estuary. A pump station and tide gate regulate the tidal exchanges between Lake Merritt Channel and the Oakland Estuary. During the summer, water levels within Lake Merritt Channel are kept high for recreational activities. In the winter, the water levels are kept low to accommodate storm flows. The tide gate and pump station that regulate these water levels are located upstream (north) of the Project limits at the 7th Street crossing.

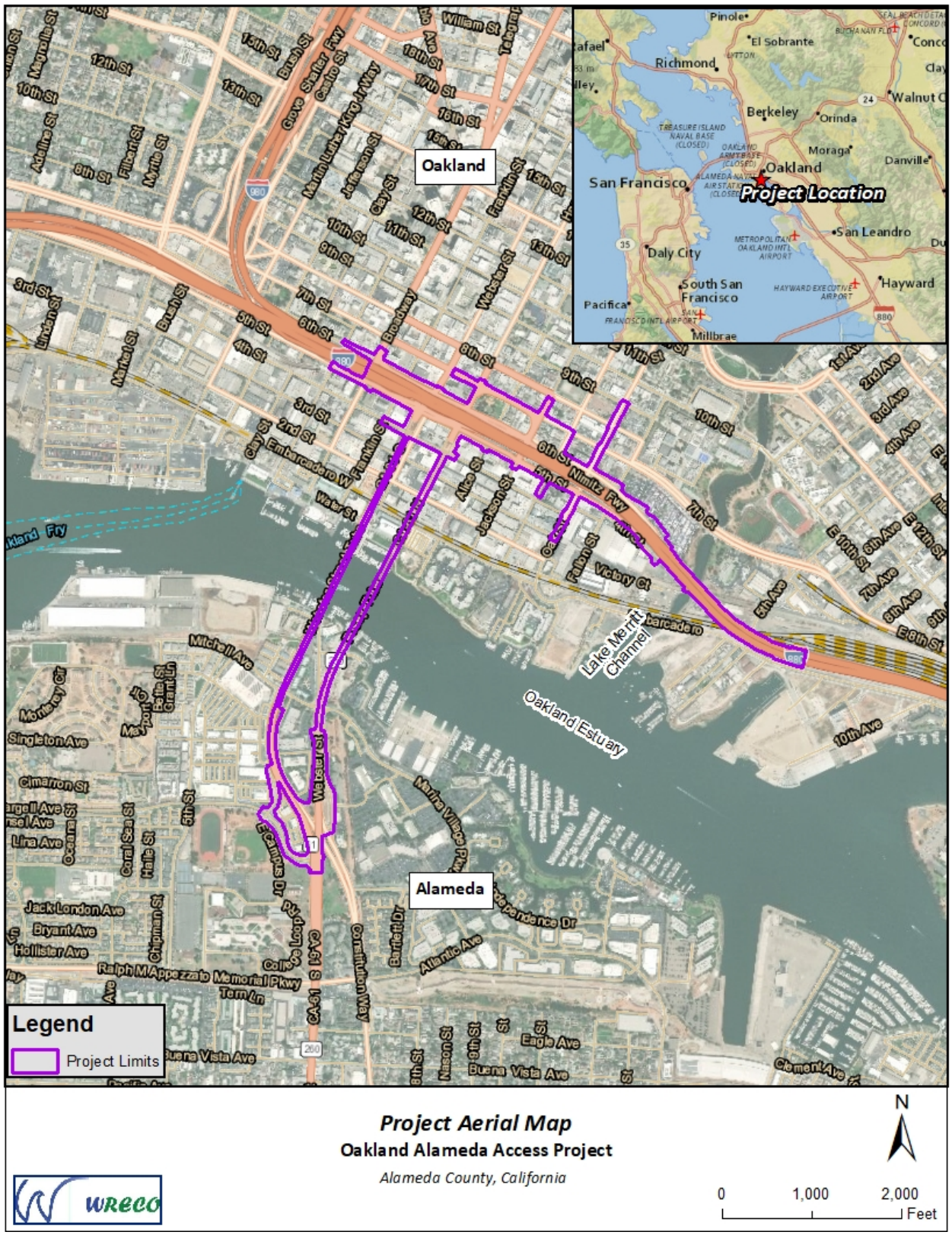


**Figure 5. Project Aerial Map**

Source: ESRI

### 2.3.2 City of Alameda Project Limits

Runoff within the City of Alameda Project limits collects along the roadway shoulders, conveys into underground storm drainage systems, and flows towards the Oakland Estuary (Sowers 2000; Schaaf and Wheeler 2008).

## 2.4 FEMA Floodplains

### 2.4.1 Effective FIRM

The Project site is located within the FIRM Number 06001C0067H, which is panel 67 of 725 and has been effective since December 21, 2018 (see Appendix A). The special flood hazard areas extending through the portions of the Project in both the City of Oakland and Alameda are classified as Zone AE and shaded Zone X. A Zone AE floodplain is an area inundated by the 1 percent annual chance flood event (or 100-year storm event). The Zone AE floodplain inundation within the Project limits include Project areas over the Lake Merritt channel in the City of Oakland and the roadway and pedestrian/bike path areas in the City of Alameda including the entrance/exit of the Tubes. Since the Alameda entrance and exit of the Posey and Webster Tubes are within the FEMA 100-year floodplain, the tubes have the potential to flood during a 100-year event. Per the FIRM, the stillwater elevation of the Zone AE floodplain with the Project limits both in the City of Oakland and Alameda has an elevation of approximately 10 ft NAVD 88. The effective FIRM defines the shaded Zone X region in the vicinity of the Project a 0.2%-annual chance flood hazard are, where the 1%-annual chance flood has an average depth less than one foot or with drainage areas of less than one square mile.

## 2.5 Sea Level Rise

Sea level rise (SLR) at the Project site was estimated using the *State of California Sea-Level Rise Guidance, 2018 Update* (Coastal and Ocean Working Group of the California Action Team, 2018). A medium-to-high risk scenario SLR value of 4.3 ft was calculated using the Project's design life of 50 years.

Using the 100-year storm surge as the base, the elevation of SLR is predicted to be 14.3 ft NAVD 88 within the Project site. However, per the Project Design Team (PDT), the Project was evaluated for potential SLR impacts using the Mean Higher High Water (MHHW) as the base water level, which is a more frequent and lower water level than the 100-year storm event. Because this report evaluates the potential Project impacts associated with the 100-year storm event, the potential Project impacts and adaptive measures due to SLR are instead discussed in detail in the Project's SLR Memorandum (see Appendix B).

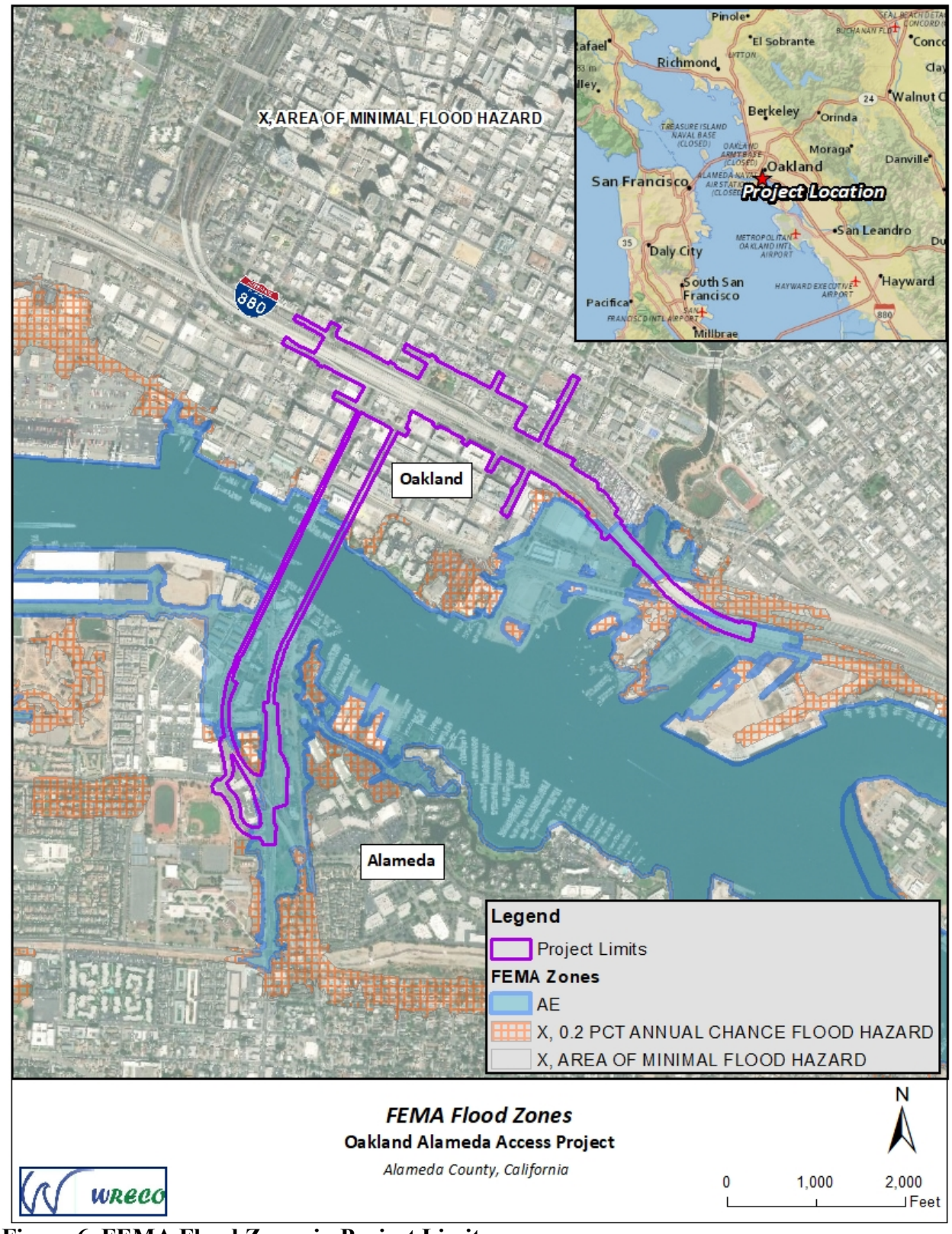


**Figure 6. FEMA Flood Zones in Project Limits**

Source: FEMA

# 3 PROJECT EVALUATION

Executive Order 11988 requires federal agencies to avoid to the maximum extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. This section analyzes the impacts associated with this Project.

## 3.1 Risk Associated with the Proposed Action

As defined by the FHWA, risk shall mean the consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the roadways and pedestrian/bicycle path.

As defined by the FHWA, risk shall mean the consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the bridge and roadway.

The potential risk associated with the implementation of the proposed action includes but is not limited to: 1) change in land use, 2) change in impervious surface area, 3) fill inside the floodplain, or 4) change in the 100-year water surface elevation (WSE):

### 3.1.1 Change in Land Use

The majority of the design changes in both the City of Oakland and Alameda are improvements to existing roads and paths, impacts would not significantly change land use within the Project limits.

### 3.1.2 Change in Impervious Surface Area

Proposed improvements in the City of Oakland right-of-way would add approximately 0.03 ac of net new impervious surface to the watershed. The proposed improvements in the City of Alameda right-of-way would add approximately 0.09 ac of impervious surface. The total net new impervious surface within the Project limits would be approximately 0.92 ac including net new impervious areas in Caltrans right-of-way (0.84 ac) and removal of 0.04 ac from Laney College Special District, which would be approximately 0.0005% of the total watershed area at the Project location (245 $mi^2$). Overall, the Project would have an insignificant impact to the land use within the watershed.

### 3.1.3 Fill Inside the Floodplain

Construction within the City of Oakland Project limits does not include fill within the floodplain.

Work within the City of Alameda Project limits includes the construction of pedestrian/bike paths within the FEMA floodplain as shown on Figure 6. The pedestrian/bike paths would be constructed at approximately the existing grade, any required fill would be minimal. The ground elevation of the pedestrian/bike path is lower than the 100-year tidal elevation of flood zone (10 ft NAVD 88). The submerged portions of potential fill would be considered to be inside the 100-year floodplain, but would insignificantly reduce the floodplain storage volume. Potential impacts to the FEMA 100-year floodplain will be further evaluated during the Project's Plans,

Specifications and Estimates (PS&E) phase upon the availability of additional design information.

### 3.1.4 Change in the 100-Year Water Surface Elevation

Work within the City of Oakland Project limits in the vicinity of the floodplain is limited to roadway striping on the bridge above the water and would not affect the 100-year WSE.

Work within the City of Alameda Project limits would be constructed to approximately the existing grade, requiring minimal filling. Slight loss of the floodplain storage volume would not significantly impact the existing 100-year WSE in the vicinity of the Project location. Potential impacts to the 100-year water surface elevation in the Project area will be further evaluated during the Project's PS&E phase.

## 3.2 Summary of Potential Encroachments

The Federal Highway Administration (FHWA) defines a significant encroachment as a highway encroachment, and any direct support of likely base floodplain development, that would involve one or more of the following construction or flood-related impacts: 1) significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route, 2) a significant risk, or 3) a significant adverse impact on the natural and beneficial floodplain values (FHWA 1994). The following sections discuss the potential impacts to the floodplain that may result from the proposed action.

### 3.2.1 Potential Traffic Interruptions

Proposed work in the City of Oakland within the FEMA 100-year floodplain is limited to traffic striping. The proposed trails in the City of Alameda are currently not anticipated to modify the local roadway elevations within the FEMA 100-year floodplain significantly. Therefore, additional traffic interruptions due to the Project are not anticipated. Potential traffic interruptions during the 100-year floodplain due the Project will be verified during the Project's PS&E phase.

### 3.2.2 Potential Impacts on Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include, but are not limited to: fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and ground water recharge.

The existing and potential beneficial uses of the Oakland Estuary and Lake Merritt Channel identified in the San Francisco Bay Basin Water Quality Control Plan are as follows:

- Oakland Estuary
    - Estuarine habitat
    - Noncontact Water Recreation
    - Navigation
    - Wildlife habitat

  - Water Contact Recreation

- Lake Merritt Channel
  - Commercial and Sport Fishing
  - Estuarine habitat
  - Noncontact Water Recreation
  - Water Contact Recreation
  - Wildlife habitat

The potential impacts to the beneficial floodplain values are included in the Project's Water Quality Assessment Report (WRECO, 2020). The Project's Natural Environment Study (WRECO, 2020) provides discussions of the natural floodplain values and the potential impacts due to the Project.

### 3.2.3 Support of Probable Incompatible Floodplain Development

As defined by the FHWA, the support of incompatible base floodplain development will encourage, allow, serve, or otherwise facilitate incompatible base floodplain development, such as commercial development or urban growth.

The proposed Project is the construction of improvements to portions of existing roadways in the City of Oakland and pedestrian/bike path improvements in the City of Alameda. The proposed improvements are designed to improve the local traffic pattern and would not create new access routes to developed or undeveloped land in the 100-year floodplain. The Project would not support probable incompatible floodplain development.

### 3.2.4 Longitudinal Encroachments

As defined by FHWA, a longitudinal encroachment is an action within the limits of the base floodplain that is longitudinal to the normal direction of the floodplain. A longitudinal encroachment is "[a]n encroachment that is parallel to the direction of flow. Example: A highway that runs along the edge of a river is, usually considered a longitudinal encroachment." The requirement for consideration of avoidance alternatives must be included in a Location Hydraulic Study by including an evaluation and a discussion of the practicability of alternatives to any significant encroachment or any support of incompatible floodplain development.

The flow direction of the tidal floodplain within the Project limits is not parallel to the direction of the proposed in the City of Alameda pedestrian/bike path improvements. The Project would not be considered as a longitudinal encroachment.

## 3.3 Sea Level Rise Impacts

The potential Project impacts due to SLR are discussed in detail in the Project's SLR Memorandum (see Appendix B).

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# 4 AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

## 4.1 Minimize Floodplain Impacts

The Project would not result in significant floodplain impacts. No work is planned in the Zone AE floodplain in the Lake Merritt Channel in the City of Oakland. The majority of improvements in the Project are outside of the 100-year floodplain. Within the Zone AE floodplain in the City of Alameda, minor improvements to pedestrian/bike paths would be placed at approximately the existing grade and would not significantly increase fill in the floodplain. The Project would increase the impervious area; however, any increase in runoff attributable to the increased impervious area would be minimal. Therefore, no floodplain avoidance or minimization measures are proposed, and no mitigation measures are required for this Project under the Build Alternative.

## 4.2 Measures to restore and preserve the natural and beneficial floodplain values impacted by this action

The minimization and mitigation measures to restore and preserve the natural and beneficial floodplain values impacted by this action are included in the Project's Water Quality Assessment Report and Natural Environment Study report.

## 4.3 Practicability of alternatives to any significant encroachments

The FHWA defines a "significant encroachment" as a highway encroachment, and any direct support of likely base floodplain development, that would involve one or more of the following construction or flood-related impacts: 1) significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route; 2) a significant risk; or 3) a significant adverse impact on the natural and beneficial floodplain values (1994).

The proposed Project would not significantly modify the extent and elevation of the 100-year floodplain within the Project vicinity. As this Project is not considered a significant encroachment, alternatives were not analyzed.

## 4.4 Practicability of alternatives to any longitudinal encroachments

As defined by the FHWA, a longitudinal encroachment is an action within the limits of the base floodplain that is longitudinal to the normal direction of the floodplain.

A longitudinal encroachment is "[a]n encroachment that is parallel to the direction of flow. Example: A highway that runs along the edge of a river is, usually considered a longitudinal encroachment." The requirement for consideration of avoidance alternatives must be included in a Location Hydraulic Study by including an evaluation and a discussion of the practicability of alternatives to any significant encroachment or any support of incompatible floodplain development.

The flow direction of the tidal floodplain within the Project limits is not parallel to the direction of the proposed improvements. The Project would not be considered as a longitudinal encroachment. Therefore, the practicability of avoidance alternatives was not analyzed.

## 4.5 Sea Level Rise

The SLR adaptation measures considered for the Project are presented in the Project's SLR Memorandum (see Appendix B).

## 4.6 Coordination with Local, State, and Federal Water Resources and Floodplain Management Agencies

The floodplain inside the Project limits is tidal floodplain. The Project would not change the tidal flood elevation at the Project vicinity. A Conditional Letter of Map Revision is not anticipated for this Project. Regulatory permits from and coordination with the following agencies are anticipated to be required as the Project enters into the final design phase:

- California Public Utility Commission
- California Department of Fish and Game
- San Francisco Bay Regional Water Quality Control Board
- United States Fish and Wildlife Service
- City of Alameda
- City of Oakland
- Alameda County

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# Appendix A Federal Emergency Management Agency Flood Insurance Rate Map

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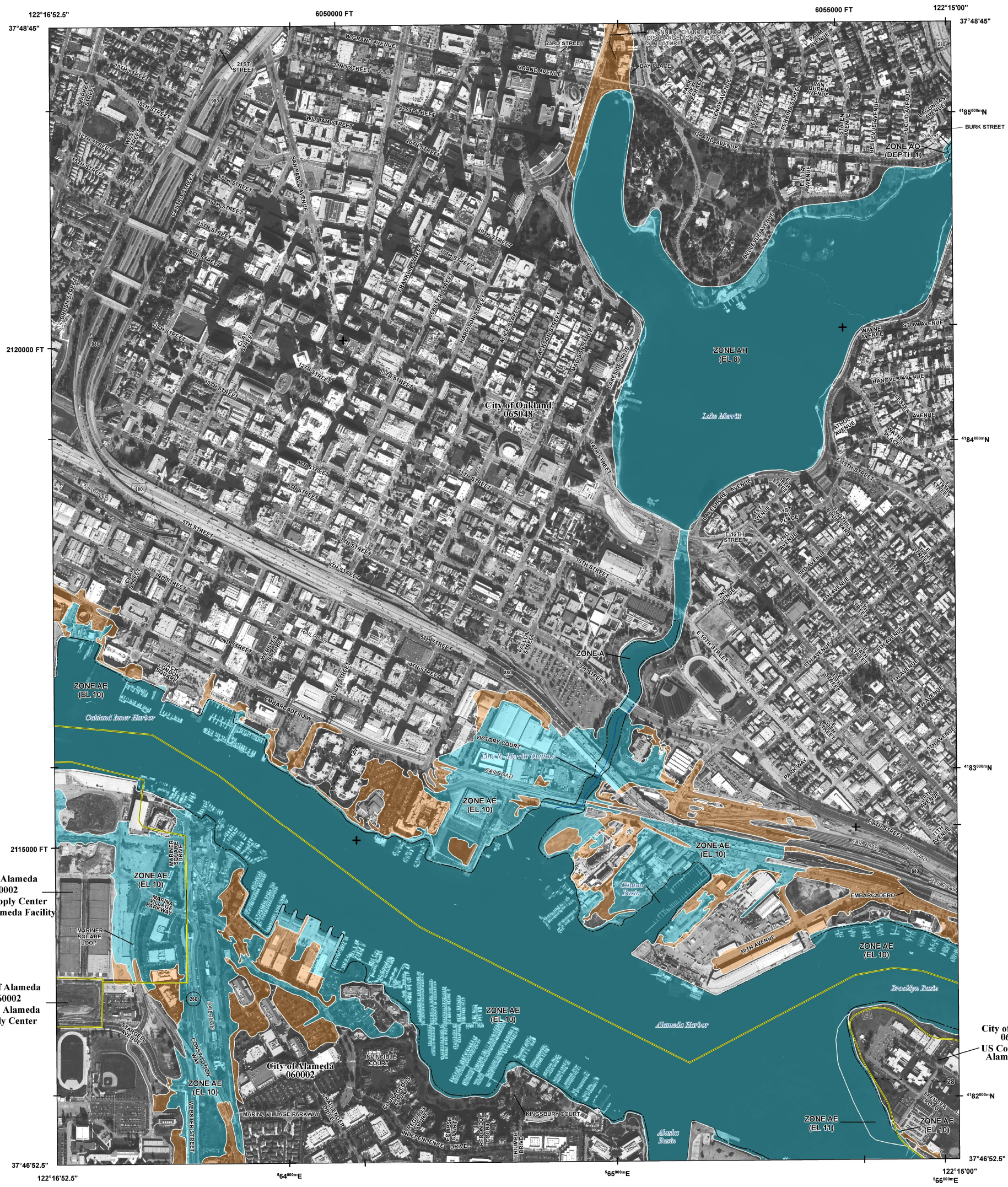



## FLOOD HAZARD INFORMATION

**SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT**

**THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV**

| | |
|---|---|
| SPECIAL FLOOD HAZARD AREAS | Without Base Flood Elevation (BFE) *Zone A,V, A99*<br>With BFE or Depth *Zone AE, AO, AH, VE, AR* |
| | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* |
| | Future Conditions 1% Annual Chance Flood Hazard *Zone X* |
| | Area with Reduced Flood Risk due to Levee See Notes. *Zone X* |
| | Area with Flood Risk due to Levee *Zone D* |
| OTHER AREAS | NO SCREEN Area of Minimal Flood Hazard *Zone X* |
| | Area of Undetermined Flood Hazard *Zone D* |
| GENERAL STRUCTURES | Channel, Culvert, or Storm Sewer |
| | Levee, Dike, or Floodwall |
| OTHER FEATURES | E 18.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation |
| | 8 Coastal Transect |
| | Coastal Transect Baseline |
| | Profile Baseline |
| | Hydrographic Feature |
| | 513 Base Flood Elevation Line (BFE) |
| | Limit of Study |
| | Jurisdiction Boundary |

## NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was derived from Coastal California LiDAR and Digital Imagery dated 2011. USDA NAIP 2012 imagery is used in areas not covered by the Coastal California imagery.

## SCALE

N

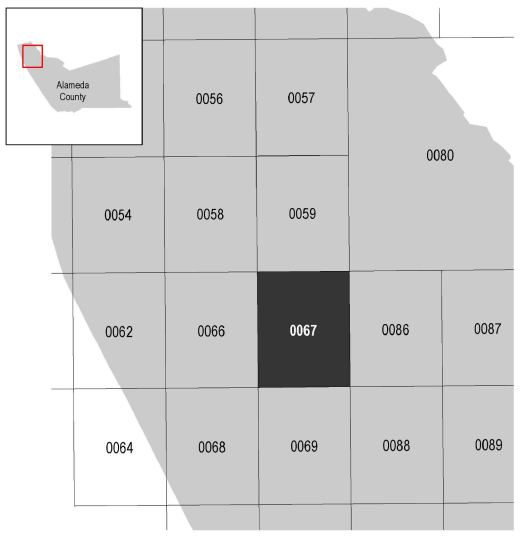
**Map Projection:**
Universal Transverse Mercator Zone 10N; North American Datum 1983; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 250 500 750 1,000 2,000 Feet

0 125 250 500 Meters

## PANEL LOCATOR




FEMA National Flood Insurance Program

**NATIONAL FLOOD INSURANCE PROGRAM**

**FLOOD INSURANCE RATE MAP**

**ALAMEDA COUNTY, CALIFORNIA**
and Incorporated Areas

PANEL 67 OF 725

FEMA

Panel Contains:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ALAMEDA, CITY OF | 060002 | 0067 | H |
| OAKLAND, CITY OF | 065048 | 0067 | H |

VERSION NUMBER
2.3.2.0

MAP NUMBER
06001C0067H

MAP REVISED
DECEMBER 21, 2018

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# Appendix B Project Sea-Level Rise Memorandum: Review and Assessment of Sea-Level Rise at the Oakland Alameda Access Project

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WRECO

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Walnut Creek, CA 94596
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www.wreco.com

***Memorandum***

**Date:** **May 6, 2020**

**To:** **Rodney Pimentel and Lillie A. Lam, HNTB CORPORATION**

**From:** **Kazuya Tsurushita and Haimet Kassaye, WRECO**

**Subject:** **Review and Assessment of Sea-Level Rise at the Oakland Alameda Access Project**

# 1. INTRODUCTION

This memorandum is prepared to document the findings of the review of available information on the potential for Sea-Level Rise (SLR) at the Oakland Alameda Access Project (Project). All applicable SLR data, the pertinent project information, and the assessment of the implications of the findings were analyzed and summarized in this memorandum.

# 2. PROJECT DESCRIPTION

The proposed Project is located in the cities of Oakland and Alameda in Alameda County, California. The Project proposes to improve access along Interstate 880 (I-880) and in and around the Posey and Webster Tubes (Tubes), downtown Oakland, and the City of Alameda. Within the approximately 1-mile-long Project, I-880 (PM ALA 30.47 to PM 31.61) and State Route 260 (SR-260) (PM ALA R0.78 to R1.90) are major transportation corridors. Also, the I-880 freeway viaduct is a physical barrier, limiting bicycle and pedestrian connectivity between downtown Oakland and Chinatown to the north and the Jack London District and Oakland Estuary to the south. Existing local street patterns across I-880 are intertwined with on- and off-ramps and the Tubes connecting Oakland and Alameda affecting the cross-freeway circulation of motorists, bicyclists, and pedestrians.

## *Purpose and Need*

Purpose

The purpose of the Project is to:

- Improve multimodal safety and reduce conflicts between regional and local traffic;
- Enhance bicycle and pedestrian accessibility and connectivity within the project study area;
- Improve mobility, and accessibility between I-880, SR-260 (Tubes), City of Oakland downtown neighborhoods, and City of Alameda;
- Reduce freeway-bound regional traffic and congestion on local roadways and in area neighborhoods.

Need

Access between the freeway and the roadway networks between I-880 and the Tubes is limited and indirect, and access to/from the cities of Oakland and Alameda is circuitous. Existing access

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to I-880 from Alameda and the Jack London District requires loops through several local streets and intersections, routing vehicles through the downtown Oakland Chinatown neighborhood, which has the following operational impacts on local streets:

- Streets in and around the downtown Oakland Chinatown area have a high volume of pedestrian activity and experience substantial vehicle-pedestrian conflicts, and the I-880 viaduct limits bicycle and pedestrian connectivity between downtown Oakland and the Jack London District.
- SB I-880 traffic heading to Alameda must exit at the Broadway/Alameda off-ramp, then travel south along 5th Street for more than a mile — through nine signalized and unsignalized intersections — before reaching the Webster Tube at 5th Street/Broadway.
- WB I-980 traffic heading to Alameda must exit at the Jackson Street off-ramp and circle back through Chinatown through seven signalized and unsignalized intersections to reach the Webster Tube.
- NB I-880 traffic heading to Alameda must exit at the Broadway off-ramp and form a queue on Broadway between 5th and 6th streets, which backs up onto the ramp. Alternatively, drivers may loop through Chinatown to access the Webster Tube.

## *No-Build (No-Action) Alternative*

Under the No-Build Alternative, there would be no improvements to bicycle or pedestrian connectivity or safety. Freeway traffic to/from the cities of Oakland and Alameda would continue to use city streets through Oakland and Chinatown, which are areas with a high volume of pedestrian activity. Vehicle-pedestrian or -bicycle conflicts from traffic traveling through city streets would continue. The I-880 viaduct would continue to impede connectivity between downtown Oakland and the Jack London District, and access would not be improved for bicycles and pedestrians traveling between Oakland and Alameda.

## *Build Alternative*

Under the Build Alternative, Caltrans and ACTC propose to remove and modify the existing freeway ramps and to modify the Posey Tube exit in Oakland. The Build Alternative would improve access to NB and SB I-880 from the Posey Tube via a right turn-only lane from the Posey Tube to 5th Street and a new horseshoe connector at Jackson Street below the I-880 viaduct that would connect to the existing NB I-880/Jackson Street on ramp. The existing WB I-980/Jackson Street off ramp would be reconstructed and shifted to the south.

The Webster Tube entrance at 5th Street and Broadway would be shifted to the east to create more space for trucks to make the turn from Broadway into the Webster Tube. A bulb-out would be constructed to extend the sidewalk, reducing the crossing distance and allowing improved visibility of pedestrians on the southeast corner.

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The NB I-880/Broadway off-ramp would be removed and the NB I-880/ Oak Street off-ramp to 6th Street would be widened. The NB I-880/Oak Street intersection would become the main NB I-880 off-ramp to downtown Oakland and to Alameda. 6th Street would become a one-way through street from Oak Street to Harrison Street and a two-way street from Harrison Street to Broadway.

The proposed Project would include the addition of a Class IV two-way cycle track on 6th Street between Oak and Washington streets and on Oak Street between 3rd and 9th streets. Bicycle and pedestrian improvements would be constructed at the Tubes' approaches in Oakland and Alameda, and the Webster Tube westside walkway would be opened to pedestrians. This would improve connectivity to existing and future planned bicycle paths in the City of Oakland and implement various "complete streets" improvements to create additional opportunities for non-motorized vehicles and pedestrians to cross under I-880 between downtown Oakland, the Jack London District, and Alameda. See Figure 1, Figure 2, Figure 3, and Figure 5 for proposed elements of the Build Alternative.

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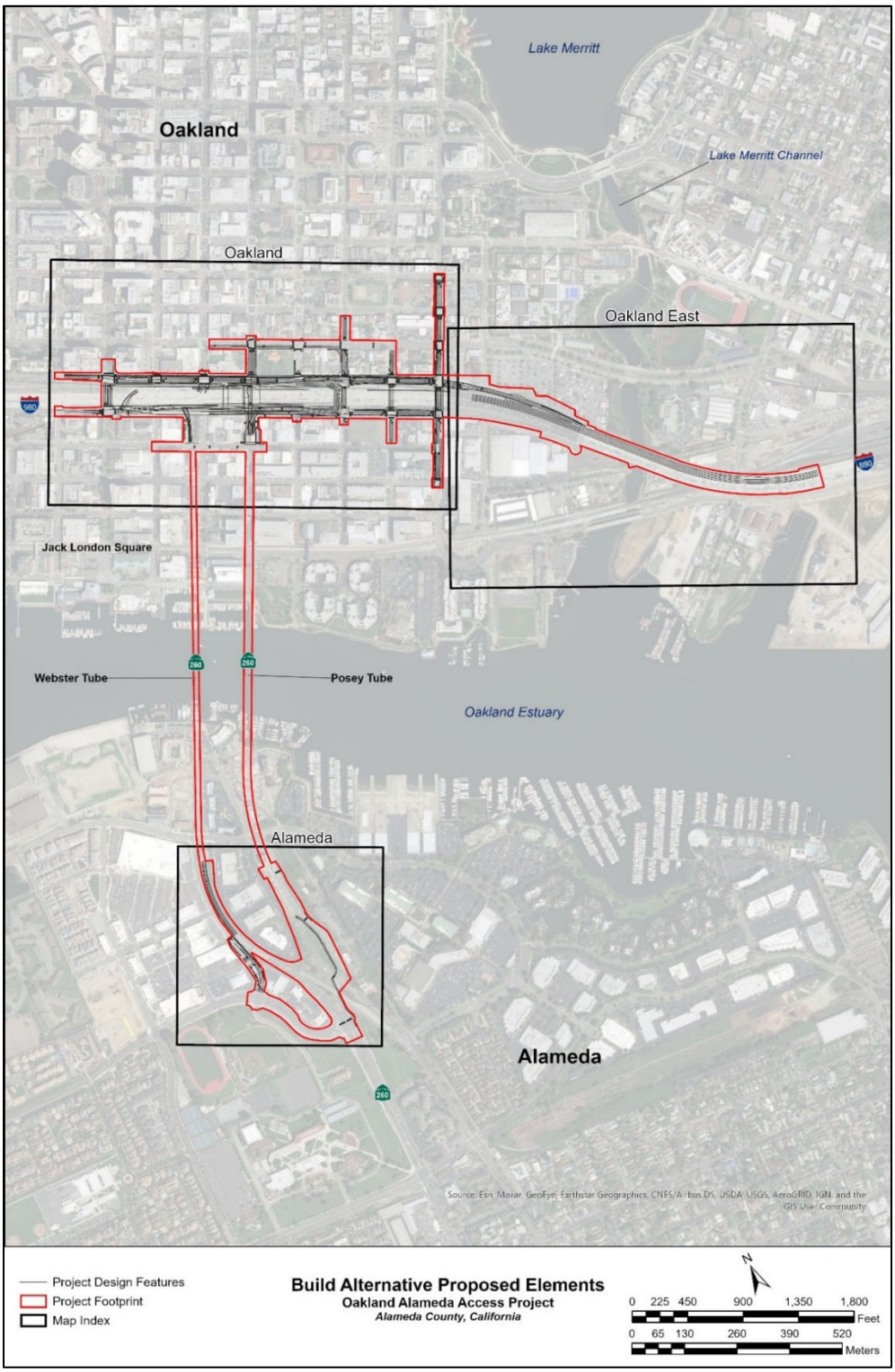


**Figure 1. Build Alternative Proposed Elements, Project Overview**

Source: HNTB

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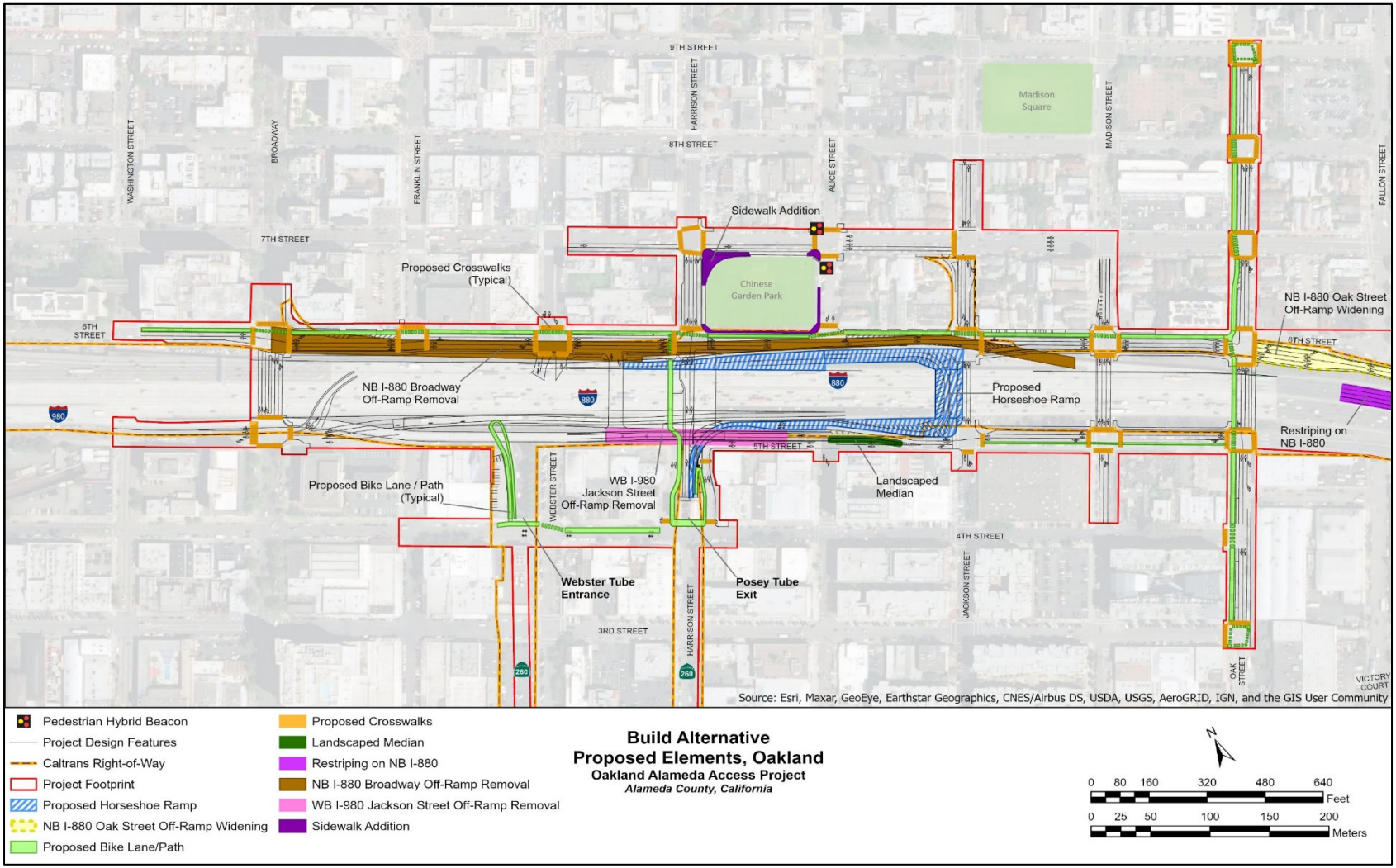


**Figure 2. Build Alternative Proposed Elements, Oakland**

Source: HNTB

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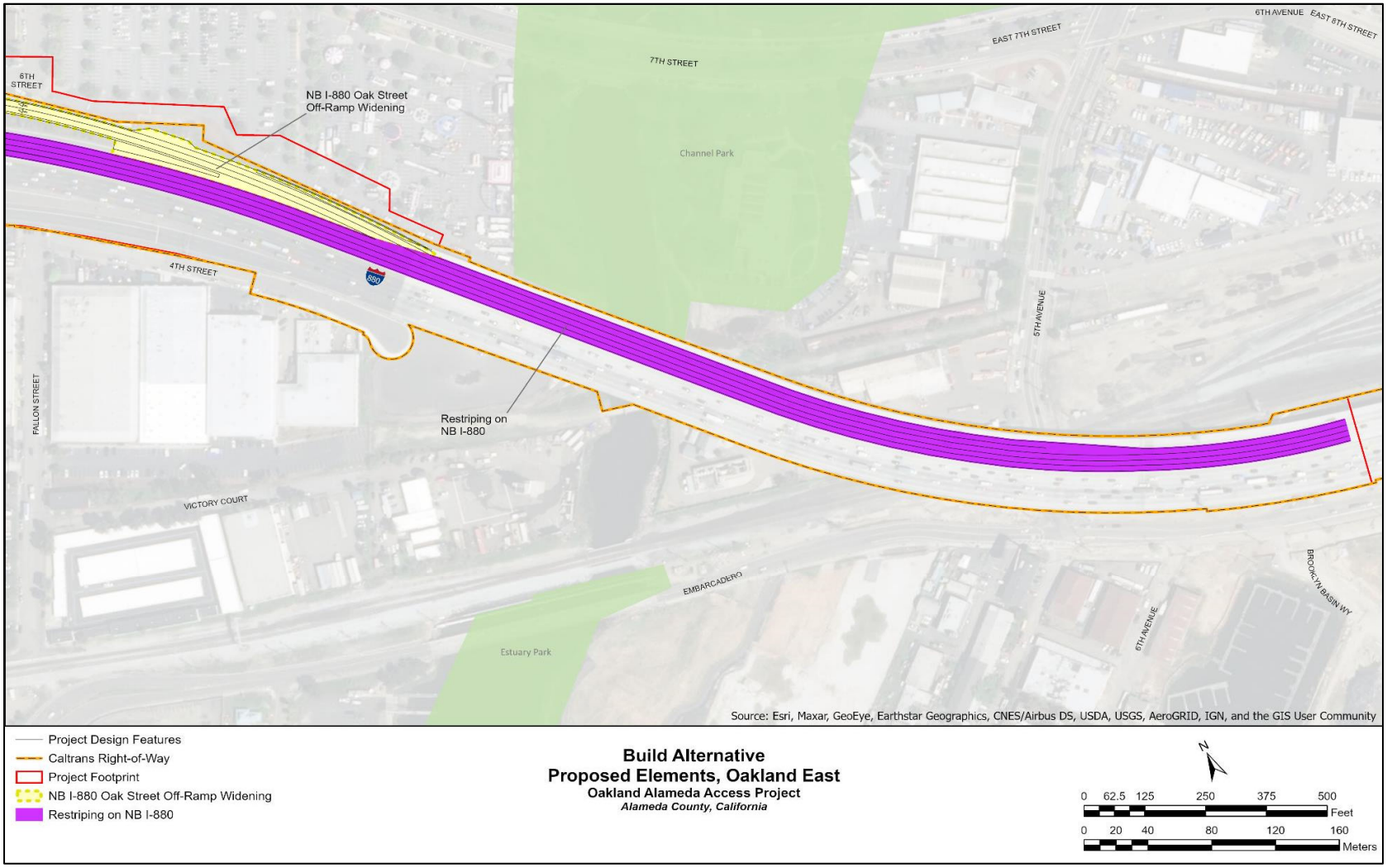


**Figure 3. Build Alternative Proposed Elements, Oakland East**

Source: HNTB

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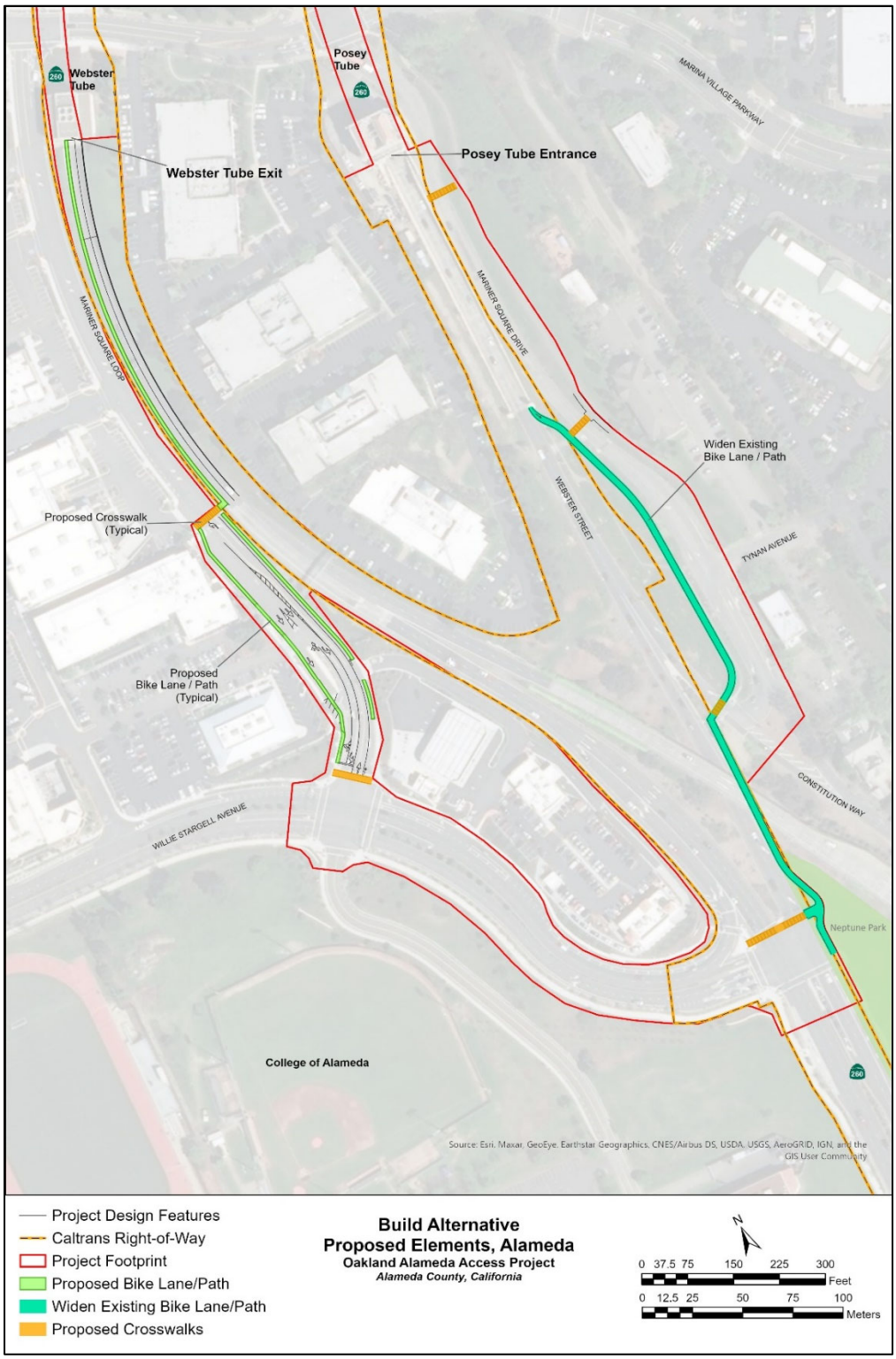


**Figure 4. Build Alternative Proposed Elements, Alameda**

Source: HNTB

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# 3. REGULATORY SETTING

In the state of California, then-Governor Arnold Schwarzenegger signed Executive Order S-13-08 on November 14, 2008. This executive order directed all state agencies planning to construct projects in areas vulnerable to future sea-level rise to consider a range of sea-level projections for the years 2050 and 2100, assess project vulnerability, and to the extent feasible, reduce expected risks and increase resiliency to sea-level rise. As stated in a recent report by the California Coastal Commission, *Sea Level Rise Policy Guidance* (2018), as a result of the Executive Order S-13-08 and agency needs for guidance, many state agencies, including the California Department of Transportation (Caltrans), have since developed climate change and sea-level rise policies and guidance documents.

Caltrans adheres to Order S-13-08 with guidance summarized in *Guidance on Incorporating Sea Level Rise – For use in the planning and development of Project Initiation Documents*, published by Caltrans on May 16, 2011 (Caltrans Guidance). This guidance includes statewide SLR projections published by the Ocean Protection Council in March 2011. The latest SLR study, *State of California Sea-Level Rise Guidance, 2018 Update* published by the California Natural Resources Agency and California Ocean Protection Council provides scenario-based SLR projections at local active tidal gauge locations including San Francisco. In addition, according to the 2019 *Climate Change Annotated Outline Non-Capacity Increasing Projects* (AO) found in the Forms and Templates section of the Caltrans Standard Environmental Reference (SER), a project is recommended to consider a list of factors to determine the need for SLR adaptation measures.

# 4. TIDAL, FLOODPLAIN, AND TOPOGRAPHIC DATA

## *Tidal Data*

Tidal data was obtained from the National Oceanic Atmospheric Administration (NOAA). The published tidal datum data at the tidal gauge station closest to the Project site, Alameda Station (Station 9414750), was used to relate the tidal datums to geodetic datums (see Table 1 for the gauge data and Figure 5 in the Attachments for the gauge location map). The elevation of the tidal datums for this station referenced the Mean Lower Low Water (MLLW) datum. The station had a published Highest Observed Tide (HOT) as well as a Lowest Observed Tide (LOT). The National Average Vertical Datum of 1988 (NAVD 88) is 0.23 ft MLLW, which means an elevation of 0.0 ft NAVD 88 is equal to an elevation of 0.23 ft MLLW. Based on this conversion factor at Alameda Station, the relevant tidal datum was converted to NAVD 88 and summarized in Table 2. Accordingly, the Mean Higher High Water (MHHW) at this gauge is approximately 6.4 ft NAVD 88.

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## Table 1. Tidal Datum for Alameda Station 9414750

**Elevations on Mean Lower Low Water**

**Station:** 9414750, Alameda, CA
**Status:** Accepted (Oct 6 2011)
**Units:** Feet
**Control Station:**
**T.M.:** 0
**Epoch:** 1983-2001
**Datum:** MLLW

| Datum | Value | Description |
|---|---|---|
| MHHW | 6.60 | Mean Higher-High Water |
| MHW | 5.98 | Mean High Water |
| MTL | 3.56 | Mean Tide Level |
| MSL | 3.45 | Mean Sea Level |
| DTL | 3.30 | Mean Diurnal Tide Level |
| MLW | 1.14 | Mean Low Water |
| MLLW | 0.00 | Mean Lower-Low Water |
| NAVD88 | 0.23 | North American Vertical Datum of 1988 |
| STND | -3.33 | Station Datum |
| GT | 6.59 | Great Diurnal Range |
| MN | 4.84 | Mean Range of Tide |
| DHQ | 0.62 | Mean Diurnal High Water Inequality |
| DLQ | 1.13 | Mean Diurnal Low Water Inequality |
| HWI | 8.01 | Greenwich High Water Interval (in hours) |
| LWI | 1.50 | Greenwich Low Water Interval (in hours) |
| Max Tide | 9.65 | Highest Observed Tide |
| Max Tide Date & Time | 12/03/1983 18:18 | Highest Observed Tide Date & Time |
| Min Tide | -2.57 | Lowest Observed Tide |
| Min Tide Date & Time | 01/11/2009 01:42 | Lowest Observed Tide Date & Time |
| HAT | 7.98 | Highest Astronomical Tide |
| HAT Date & Time | 12/31/1986 19:18 | HAT Date and Time |
| LAT | -1.94 | Lowest Astronomical Tide |
| LAT Date & Time | 05/25/1990 14:24 | LAT Date and Time |

Source: NOAA Tides and Currents, 2019

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**Table 2. Alameda Tidal Datum Conversion from MLLW to NAVD 88**

| Datum | MLLW ft | NAVD 88 ft |
|---|---|---|
| **HOT (DHT)** | 9.65 | 9.42 |
| **MHHW** | 6.60 | 6.37 |
| **MHW** | 5.98 | 5.75 |
| **MTL** | 3.56 | 3.33 |
| **MSL** | 3.45 | 3.22 |
| **MLW** | 1.14 | 0.91 |
| **NAVD88** | 0.23 | 0.00 |
| **MLLW** | 0.00 | -0.23 |
| **LOT** | -2.57 | -2.80 |

Source: NOAA Tides and Currents, 2019

### *Topographic Data*

Due to the nature of the proposed work, the existing elevations would not change significantly as a result of the Project. Therefore, identification of tidally influenced areas is based on the existing topography within the limits of the Project.

The Oakland study area is located in the southern slope of the knoll that holds downtown Oakland. In addition to the sloped knoll, the Project site is also located on flatter terrain near the Oakland Estuary and San Francisco Bay. The Alameda study area is located on the northerly side of the ridgeline, where terrain gently slopes toward the Oakland Estuary. Figure 6 (see Attachments) shows all the elevations below the 6.4 ft NAVD 88 MHHW elevation. The map was developed using a 1/9th arc-second Digital Elevation Model (DEM) obtained from the United States Geological Survey (USGS). The topographic map shows that within the City of Oakland, all the proposed surface improvements would be above 6.4 ft NAVD 88, and therefore, these portions of the Project would not be tidally influenced.

Approximately 25% of the Project areas located within the City of Alameda are below 6.4 ft NAVD 88 and are therefore, tidally influenced. Figure 7, the topographic map (included in the Attachments), shows areas within the Project limits that are below 6.4 ft NAVD 88.

## 5. SEA LEVEL RISE PROJECTIONS

### *State of California Guidance*

The *State of California Sea-Level Rise Guidance, 2018 Update* (2018 SLR Guidance), was used to obtain scenario-based SLR projections applicable to the Project site. The SLR projections for San Francisco included in the 2018 SLR Guidance are provided in Table 3. The 2018 SLR Guidance uses 2000 as the baseline for the probabilistic projections and have low and high emission scenarios leading up to 2150.

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**Table 3. SLR Projections for San Francisco**

| | | Probabilistic Projections (in feet) (based on Kopp et al. 2014) | | | | |
|---|---|---|---|---|---|---|
| | | MEDIAN | LIKELY RANGE | | 1-IN-20 CHANCE | 1-IN-200 CHANCE |
| | | *50% probability sea-level rise meets or exceeds...* | *66% probability sea-level rise is between...* | | *5% probability sea-level rise meets or exceeds...* | *0.5% probability sea-level rise meets or exceeds...* |
| | | | | Low Risk Aversion | | Medium - High Risk Aversion |
| High emissions | 2030 | 0.4 | 0.3 - | 0.5 | 0.6 | 0.8 |
| | 2040 | 0.6 | 0.5 - | 0.8 | 1.0 | 1.3 |
| | 2050 | 0.9 | 0.6 - | 1.1 | 1.4 | 1.9 |
| Low emissions | 2060 | 1.0 | 0.6 - | 1.3 | 1.6 | 2.4 |
| High emissions | 2060 | 1.1 | 0.8 - | 1.5 | 1.8 | 2.6 |
| Low emissions | 2070 | 1.1 | 0.8 - | 1.5 | 1.9 | 3.1 |
| High emissions | 2070 | 1.4 | 1.0 - | 1.9 | 2.4 | 3.5 |
| Low emissions | 2080 | 1.3 | 0.9 - | 1.8 | 2.3 | 3.9 |
| High emissions | 2080 | 1.7 | 1.2 - | 2.4 | 3.0 | 4.5 |
| Low emissions | 2090 | 1.4 | 1.0 - | 2.1 | 2.8 | 4.7 |
| High emissions | 2090 | 2.1 | 1.4 - | 2.9 | 3.6 | 5.6 |
| Low emissions | 2100 | 1.6 | 1.0 - | 2.4 | 3.2 | 5.7 |
| High emissions | 2100 | 2.5 | 1.6 - | 3.4 | 4.4 | 6.9 |

Source: Coastal and Ocean Working Group of the California Action Team (CO-CAT), 2018

Since the Project includes various types project improvements, the design life was determined in close coordination with Caltrans. The Project Design Team (PDT) reviewed the Project's design elements and decided upon a Project design life of 50 years. Therefore, based on an anticipated Project completion in 2027, the Project's SLR projections for 2077 were interpolated from the San Francisco SLR trends presented in the 2018 SLR Guidance for the low and medium-to-high risk scenarios. Based on the high emission SLR projections from 2030 and 2150, a low risk SLR projection of 2.2 ft and medium-to-high projection of 4.3 ft were interpolated using a second order polynomial best-fit curve (see Attachments for the calculations). The projections are summarized in Table 4.

## *United States Army Corps of Engineers Sea Level Change Curve Calculator*

In addition to the 2018 SLR Guidance, the United States Army Corps of Engineers' (USACE) Sea-Level Change Curve Calculator (SLCC Calculator), Version 2019.21, was used to calculate SLR projections at the Project location. The USACE scenarios (USACE, 2013), the 2012 NOAA scenarios (NOAA et al., 2012), the Coastal Assessment Regional Scenario Working Group's scenarios (CARSWG, 2016), and the NOAA 2017 scenarios (NOAA et al., 2017) were used to obtain MSL at the Project site.

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The MSL values obtained from the SLCC Calculator were used to determine the changes from 2027 to 2077 for the low and medium-to-high risk values. Because some of the scenario sources had more than three risk levels, the range of the values were taken where applicable. The SLR changes calculated using the NOAA 2017 scenarios were the most conservative and therefore, selected as the basis of comparison with the SLR projections determined from the 2018 SLR Guidance (see Table 4). Because the NOAA 2017 scenarios provide MSL values at the end of each decade between 2000 and 2100, the MSL values were interpolated using a second order polynomial best-fit curve to determine the MSL change that could occur during the Project's design life timeframe (see Attachments for the calculations).

**Table 4. SLR Projections at Project Site**

| Scenario Source | 2018 SLR Guidance Projections at Year 2077 (ft) | |
|---|---|---|
| | Low Risk | Medium-to-High Risk |
| 2018 SLR Guidance | 2.2 | 4.3 |
| NOAA et al. 2017 | 0.4 | 0.6 – 3.4 |

Source: CO-CAT and USACE

Compared to the SLCC Calculator results, the SLR projections for the San Francisco Bay from the 2018 SLR Guidance were more conservative. Therefore, the 2018 SLR Guidance Medium-to-High Risk scenario SLR of 4.3 ft was used to determine the potential impacts of SLR on the Project. On April 10, 2020, the PDT selected the MHHW as the baseline for the Project's SLR evaluation as used in BCDC's mapping tool, Adapting to Rising Tides: Bay Shoreline Flood Explorer. Table 5 summarizes the MHHW elevation projected to 2077.

**Table 5. Design Tidal Elevations at Project Site with SLR**

| Elevation/Datum | Existing Elevations (ft NAVD 88) | Year 2077 Elevations (ft NAVD 88) |
|---|---|---|
| MHHW | 6.4 | 10.7 |

Source: FEMA, 2018

The potential inundations that could result from the determined SLR projections within the Project vicinity were obtained from the NOAA and BCDC mapping tools. An SLR value of 52 inches (4.3 ft) was used in the Bay Shoreline Flood Explorer to map the potential inundation in the Project vicinity. Because only whole numbers could be selected in the NOAA SLR mapping tool, Sea Level Rise Viewer, a 5 ft SLR was used (see Figure 7 and Figure 8 in the Attachments for the inundation maps). Note that the SLR elevation of 10.7 ft NAVD 88 does not account for temporary factors such as El Nino or storm surges that could also increase water levels. King Tides, which occur every winter, would raise the water levels above the typical daily high tide elevation, as well.

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# 6. SEA-LEVEL RISE IMPACTS AND ADAPTATION MEASURE CONSIDERATIONS

Based on the estimated 2077 SLR projected elevation of 10.7 ft NAVD 88, the Project is prone to potential inundations caused by the overtopping of the waterbodies in the Project vicinity as shown on the inundation maps.

The Project areas at or below 10.7 ft NAVD 88 that are predicted to be inundated by the projected SLR, include the Project Areas adjacent to the 5th Street on-ramp near the Lake Merritt Channel, and a majority (approximately 70% of the Project area) of the proposed improvements in the City of Alameda. These areas are shown on the inundation maps. Based on the Bay Shoreline Flood Explorer mapping, flooding depths could be up to approximately 1 ft in the inundated Project areas in the City of Oakland and greater than 15 ft near the Tube portals in the City of Alameda.

## *Factors Considered to Determine the Need for SLR Adaptation Measures*

As mentioned in Section 3, the proposed Project was evaluated for the need to incorporate SLR adaptation measures according to the AO guidelines and Table 1 of the Guidance on Incorporating Seal Level Rise (Caltrans, 2011). The 10 steps and factors used to aid in the determination of the need to consider adaptation measures are provided below. Definitions and/or explanations of the factors, as stated in the Caltrans Guidance, are provided in italics.

1. Project Design Life

*"Those projects that have a longer design life of 20+ years should include further SLR analysis. These projects have a very high likelihood of being impacted by SLR at some point during their lifespan. The shorter lifespan projects may be less likely to face SLR impacts, and as a result be less inclined to incorporate SLR, depending on their proximity to the coast line."*

As stated in Section 5, the proposed Project's design life was determined to be 50-years per the PDT.

2. Redundancy/Alternative Route(s)

*"Looking at the State Highway System (SHS), as a system, there are, however, some locations that are serviced by multiple routes. Even in cases where the SHS does have parallel routes, it is important to keep in mind that the need for traveler and goods movement necessitated the construction of those parallel routes."*

In the City of Oakland, Project routes would have multiple alternative routes during the predicted SLR inundation effect. In the City of Alameda, the roadway access routes (including the Tubes) and ferry service are all anticipated to be impacted by the projected SLR. Therefore, there would likely be no alternative routes available within Alameda.

3. Anticipated Travel Delays

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*"What impacts will result if SLR impacts a roadway? For instance, if during high tides or a storm event a roadway is splashed by spray, the travel delays would be minimal. However, if a roadway is inundated by waves, the delays will be substantial and should warrant further consideration of incorporating SLR."*

In the City of Oakland, Project roadway closures due to the projected SLR impacts would not be substantial because of the multiple available alternative routes and minimal inundations by the projected SLR. In the City of Alameda, there are four other routes connecting Oakland and Alameda, none which are located close to the Tubes. These routes are also anticipated to be impacted by SLR inundation. Therefore, substantial travel delays would occur due to Project roadway closure resulting from the estimated SLR impacts.

4. Goods Movement/Interstate Commerce

*"If the route is a high priority commercial goods movement route in the State, the cost of delays due to impacts from SLR will be high, and the project should incorporate SLR consideration."*

The Project routes in both the cities of Oakland and Alameda were determined to be non-critical routes for interstate or commercial goods movement.

5. Evacuations/Emergencies

*"If the route is vital for emergency evacuations, and SLR impacts would greatly increase emergency response time, the project should incorporate SLR analysis."*

In the City of Oakland, there are multiple alternative routes and minimal SLR inundation. Therefore, potentially flooded roadways within the proposed Project footprint would likely not impact emergency evacuation routes. In the City of Alameda, roadways within the footprint are considered to be emergency evacuation routes and the estimated SLR impacts are anticipated to increase emergency response time substantially.

6. Traveler Safety

*"If incorporating SLR considerations will substantially delay a safety project getting to construction, then the risk to traveler safety must take precedent. However, it is also important to weight the possibility that if the highway is not designed to incorporate SLR that the result could be flooding of the facility in the future and that inundation of the facility may prevent the route from being used in the event of an emergency or evacuation."*

Incorporation of SLR measures would delay Project construction, funding, and acquisition of necessary clearances. Within the existing Project area, traffic accident rates on SR 260 are above the statewide average. Reducing the speed in the Tubes should improve driver awareness. Additionally, there is a high incidence of accidents between motorists and pedestrians on local streets in Oakland. The proposed improvements will reduce motorist and pedestrian conflicts within the Project footprint.

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7. Expenditure of Public Funds

*"Future allocations of resources should consider SLR impacts on the SHS and Caltrans' facilities. Considerations include potential or increased facility maintenance costs and/or more frequent repair/rehabilitation needs due to SLR impacts."*

Considerations to include SLR measures will have high increased maintenance costs for both the cities of Oakland and Alameda.

8. Scope of Project – "point" vs. "linear"

*"If the scope of a project is a single "point" or single project task, it may be less necessary to incorporate SLR (given all other factors)."*

This is a linear project located within the cities of Oakland and Alameda. Additionally, its scope is considered to be substantial (important) by Caltrans and the local communities. The proposed Project will address existing and projected traffic congestion, geometric deficiencies, and multi-modal connectivity within and between the cities of Oakland and Alameda.

9. Effect of Incorporating SLR on Non-State Highway

*"Consideration should be given to whether the infrastructure around Caltrans' facility (adjacent local streets and roads) is being adapted for SLR. For example, if Caltrans were to raise the grade of its roadway to what extent, if any, are the surrounding local entities raising their roadways? Will the two systems interconnect efficiently and effectively?"*

The City of Oakland has no adopted plans for SLR infrastructure improvements. The City of Alameda recently implemented their SLR resiliency plan in 2019 (Climate Action and Resiliency Plan [CARP]). Incorporation of SLR adaptation measures within the project area could substantially increase interconnectivity issues between Caltrans infrastructure and local roadways. For example, raising the grade of state roadways would require corresponding work on local roadways to ensure connectivity.

10. Environmental Constraints

*"Adapting the project to SLR may mean an increase in the environmental impacts of the project due to design aspects of adaption, such as more reinforced bridge structures, larger culverts, or alternative pavements. There is also the potential that adapting the project to SLR may mean modifying the hydrology in the area in ways that could be beneficial to some species while doing greater harm to others."*

Incorporating SLR adaptation measures into the proposed Project would likely have substantial additional environmental impacts. Measures would generally expand the project footprint, increasing the likelihood of additional environmental and engineering impacts. For example, a measure proposed along the shoreline would likely impact biological communities/resources. Work on the National Register Historic Posey Tube would result in adverse cultural resource impacts. The level and type of impacts would depend upon the scope of the proposed SLR

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measure(s). Additional impacts to visual resources, cultural resources, hydrology (including floodplain), and biological resources would also be expected with the measures analyzed.

Only three of the 10 considered factors pertaining to the proposed Project area in the City of Oakland indicated the need to incorporate SLR adaptation measures: project design life, expenditure of public funds, and scope of project. The Project area in the City of Oakland has multiple alternative routes and would have minimal flooding per the estimated SLR projections. Therefore, the PDT determined that it was not beneficial for the proposed Project to consider SLR adaptation measures within the City of Oakland.

Six of the 10 considered factors (Table 6) indicated the proposed Project areas within the City of Alameda should consider incorporating SLR adaptation measures. Therefore, SLR adaptation measures were evaluated for the proposed Project area within the City of Alameda.

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**Table 6: Factors to Consider Regarding the Incorporation of SLR into Programming and Design (Source: Caltrans, 2011)**

| | Factor | Towards Incorporating SLR into Project Design | | ⟶ | | Towards Not Incorporating SLR into Project Design | |
|---|---|---|---|---|---|---|---|
| 1 | **Project design life** | Long (20+ years) | ✓ | | | Short (less than 20 years) | |
| 2 | **Redundancy/ alternative route(s)** | No redundant/ alternative route | ✓ | | | Redundant/ alternative route | |
| 3 | **Anticipated travel delays** | Substantial delays | ✓ | | | Minor or no delay | |
| 4 | **Goods movement/ interstate commerce** | Critical route for commercial goods movement | | | | Non-critical route for commercial goods movement | ✓ |
| 5 | **Evacuations/ emergencies** | Vital for emergency evacuations; loss of route would result in major increases to emergency response time | ✓ | | | Minor or no delay in the event of an emergency or evacuation | |
| 6 | **Traveler safety (delaying the project to incorporate SLR would lead to ongoing or new safety concerns)** | Safety project in which little or no delay would result; non-safety project | | | | Safety project and delay would be substantial | ✓ |
| 7 | **Expenditure of public funds** | Large investment | ✓ | | | Small investment | |
| 8 | **Scope of project — "point" vs. "linear"** | Project scope is substantial — important to the community | ✓ | | | Project scope is not substantial — e.g., ? | |
| 9 | **Effect of incorporating SLR on non-state highways (interconnectivity issues with local streets and roads)** | Minor or no effect — adjacent local streets and roads would not have to be modified | | Medium to minor interconnectivity issues | | Substantial interconnectivity issues | ✓ |
| 10 | **Environmental constraints** | Minor or no increase in project footprint in an Environmentally Sensitive Area (ESA) | | Less than significant increase in project footprint in ESAs | | Substantial increase in project footprint in ESAs | ✓ |

* Note that this table only reflects the portion of the Project located within the City of Alameda, which was identified as being more susceptible to SLR inundation.

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## *Considered SLR Adaptation Measures*

Adaptation measures were researched using other coastal areas in the country, similar local projects, as well as other on-going SLR adaptation efforts currently proposed by the City of Alameda. Measures researched included inflatable dams, seawalls, and deployable floodwalls. See Attachments for sample photos. SLR adaptation measure recommendations within the City of Alameda were grouped into two categories, which were then reviewed for feasibility and cost-benefit.

SLR Adaptation Measure Categories

I. Category I – SLR Adaptation Measures along the Oakland Estuary Shoreline:
- Seawalls/Floodwalls/Deployable Floodwalls
- Tide Gates/Storm Surge Barriers
- Levees

II. Category II – SLR Adaptation Measures within the Proposed Project Area:
- Portal plugs at the Tube portals
- Raising existing retaining walls/watertight roadway approaches
- Resilient Electrical Infrastructure
- Other considered measures:
  - Raising roadway and/or bicycle/pedestrian path elevations
  - Inflatable dams
  - Evacuation plans for the Tubes

Feasibility and Cost-Benefit Analysis

The feasibility analysis of incorporating SLR adaptation measures included the evaluation of the potential benefits of the proposed improvements, the potential impacts to the current Project scope, and the costs of the SLR adaptation measures.

1. Category I – SLR Adaptation Measures along the Oakland Estuary Shoreline

Category I SLR adaptation measures would need to be implemented along and/or near the shoreline of the Oakland Estuary bordering the City of Alameda. Implementing these shoreline SLR adaptation measures would be beneficial to the proposed Project because they would be implemented at the source of flooding and therefore, reduce additional impacts due to inland flooding. However, incorporating these SLR adaptation measures would extend the Project's footprint into areas adjacent to the Oakland Estuary. This biological habitat, and its various beneficial uses are detailed in the Project's Natural Environment Study and Water Quality Assessment Reports. This work would also extend into the 100-year floodplain. Therefore, work near and along the shoreline would potentially increase the proposed Project's impacts to biological resources and the floodplain. Various approvals/permits may be required for this work including (but not limited to) the following: BCDC permit, United States Army Corps of

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Engineers (USACE) Section 404 permit, Regional Water Quality Control Board (RWQCB) Section 401 permit, and United States Fish and Wildlife Service (USFWS) biological opinion.

The City of Alameda proposes SLR adaptation measures under CARP. Per this plan, the city has outlined both short-term (<5 years) and long-term (5-10 years) measures to address SLR inundation at the Tubes. Short-term measures include flood-proofing of facilities, regrading of SR 260, floodwall construction, and installing salt-resistant pumps. By the Project's anticipated completion in 2027, the City of Alameda's may have implemented some of these short-term SLR adaptation measures.

Per coordination with the City of Alameda, SLR adaptation measures that are currently being implemented for developers along the City of Alameda waterfront include:

- Design buildings and site construction to withstand 36 inches of SLR on day one (occupancy).
- Include a design, but not construct plans that show how a barricade or seawall could be added at a later date (in 15 or 20 years) if it is later determined that 36 inches is not sufficient.
- Include a funding mechanism that can be used by the Project in 15 or 20 years to construct the additional barricade, if needed.

CARP includes cost estimates to provide protection against the 2030, 2050, and 2100 SLR scenarios over the 100-year flood at the Tubes and the shoreline near the Tubes. These estimates range from $1.7 million to $2.2 million (see the Cost Estimate table from CARP in the Attachments). This would be a substantial cost increase (2.5%) for the proposed Project, which has a construction budget of $88,200,000. Because of this, and the increased environmental impacts previously discussed, these SLR adaptation measures appear to be infeasible for the Project.

2. Category II – SLR Adaptation Measures within the Project Limits

Three Category II SLR adaptation measures were evaluated after coordination with the PDT: portal plugs, elevating retaining walls/roadway approaches, and installation of resilient electrical infrastructure. The feasibility for all three of these measures was evaluated.

A. Portal plugs at the Tube portals

Tunnel portal plugs at the Tubes in the City of Alameda would protect the Tubes, which are critical emergency and evacuation routes, from being inundated due to the projected SLR. Preliminary plans illustrating these plugs are provided in the attachments. However, plugs would not be able to protect the remaining inundated areas including the tunnel approaches. Additionally, the Posey Tube is listed on the National Register of Historic Places and modifying this structure would result in an adverse impact to the resource. Implementing this measure would require additional environmental mitigation and significant additional cost and schedule delays.

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The preliminary cost estimate for this option (Table 7) was substantial compared to the proposed Project's overall cost, representing an over a 5% increase in the Project's construction budget. Although this option protects the Tubes from the projected SLR impacts, both the environmental considerations and cost make this option infeasible for the Project.

**Table 7**. Estimated Costs for Portal Plugs at Tubes

| Sub-Items | Unit | Quantity | Unit Price | Cost |
|---|---|---|---|---|
| Structural steel | LB | 80,000 | $ 2.00 | $ 160,000.00 |
| Hoist, Roller Bearing, and Seal Assembly | LS | 2 | $ 1,000,000.00 | $ 2,000,000.00 |
| Architectural Treatment | LS | 1 | $ 1,000,000.00 | $ 1,000,000.00 |
| 50% Contingency | LS | 1 | $ 1,580,000.00 | $ 1,580,000.00 |
| | | | **TOTAL =** | **$ 4,740,000.00** |

Source: HNTB, 2020

B. Raising existing retaining walls/watertight roadway approaches

Raising the existing retaining walls along the approach roadways of the Tubes (or providing watertight roadway approaches) in the City of Alameda would protect these critical emergency and evacuation routes from the projected SLR inundation. This option would raise the existing retaining walls along the Posey Tube approaches from an approximate elevation of 9.0 to 12.7 ft NAVD 88. Similarly, the existing retaining walls along the Webster Tube approaches would be raised from the existing elevation of 8.5 ft NAVD 88 to 12.7 ft NAVD 88. The preliminary plans illustrating this work are attached under Option 2.

The proposed Project does not currently propose improvements to these existing retaining walls. Therefore, adopting this SLR adaptation measure would have impacts to the Project's scope, cost, and schedule. The new retaining walls would need to be designed to withhold large hydraulic pressures, which would introduce additional cost. The preliminary cost estimate for this option (Table 8) was substantial, representing an approximate 21% increase in the Project's construction budget. Although this option protects critical emergency and evacuation routes from the projected SLR impacts, the potential budget impacts associated with incorporating the measure makes this option infeasible for the proposed Project.

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**Table 8. Cost Estimates for Raising Existing Retaining Walls**

| Sub-Items | Unit | Quantity | Unit Price | Cost |
|---|---|---|---|---|
| Posey Retaining Walls | SQFT | 18,000 | $ 285.00 | $ 5,130,000.00 |
| Webster Retaining Walls | SQFT | 22,000 | $ 285.00 | $ 6,270,000.00 |
| Imported Borrow | CY | 1,500 | $ 15.00 | $ 22,500.00 |
| HMA | TON | 2,200 | $ 160.00 | $ 352,000.00 |
| Class 2 AB | CY | 1,600 | $ 60.00 | $ 96,000.00 |
| Class 2 AS | CY | 1,800 | $ 80.00 | $ 144,000.00 |
| Demolition | LS | 1 | $ 2,000,000.00 | $ 2,000,000.00 |
| Electrical | LS | 1 | $ 500,000.00 | $ 500,000.00 |
| 30% Contingency | LS | 1 | $ 4,354,350.00 | $ 4,354,350.00 |
| | | | **TOTAL =** | **$ 18,868,850.00** |

Source: HNTB, 2020

C. Resilient Electrical Infrastructure

Placement, relocation, and protection of electrical equipment that may be vulnerable to inundation such as communications and power equipment above the projected SLR inundation elevation would avoid and/or reduce potential loss or damage of the infrastructure. Because the existing electrical infrastructure in the Tubes is already placed at relatively high elevations, only the electrical equipment outside of the Tubes were considered. Preliminary plans are attached under Option 3.

The preliminary cost estimate for this option is presented in Table 9 and represents an approximate 4% increase in the proposed Project's construction budget. The electrical equipment outside the Tubes was not considered critical (street lighting) and it would not be cost effective to implement these measures because the light poles and lights would need to be replaced multiple times over the design life of the proposed Project. Therefore, a future adjustment or addition as part of other non-related projects could provide SLR adaptability and would be more appropriate than adding this component to this project. Therefore, given the estimated initial costs, and timing of lighting replacements, this measure offers no benefits to the proposed Project and was found to be infeasible.

**Table 9. Cost Estimates for Resilient Electrical Infrastructure**

| Sub-Items | Unit | Quantity | Unit Price | Cost |
|---|---|---|---|---|
| Street Light and Splice Boxes | EA | 82 | $ 5,000.00 | $ 410,000.00 |
| Traffic Signal | LS | 3 | $ 500,000.00 | $ 1,500,000.00 |
| Controller Cabinet | EA | 4 | $ 25,000.00 | $ 100,000.00 |
| Water-resistant cable | LF | 8,100 | $ 20.00 | $ 162,000.00 |
| 50% Contingency | LS | 1 | $ 1,086,000.00 | $ 1,086,000.00 |
| | | | **TOTAL =** | **$ 3,258,000.00** |

Source: HNTB, 2020

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D. Other considered measures

Raising roadways and/or bicycle/pedestrian path elevations would cause substantial interconnectivity issues with local streets and roads in the City of Alameda. Addressing these issues would have a high cost, and greatly expand the project footprint (and associated environmental impacts). As a result, this option was found to be infeasible and was not evaluated further.

Inflatable dams were considered as an alternative SLR adaptation measure to the tunnel portal plugs. These dams would prevent inundated due to the projected SLR. However, this option would incur costs for storage and maintenance. In addition, the degradation of equipment over time would add cost for replacement, which would potentially need to occur before SLR inundation occurred. Based on this, this option was found to be infeasible and was not evaluated further.

Caltrans' maintenance plan for the Tubes does not currently address SLR inundation, however, Caltrans is currently working on an update.

## *Conclusion*

As discussed above, the PDT considered multiple SLR adaptive measures and calculated their associated cost estimates. However, evaluation of the benefits of the SLR adaptation measures against their potential impacts on the proposed Project, and the associated additional estimated costs, showed that incorporating the SLR adaptation measures considered here into the Project would be infeasible. The considered measures would either offer no benefits to the proposed Project because they would need to be replaced multiple times during the design life of the Project, would be too costly, cause greater environmental impacts, and/or delay the proposed Project's schedule.

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## ATTACHMENTS

Figure 5. Alameda Tide Gage 9414750 Location Map
Figure 6. Topographic Map
Sea-Level Rise Projection Calculations
Figure 7. Bay Shoreline Flood Explorer Map
Figure 8. Sea-Level Rise Viewer Map
Sea Level Rise Adaptation Measures Sample Photos from Other Projects
City of Alameda Climate Action and Resiliency Plan Cost Estimates for Sea Level Rise Measures
Sea Level Rise Adaptation Measure Options – Options 1, 2, and 3

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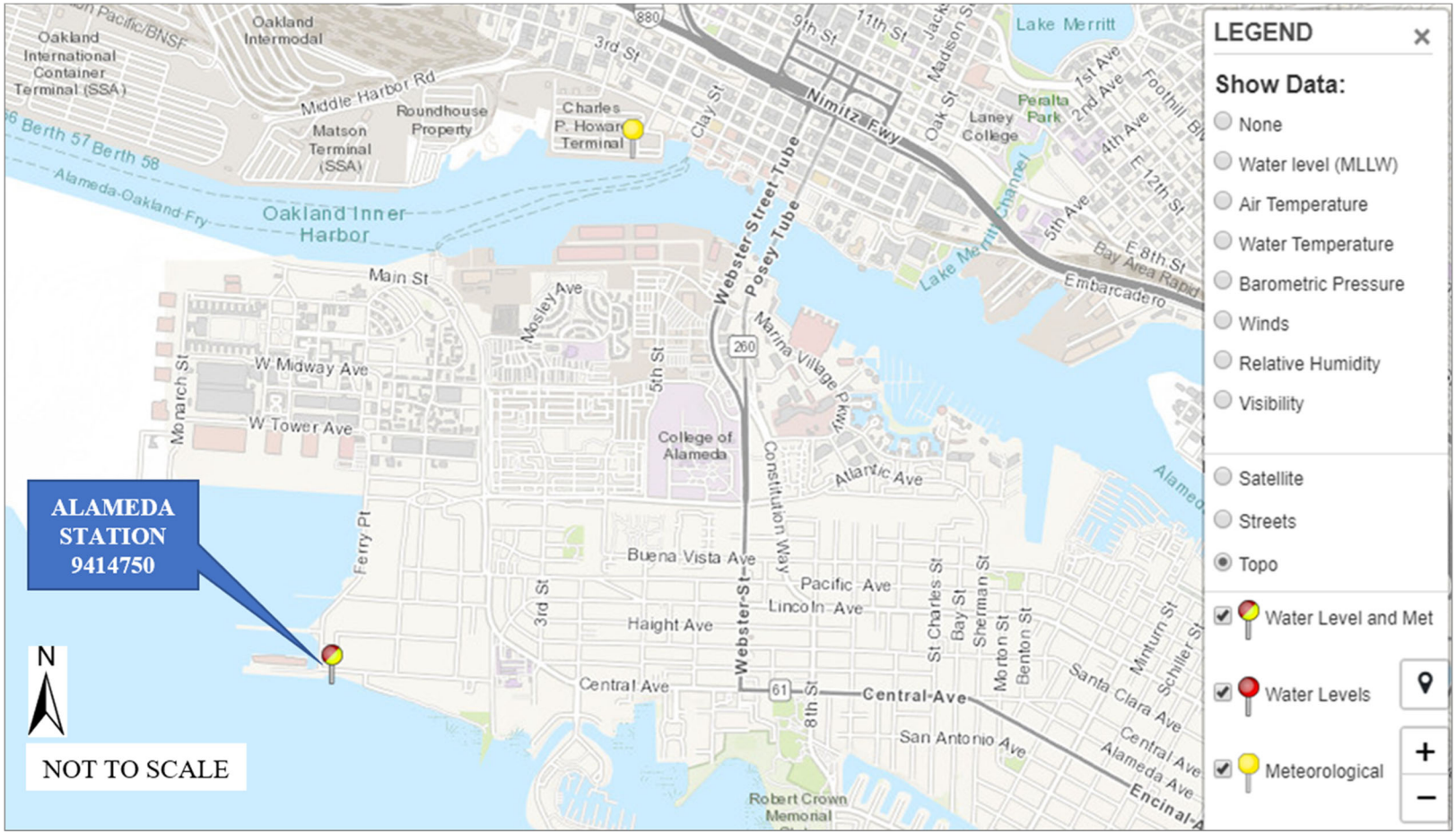


**Figure 5. Alameda Tide Gage 9414750 Location Map**

Source: NOAA, 2019

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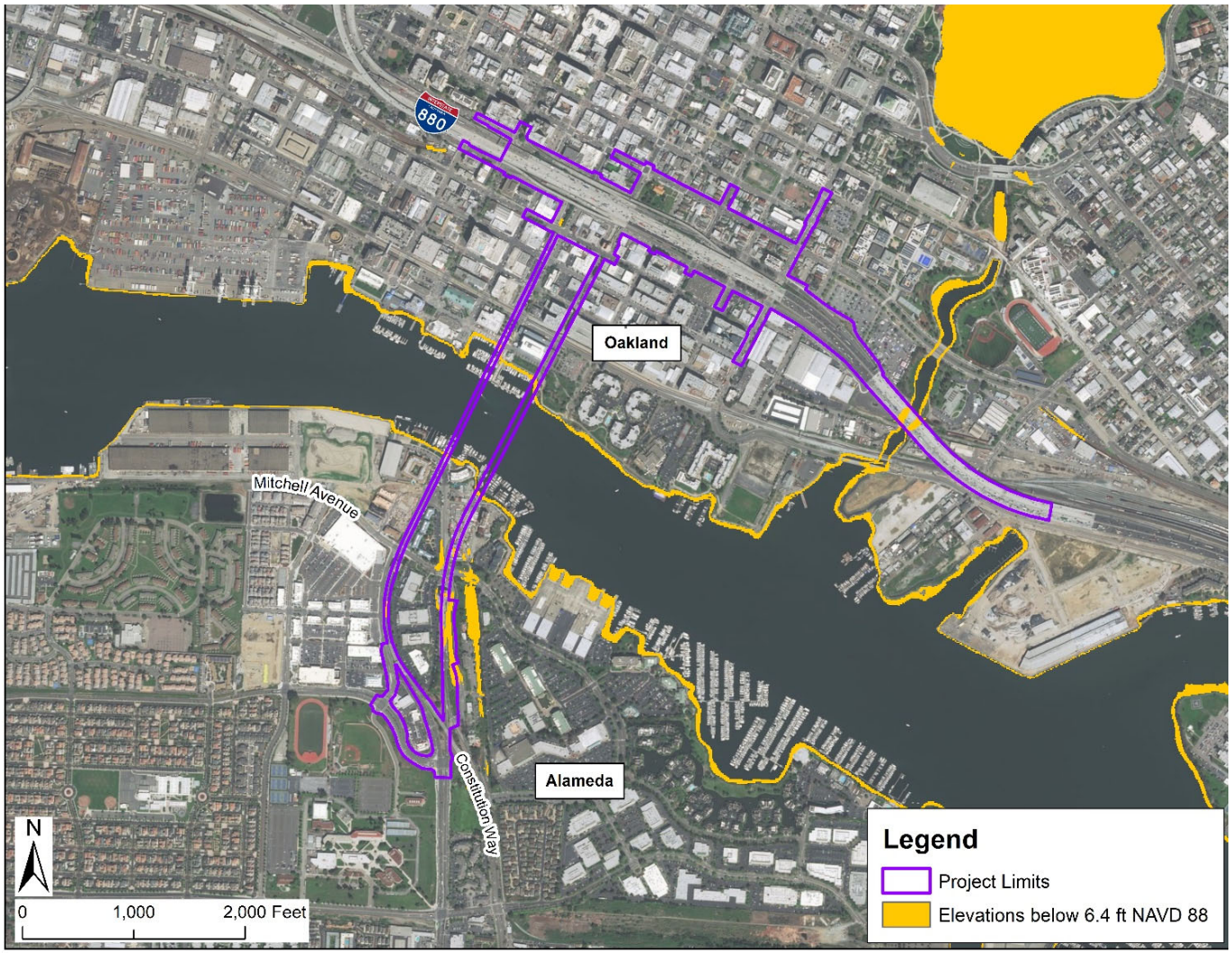


Figure 6. Topographic Map

Source: ESRI, FEMA, HNTB CORPORATION, and USGS

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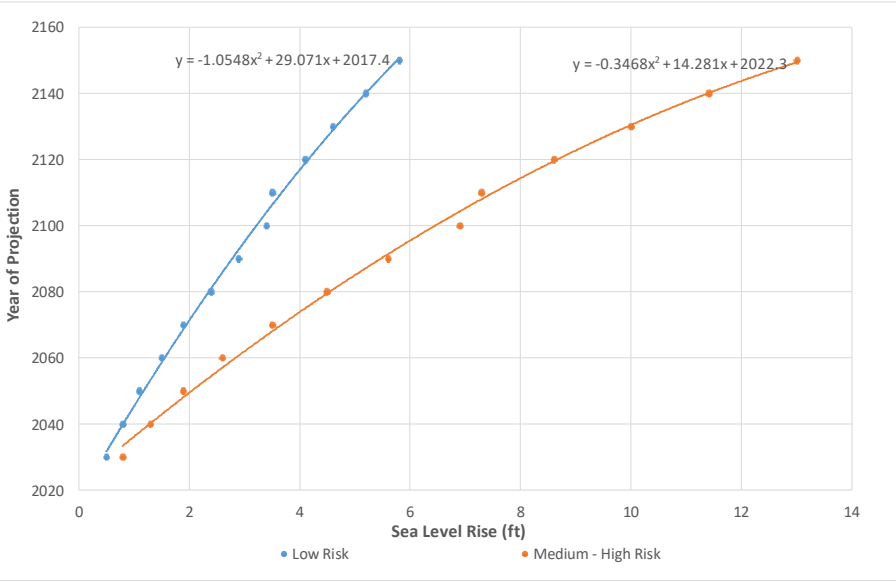
San Francisco High Emissions Sea Level Rise Values (State of California Sea-Level Rise Guidance, 2018 Update)

| Year | Low Risk | Medium - High Risk |
|---|---|---|
| 2030 | 0.5 | 0.8 |
| 2040 | 0.8 | 1.3 |
| 2050 | 1.1 | 1.9 |
| 2060 | 1.5 | 2.6 |
| 2070 | 1.9 | 3.5 |
| 2080 | 2.4 | 4.5 |
| 2090 | 2.9 | 5.6 |
| 2100 | 3.4 | 6.9 |
| 2110 | 3.5 | 7.3 |
| 2120 | 4.1 | 8.6 |
| 2130 | 4.6 | 10.0 |
| 2140 | 5.2 | 11.4 |
| 2150 | 5.8 | 13.0 |




| | Low Risk | Medium - High Risk |
|---|---|---|
| **Year** | 2077 | 2077 |
| **SLR (ft)** | 2.2 | 4.3 |

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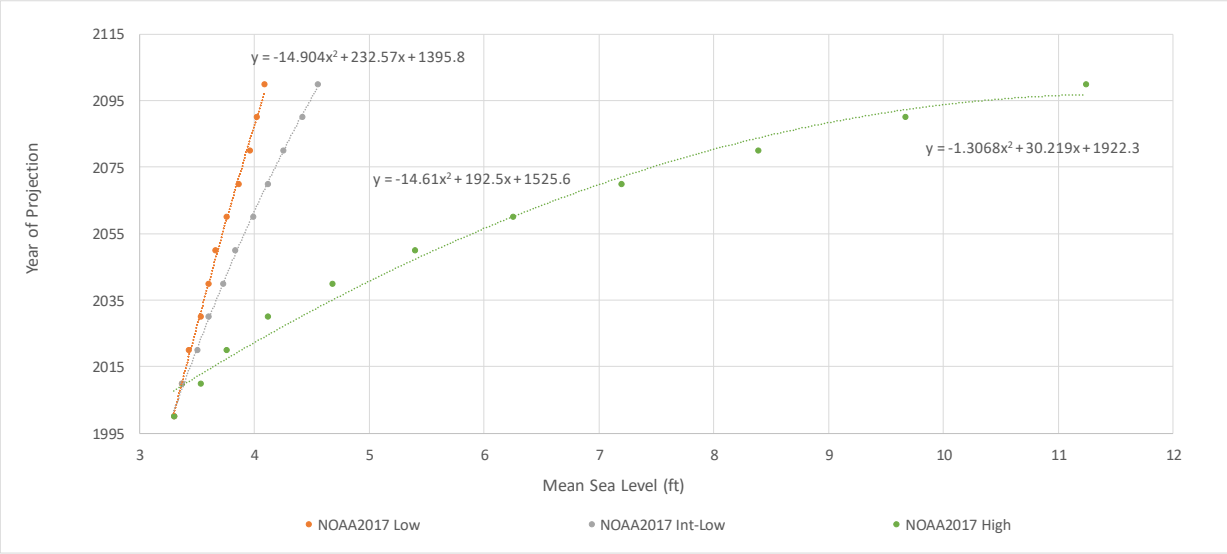
## United States Army Corps of Engineers Sea Leve Change Curve Calculator - NOAA 2017 Mean Sea Level Projections

| Year | NOAA2017 Low | NOAA2017 Int-Low | NOAA2017 Int | NOAA2017 Int-High | NOAA2017 High |
|---|---|---|---|---|---|
| 2000 | 3.30 | 3.30 | 3.30 | 3.30 | 3.30 |
| 2010 | 3.37 | 3.37 | 3.43 | 3.5 | 3.53 |
| 2020 | 3.43 | 3.5 | 3.56 | 3.66 | 3.76 |
| 2030 | 3.53 | 3.6 | 3.76 | 3.92 | 4.12 |
| 2040 | 3.6 | 3.73 | 3.99 | 4.28 | 4.68 |
| 2050 | 3.66 | 3.83 | 4.28 | 4.78 | 5.4 |
| 2060 | 3.76 | 3.99 | 4.61 | 5.33 | 6.25 |
| 2070 | 3.86 | 4.12 | 4.97 | 5.99 | 7.2 |
| 2080 | 3.96 | 4.25 | 5.4 | 6.78 | 8.39 |
| 2090 | 4.02 | 4.42 | 5.86 | 7.63 | 9.67 |
| 2100 | 4.09 | 4.55 | 6.38 | 8.65 | 11.24 |
| 2026 | 3.50 | 3.57 | -- | -- | 4.24 |
| 2077 | 3.91 | 4.21 | -- | -- | 7.65 |
| Change | 0.41 | 0.63 | -- | -- | 3.41 |

*Note: Int = Intermediate



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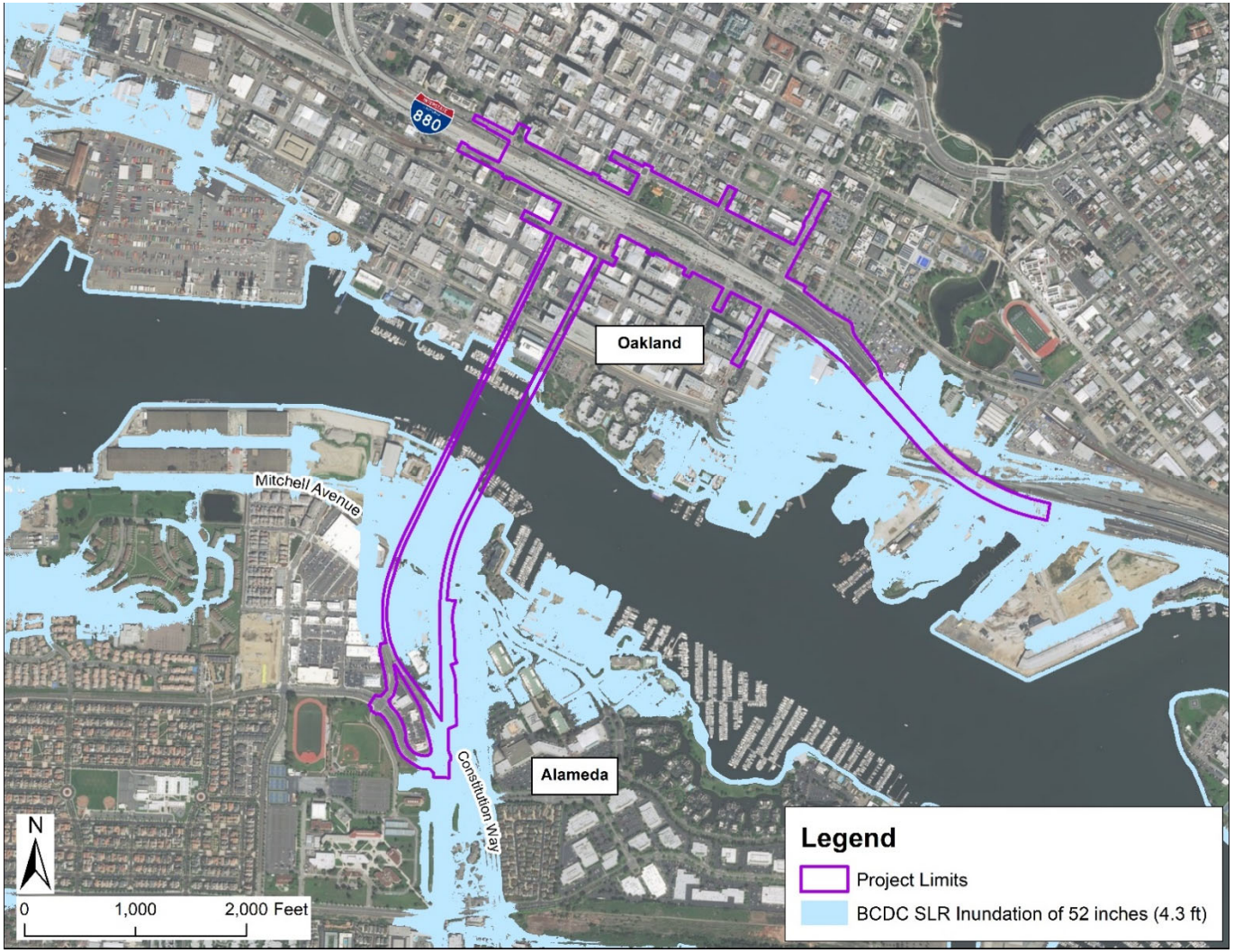


**Figure 7. Bay Shoreline Flood Explorer Map**

Source: BCDC, ESRI, and HNTB CORPORATION

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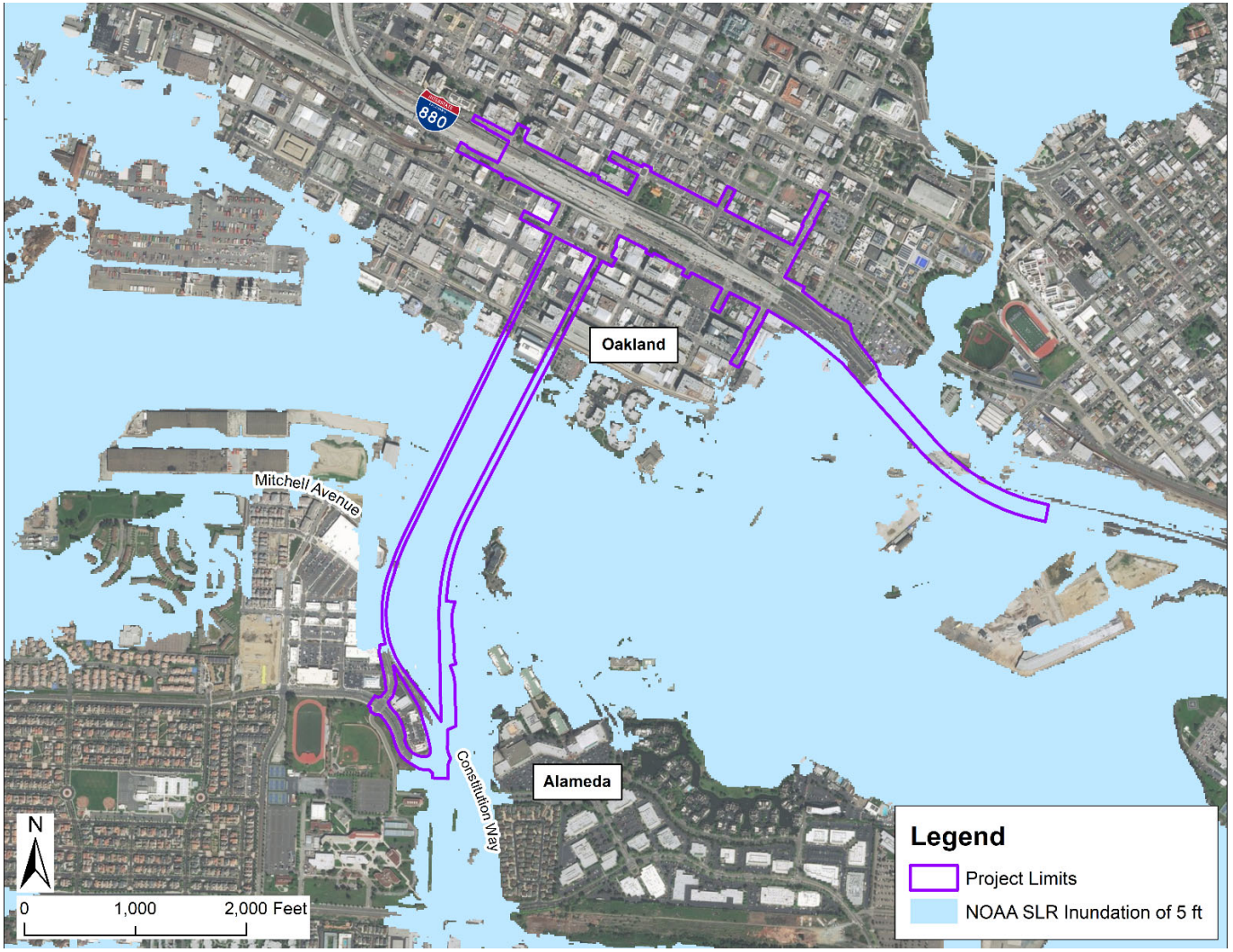


**Figure 8. Sea-Level Rise Viewer Map**

Source: ESRI, HNTB CORPORATION, and NOAA

## Sample Photos of Inflatable Dams

*Source: https://wwtonline.co.uk/features/inflated-dam-during-test-following-installation-at-omval-*

*Source: https://www.enr.com/articles/23773-tempe-had-plan-to-replace-inflatable-tubes-that-failed*

## Sample Photos of Seawalls

Photo 4-3: The Corpus Christi Seawall (Library of Congress/LC-USF34-038306)

Photo 4-4: Rubble mound structure in Bronx, New York (M&N, 2017)

*Source: New York – New Jersey Harbor and Tributaries Coastal Storm Risk Management Feasibility Study*

## Sample Photo of Deployable Floodwalls

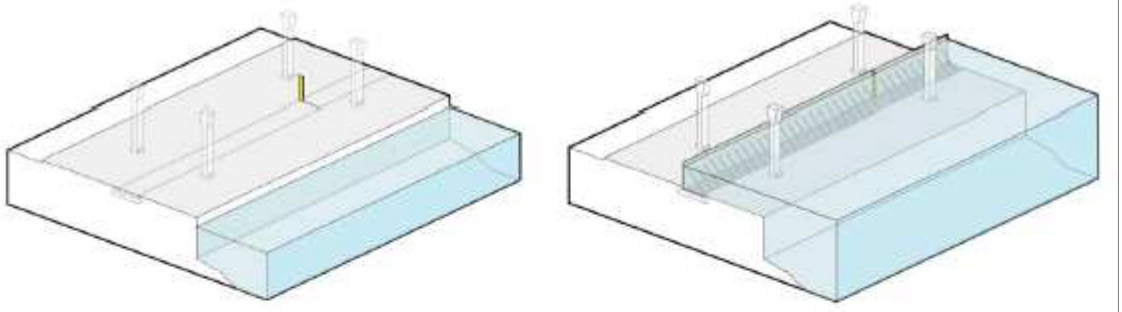

Figure 4-13: Schematic View of a Flip-up Barrier from LMCR

Photo 4-5: Flip-up barrier at Lourdes Hospital deployed automatically during a recent flood event (Floodbreak)

*Source: New York – New Jersey Harbor and Tributaries Coastal Storm Risk Management Feasibility Study*

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*Table 5-5. CARP Adaptation Strategies and Cost Estimates for Addressing Location-Based Priority Flooding*

| Location | Scenarios | | |
|---|---|---|---|
| | **2030 Sea Level Rise Plus 100-Year Storm** | **2050 Sea Level Rise Plus 100-Year Storm** | **2100 Sea Level Rise Plus 100-Year Storm** |
| **Crown Beach Adaptation** | Expand dunes<br>Augment salt marshes<br>Redistribute sand | Expand beach into the Bay<br>Add oyster reefs, cobble berms | Allow beach to retreat inland |
| | $11 million | $7.5 million | Not estimated |
| **Eastshore Drive** | Augment mudflats<br>Expand flood protection barriers | Integrate adaptation between public pathways and private parcels | Develop tidal neighborhoods |
| | $20 million [a] | Not estimated | Not estimated |
| **Shoreline Near Webster and Posey Tubes** | Expand levee and seawall to provide 100-year flood protection<br>Flood-proof critical facilities (Hazardous Materials Transfer Station) | Expand levee and seawall to address sea level rise | Develop long-term northern waterfront shoreline strategy |
| | $1.7 million [a] | $2.2 million [a] | Not estimated |
| **Bay Farm Lagoon Outlet and Seawall** | Restore submerged aquatic vegetation<br>Elevate existing seawall and upgrade pump | Explore large-scale shoreline modifications along Bay Farm's northern shore (e.g., living levee) | Coordinate approach to flooding across Bay Farm |
| | $ 3 million [a] | $9 million [a] | Not estimated |
| **Veteran's Court Seawall** | Regrade and elevate road to create flood protection structure<br>Restore submerged aquatic vegetation | Investigate options to convert Veteran's Court area into a living levee | Integrate Veteran's Court flood protection into broader Bay Farm Island flood control strategies |
| | $4 million [a] | $9 million | Not estimated |

Notes:

[ ] = Item(s) relevant to the Project

| Location | Scenarios | | |
|---|---|---|---|
| | **2030 Sea Level Rise Plus 100-Year Storm** | **2050 Sea Level Rise Plus 100-Year Storm** | **2100 Sea Level Rise Plus 100-Year Storm** |
| **Bay Farm Island Touchdown and Towata Park** | Repair/replace and elevate existing shoreline protection<br>(Additional study is needed on identifying and costing natural shoreline adaptation) | Assess bridge vulnerability | Consider local ordinance requiring or encouraging flood retrofits in this neighborhood |
| | $300,000 [a] | Not estimated | Not estimated |
| **SR260, Posey and Webster Tubes** | Construct floodwalls at exit from/entrance to the tubes | Install separate crossing for bikes/pedestrians (Caltrans Bike Plan) | Investigate long-term options for replacement or reconstruction of tubes |
| | $2 million | Not estimated | Not estimated |
| **SR61/Doolittle Drive** | Augment mudflats | Explore opportunities to collaborate with golf course on flood control | Convert roadways to levees to provide flood control |
| | $3.3 million | Not estimated | $15 million |
| **Critical and High-Use Roadways** | Unable to estimate cost | Unable to estimate cost | Unable to estimate cost |
| **Storm Drains and Pump Station** | Implement recommendations in existing stormwater master planning | Not yet planned | Not yet planned |
| | $40 to $154 million [b]<br>(note that some actions elsewhere in this table are included in this total) | Not estimated | Not estimated |
| **Bayview Weir and Outfall** | Install new flap gates, dredge near outfall | Install pump station | Integrate pump station upgrades with Shoreline Drive upgrades |
| | $1.5 million | $20.5 million | Not estimated |

[a] Strategies include cost to raise shoreline (as well as other adaptation actions). Costs to raise shoreline overlap with the cost estimate in Table 5-4.

[b] Stormwater system was discussed in "Cost of Action" section above but was not included in previous Table 5-4.

Note: Details on these adaptation strategies are provided in Chapter 4, "Adapting to Climate Change," and Appendix J, "Adaptation Strategies and Actions." In cases where adaptation strategies call for feasibility studies for the sake of costing, it is assumed that these studies will transition into project implementation. For example, it is assumed that the action to study opportunities for mudflat augmentation at Eastshore Drive (in Chapter 4) will transition into implementation of a mudflat augmentation project.

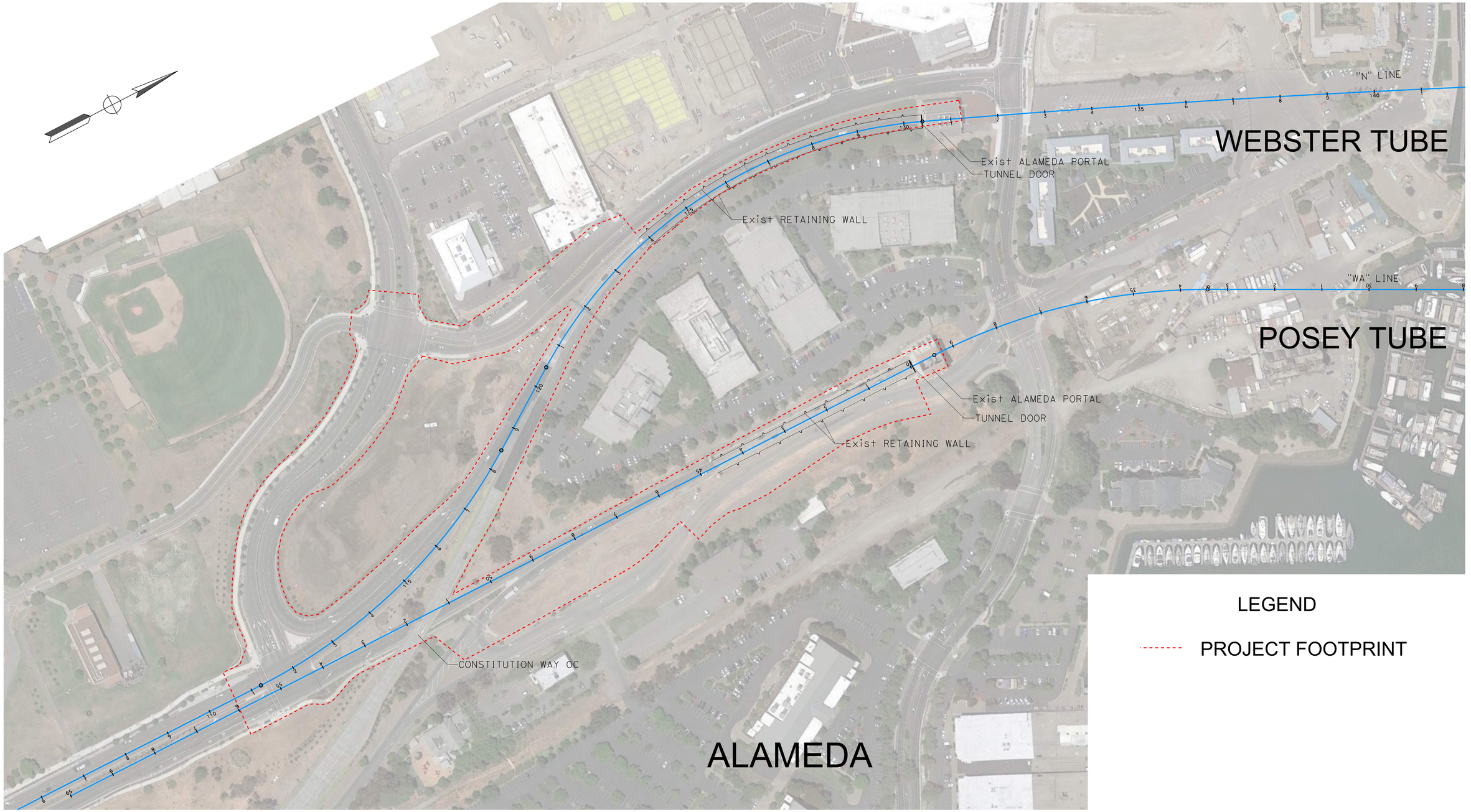
Notes:

= Item(s) relevant to the Project

# OAKLAND ALAMEDA ACCESS PROJECT

## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 1

## TUNNEL PORTAL PLUG




LEGEND

PROJECT FOOTPRINT

SCALE: 1" = 100'

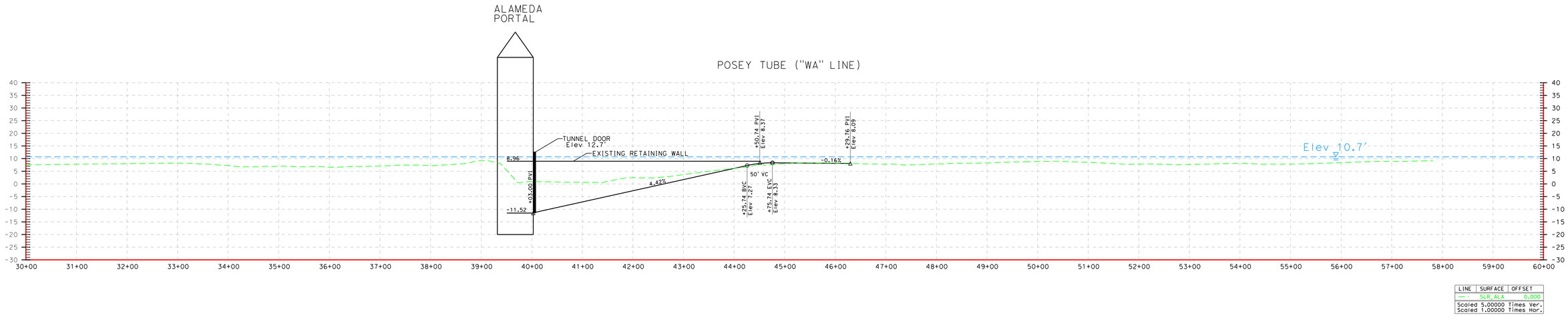
PRELIMINARY
FOR DISCUSSION ONLY

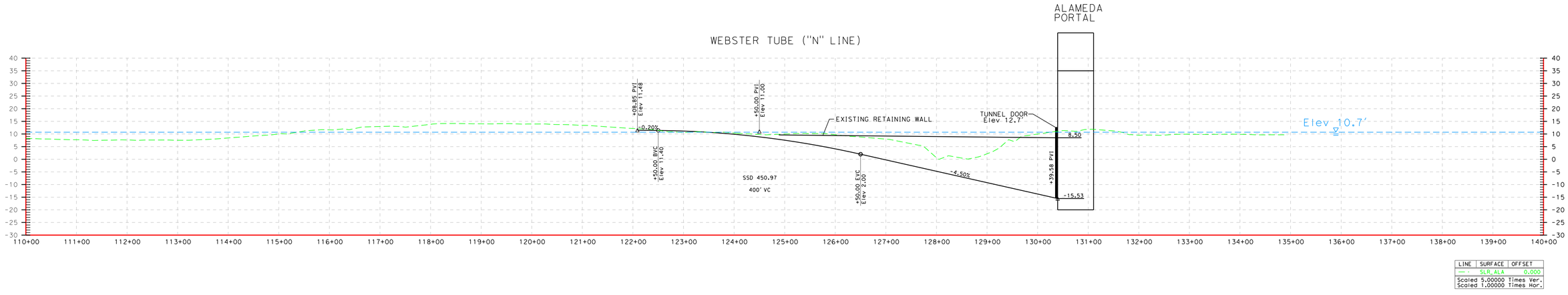
HNTB

ALAMEDA County Transportation Commission

04/13/2020

# OAKLAND ALAMEDA ACCESS PROJECT
## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 1
## TUNNEL PORTAL PLUG




Horiz SCALE: 1" = 100'
Vert SCALE: 1" = 20'

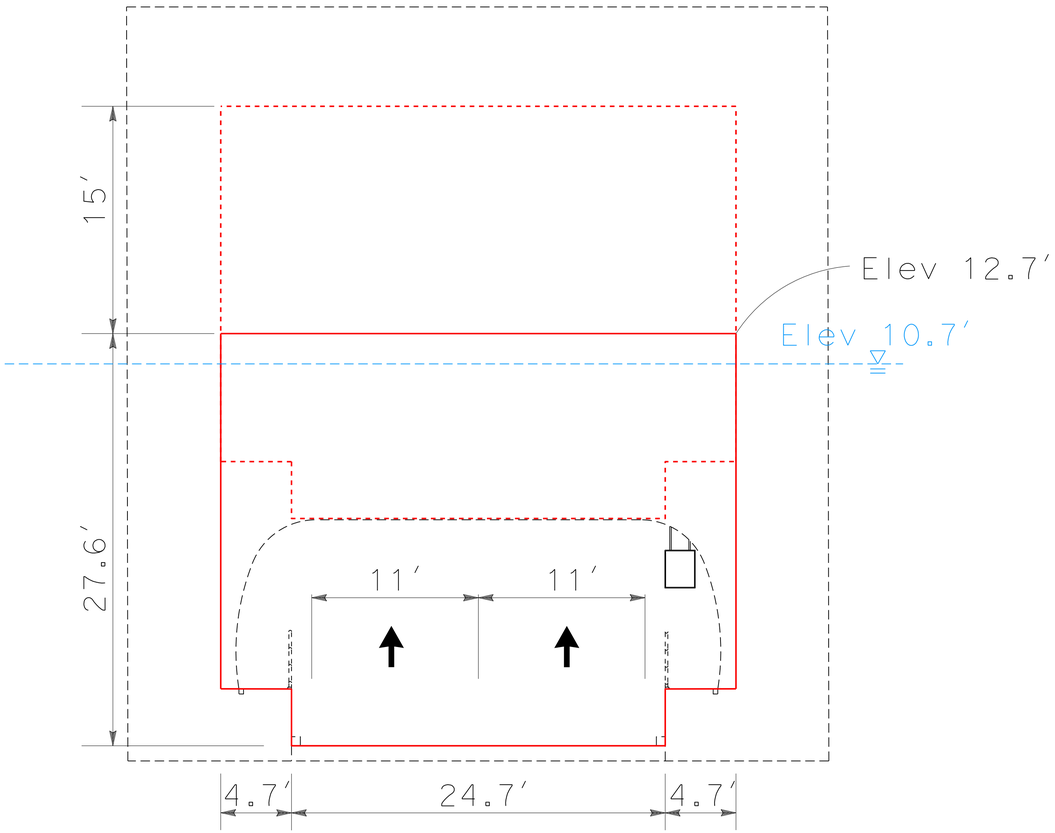
04/13/2020

PRELIMINARY
FOR DISCUSSION ONLY

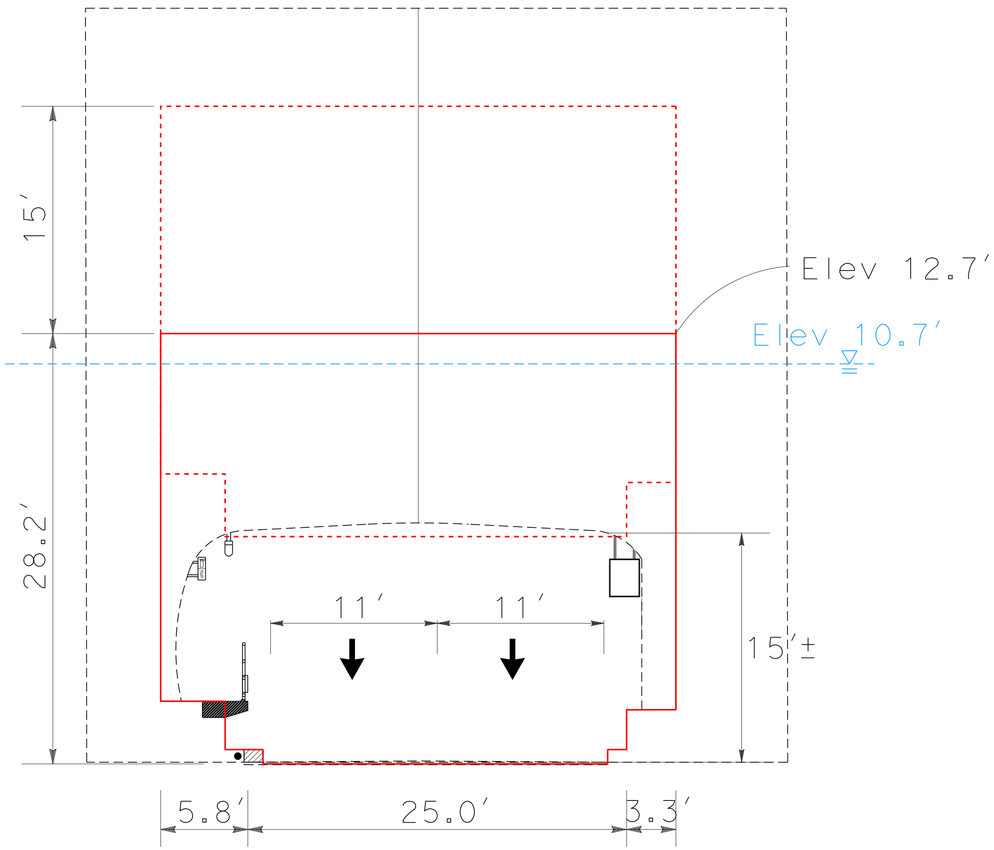
HNTB

ALAMEDA County Transportation Commission

# OAKLAND ALAMEDA ACCESS PROJECT
## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 1
## TUNNEL PORTAL PLUG




POSEY TUBE




WEBSTER TUBE

PRELIMINARY
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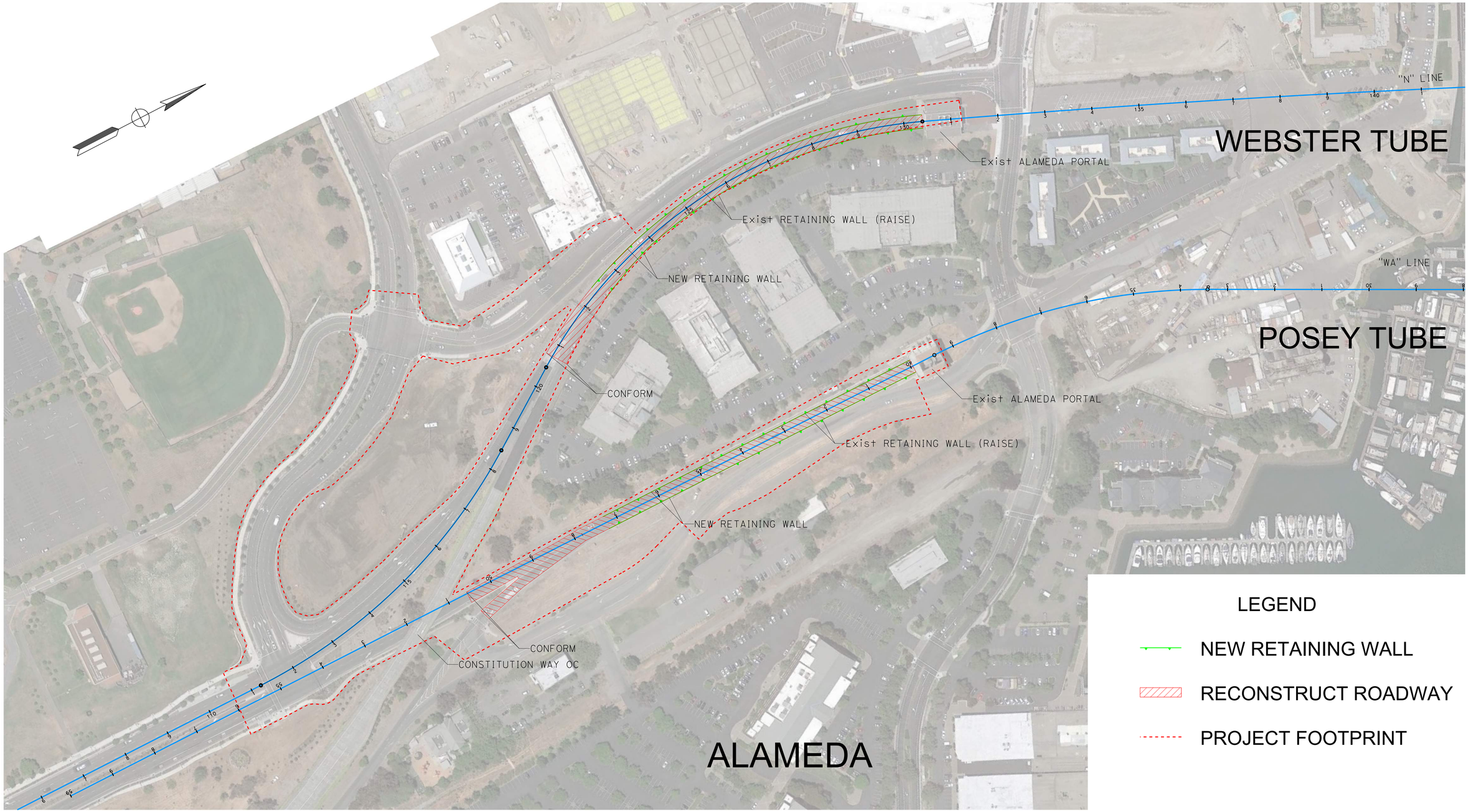
# OAKLAND ALAMEDA ACCESS PROJECT
## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 2
## WATERTIGHT ROADWAY APPROACHES




LEGEND

- NEW RETAINING WALL
- RECONSTRUCT ROADWAY
- PROJECT FOOTPRINT

SCALE: 1" = 100'

PRELIMINARY
FOR DISCUSSION ONLY

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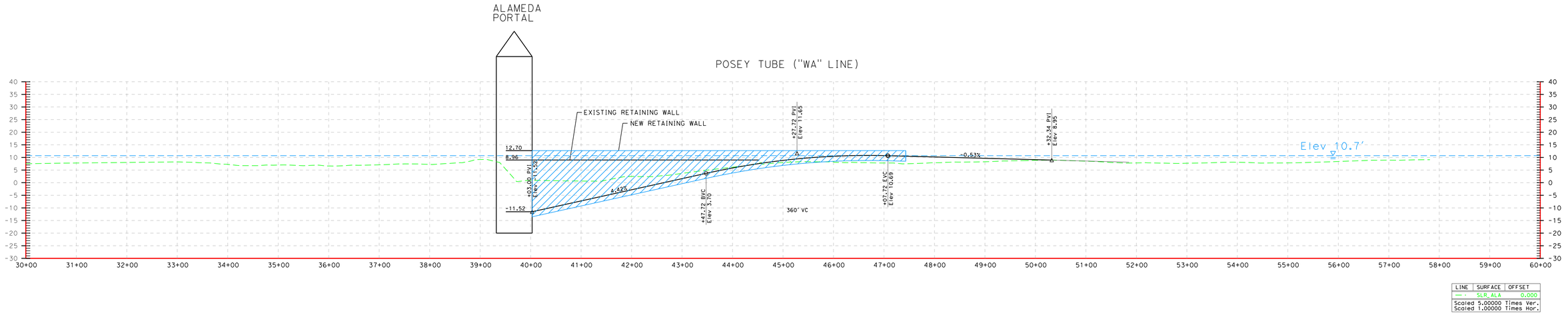
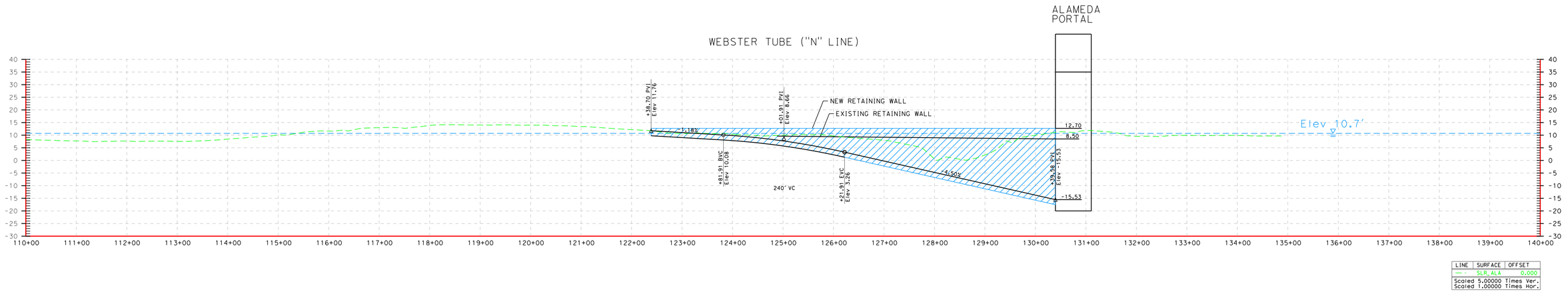
# OAKLAND ALAMEDA ACCESS PROJECT
## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 2
## WATERTIGHT ROADWAY APPROACHES




Horiz SCALE: 1" = 100'
Vert SCALE: 1" = 20'

04/13/2020

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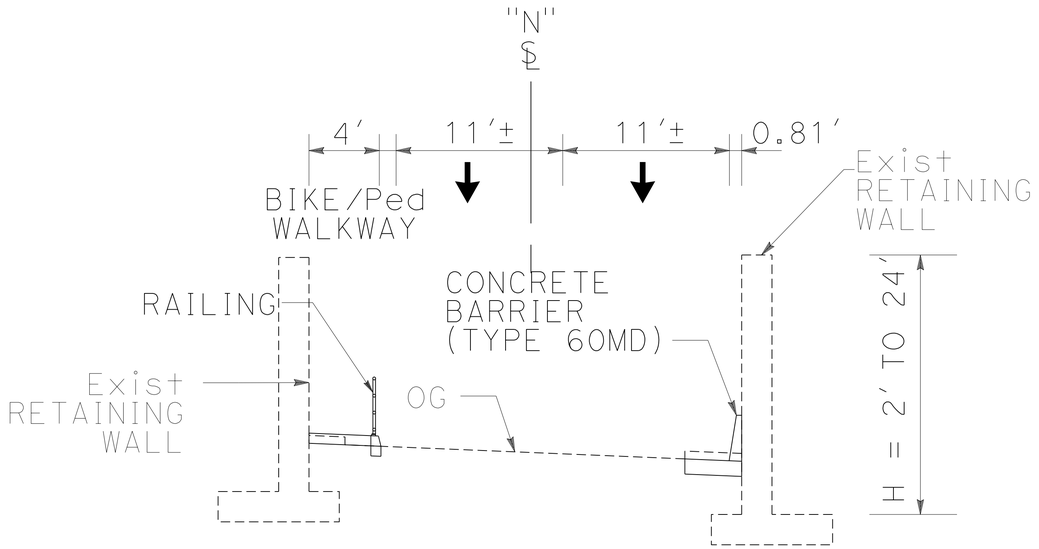
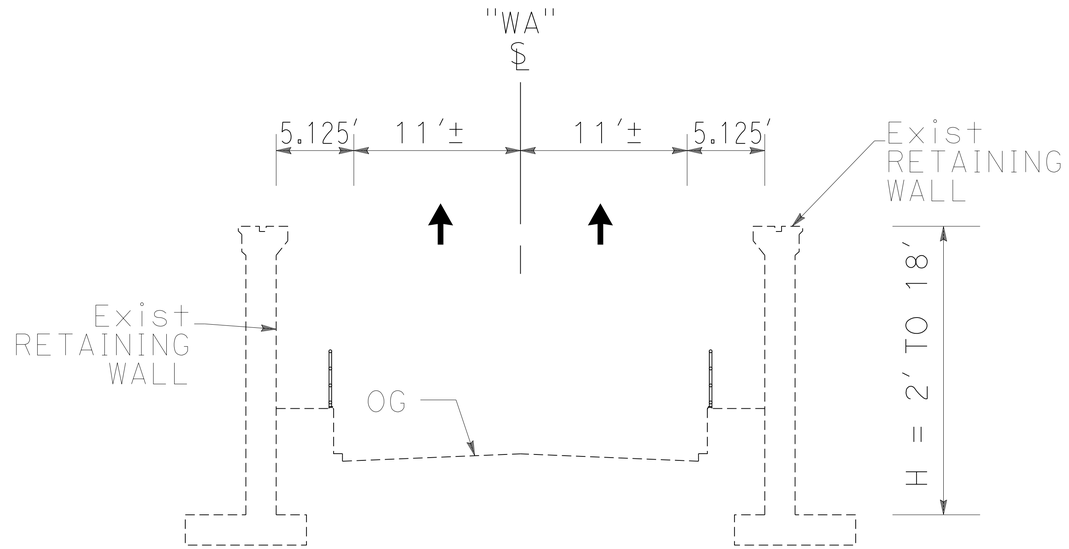
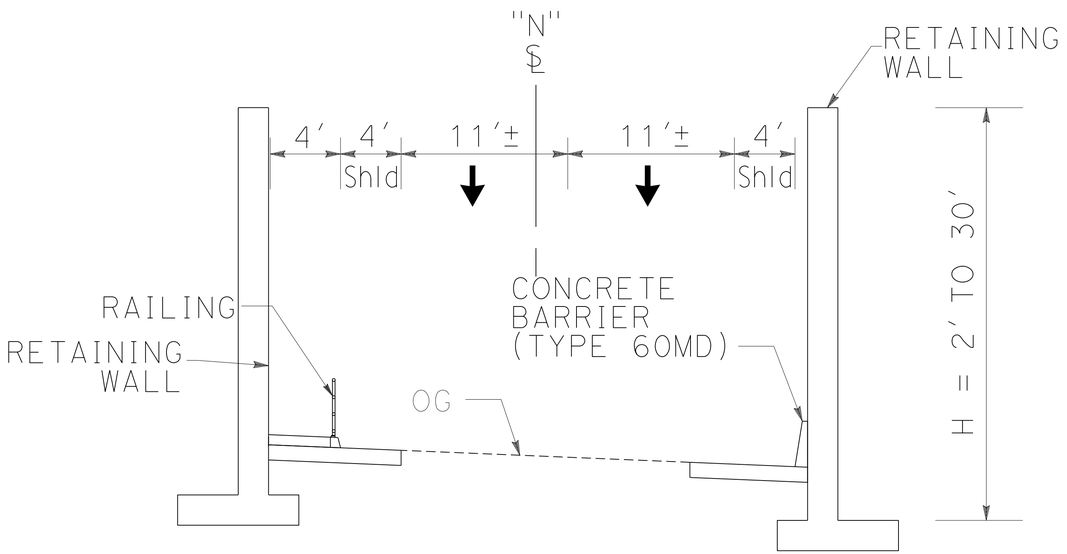
# OAKLAND ALAMEDA ACCESS PROJECT
## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 2
## WATERTIGHT ROADWAY APPROACHES



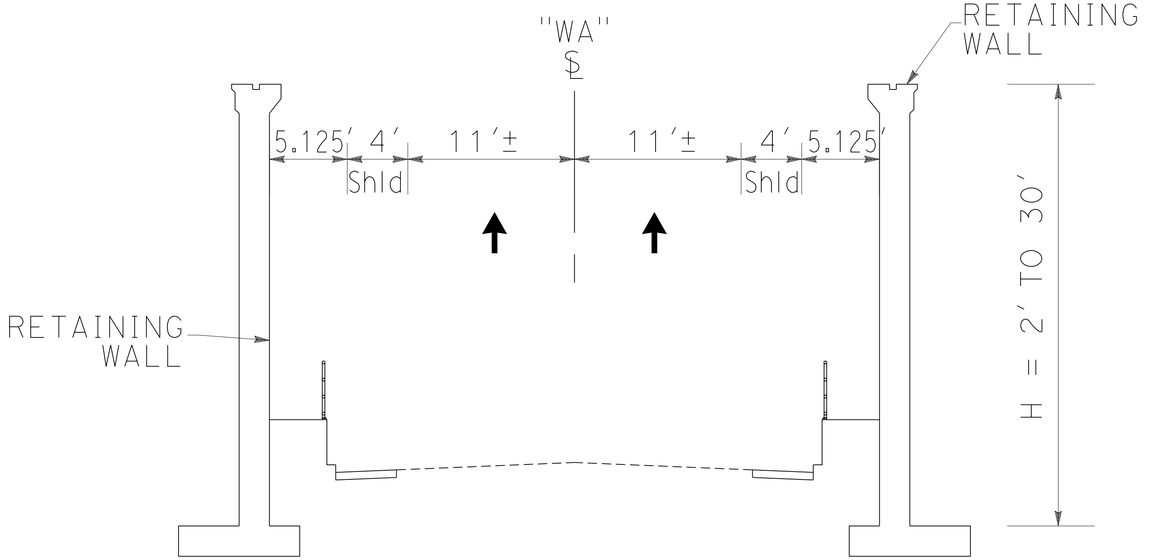

WEBSTER TUBE - EXISTING




POSEY TUBE - EXISTING




WEBSTER TUBE - PROPOSED




POSEY TUBE - PROPOSED

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# OAKLAND ALAMEDA ACCESS PROJECT
## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 3
## RESILIENT ELECTRICAL INFRASTRUCTURE


LEGEND

- STREETLIGHT
- TRAFFIC SIGNAL
- CONTROLLER CABINET
- PROJECT FOOTPRINT

SCALE: 1" = 100'

PRELIMINARY
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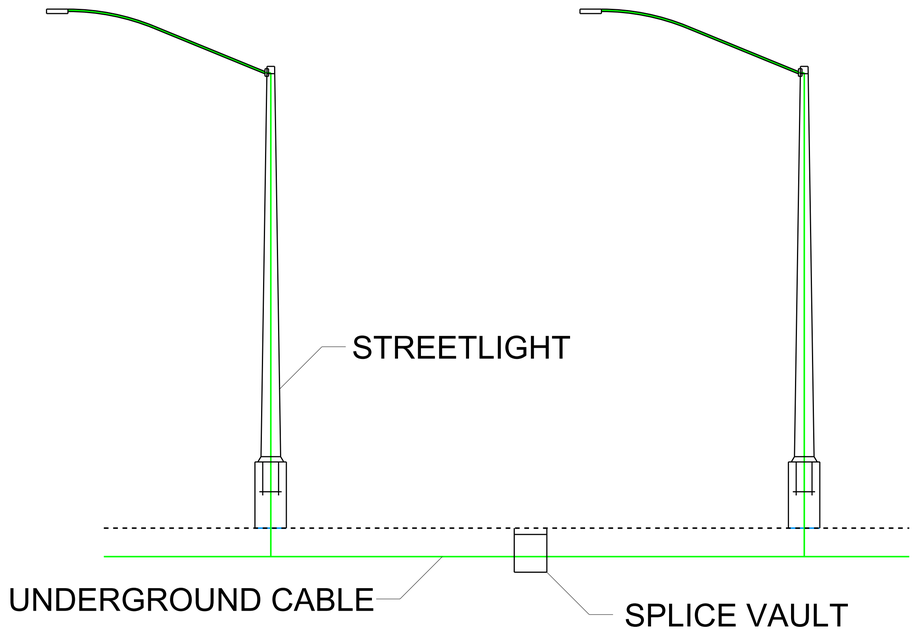
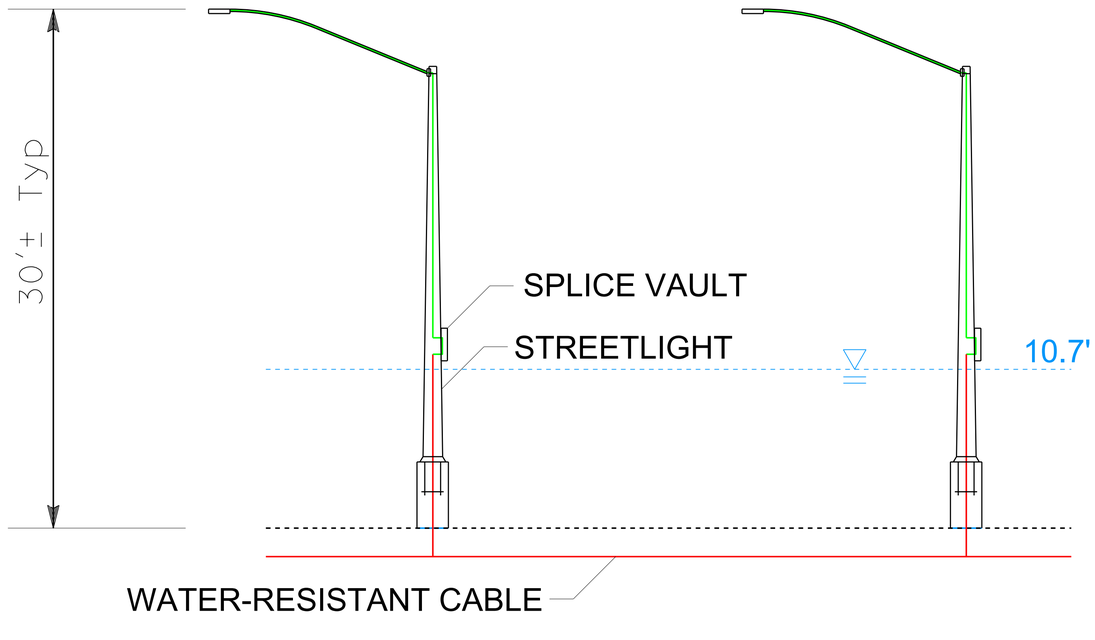
# OAKLAND ALAMEDA ACCESS PROJECT

## SEA LEVEL RISE ADAPTATION MEASURE - OPTION 3

## RESILIENT ELECTRICAL INFRASTRUCTURE




EXISTING




PROPOSED

PRELIMINARY
FOR DISCUSSION ONLY

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