

Sea Level Rise and Waterwalk

FEMA BRIC Grant Support

Concept Design Report

March 29, 2024 | Draft Report

kpff Consulting Engineers

DRAFT

SLR & Waterwalk: Concept Design Report

March 29, 2024

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1 Introduction

The Port of Port Townsend's Boat Haven boatyard and marine represents a unique resource for vessel maintenance and repairs and the Port is committed to preserving it for future generations to use, enjoy, and prosper. However, two of the highest tides ever recorded occurred in 2022, with the December 27, 2022 king tide event breaking historic records. Roadways, storm drains, and other infrastructure were all underwater during this event and with rising sea levels, climate modeling indicates more such events will become both more severe and more common.



Figure 1: Sea Level Rise and Waterwalk Project Study Area

The current phase of the Sea Level Rise and Waterwalk Project is intended to develop preliminary alignments for both flooding protection systems and the Waterwalk; consider alternative solutions, determine permitting pathways, and estimate the probable construction cost for the preferred alternative. To support the Port's efforts to obtain funding from the Federal Emergency Management Agency (FEMA) through the Building Resilient Infrastructure and Communities grant program, an estimate of the economic impacts of flooding was also developed.

The alignment can be divided into three primary stretches representing general shoreline conditions and land uses. Each stretch can be subdivided further based more specifically on shoreline and upland conditions.

Table 1: Sea Level Rise and Waterwalk Project Primary Stretches

#	Description	Typical Shore Condition	Approximate Length
1	Larry Scott Trail	Sloped beach w/rip rap	1,800 feet
2	Boat Haven Yard & Marina	Vertical seawall	2,200 feet
3	Flats District	Mix of wall, rip rap, and beach	2,600 feet

2 Economic Analysis

Economic activity in boatyards can span multiple industry categories and there is a wide variety of businesses in The Flats, the district immediately northeast of the Boat Haven yard and marina. The combined area, shown in Figure 2, is home to 79 employers and 43 sole proprietors. These businesses combined represented an estimated 1,040 workers with income (wages & salaries plus benefits) of $51.8 million, or an average of $48,200 per worker. Businesses located in the study area generated an estimated $166.1 million in gross revenues and net profits, before tax, of $17.7 million (Table 2).



Figure 2: Boat Haven and Flats District Economic Analysis Zone

Table 2: Boat Haven and Flats District Economic Activities

Sector	Workers	Total Income *$ 000s*	Gross Sales *$ 000s*	Net Revenues *$ 000s*
Construction	5	$370.7	$1,537.9	$18.4
Manufacturing	105	$4,214.4	$29,317.9	$2,931.8
Wholesalers	30	$1,855.3	$5,950.0	$1,555.8
Retailers	615	$26,708.9	$67,283.8	$2,018.5
Transportation and Warehousing	0	$48.4	$3,665.8	$366.6
Finance and Insurance	30	$1,756.7	$9,322.6	$5,761.9
Professional, Scientific, and Technical Services	5	$133.1	$212.0	$22.1
Health Care and Social Assistance	50	$3,006.6	$6,781.5	$197.2
Arts, Entertainment, and Recreation	40	$3,242.0	$10,103.9	$2,057.4
Accommodation and Food Services	110	$3,083.8	$9,610.8	$1,956.9
Other Services (Including Maintenance and Repair)	90	$7,409.8	$22,273.2	$795.4
Total	**1,080**	**$51,829.7**	**$166,059.3**	**$17,681.9**

The Boat Haven yard is a unique public asset as a working boatyard that allows both private owners and commercial businesses to operate side-by-side, using the services provided by the Port. The most important of these services is the ability of the Port's Travelifts to haul vessels out of the water for work within Boat Haven or for placement on trailers to be taken to nearby boatyards operating outside of Boat Haven. When flooding occurs, the Travelifts cannot operate, which has significant impacts throughout the regional maritime economy.

Other impacts of flooding within the Boat Haven and Flats District can include the following:

- Immediate damage from still water inside the building
- Labor costs during a temporary shutdown
- Delays in work due to loss of materials

Delays in work due to of Travelift not being available to move vessels in or out of the workspace

- Ancillary impacts to the marine trades ecosystem

A complete discussion of the economic analysis is provided in Appendix A.

3 Sea Level Elevation Analysis

The design water levels used for the development of flood protection concepts is based on the combination of current and observed water levels, coastal flood elevations developed by FEMA, storm surge heights driven by meteorological conditions, projected sea level rise, and wave modeling. All elevations are expressed in the North American Vertical Datum of 1988 (NAVD88). The complete design water level analysis is provided in Appendix B.

3.1 TIDES AND OBSERVED WATER LEVELS

Characteristic tidal datum elevations are available from the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) water level station at the ferry dock in Port Townsend. Mean higher high water (MHHW) at Port Townsend is 7.4 feet NAVD88 and the Highest Astronomical Tide (HAT, highest predicted tide over 40 years) is 8.9 feet NAVD88.

3.2 BASE FLOOD ELEVATION

The base flood elevation is established by FEMA and was most recently calculated in 20##. FEMA defines flood zones based on the type of risk presented by flood waters in that zone. Within the study area, FEMA has identified A and VE zones. In AE zones, the risk is generally associated with the water level elevation. In VE zones, the flood waters are assumed to be moving with sufficient velocity or have sufficient wave energy to cause additional damage to structures in the flood zone. The base flood elevation in the AE zones throughout most of the study area ranges from 12 feet to 13 feet. Immediately to the southwest, the AE and VE zones have an elevation of 17 feet. The key water level elevations are shown below in Table 3.

Table 3: Summary of Water Level Elevations

Datum / Elevation	Elevation (feet MLLW)	Elevation (feet NAVD88)[2]
FEMA BFE (1% AEP)[1]	13.1-18.1	Varies from 12 to 17
FEMA Stillwater elevation (1% AEP)	12.6	11.5
December 27, 2022 observed[2]	12	10.9
January 7, 2022 observed[2]	11.4	10.4
100-year water level (1% AEP)[3]	11.9	10.8
10-year water level (10% AEP)[3]	11.5	10.4
2-year water level (50% AEP)[3]	10.9	9.8
1-year water level (99% AEP)[3]	9.9	8.8
Highest Astronomical Tide (HAT)[4]	10.0	8.9
High Tide Line[4]	9.8	8.7
Mean Higher High Water (MHHW)[4]	8.5	7.4
Mean High Water (MHW)	7.8	6.8
Mean Tide Level (MTL)	5.2	4.1
Mean Sea Level (MSL)	5.0	3.9
Mean Low Water (MLW)	2.5	1.4
Mean Lower Low Water (MLLW)	0	-1.1

Notes: Conversion to NAVD88 from NOAA VDatum online tool for the project site.

1. Total water level including wave run-up
2. Verified 6-minute water level from NOAA-NOS station #944490
3. NOAA-NOS extreme water level trend analysis for 2018
4. Average of highest annual predicted tide elevations at Port Townsend from 2024 to 2034 (10 years)

3.3 STORM SURGE

Localized, short-term fluctuations in water level from the predicted tide due to meteorological conditions is known as storm surge. Storm surge is estimated by analyzing the difference between the actual recorded water levels and the predicted tidal water levels. Based on this analysis, the 100-year return interval storm surge in the project area is estimated to be 2.9 feet.

3.4 SEA LEVEL RISE

Long-term mean sea level in Puget Sound has increased over the past century and is predicted to increase versus historical rates of SLR because of climate change related impacts. The Puget Sound projections by Miller et al. (2018) are based on global SLR projections for low and high greenhouse gas scenarios known as Representative Concentration Pathways (RCP) 4.5 and RCP 8.5, respectively. Because the activities on the project site are not particularly risk tolerant (parking lots) or risk averse (emergency response facilities), using the median (50% exceedance probability) from Miller et al. is recommended.

3.5 WAVE RUN-UP

In addition to developing estimates of still water level based on the above analyses, wave action can have a significant effect on coastal flooding. Numeric modeling was used to estimate wave heights based on wind speeds, wind direction, and fetch, with the results shown in Table 4.

Table 4: Estimated Wave Heights

Transect	Wave Height (Hs)	Wave Period (Tp)
A	3.9	3.7
B	4.0	3.8
C (inside marina)	1.1	1.5
D	4.2	3.8
E	4.4	3.8

3.6 RECOMMENDED MINIMUM STRUCTURE CREST ELEVATIONS

Based on the estimated water levels and wave run-up, minimum structure crest elevations were developed for five transects representing typical conditions across the study area.



Figure 3: Design Water Level Transects

The minimum structure crest elevations are shown below.

Table 5: Recommended Structure Crest Elevations

Shoreline Length / Wave Transect	Structure Slope[1]	100-year wave height and period	Total water level (feet NAVD88)	$R_{2\%}$	Total water level (feet NAVD88)	Overtopping (l/s/m)	Structure Crest Elevation (feet NAVD88)	Freeboard (feet above SWL)
A	2.5H:1V	3.9 ft / 3.7 s	12.6	5.3	17.9	52	13.5	1.0
B	2.5H:1V	4 ft / 3.8 s	12.6	5.5	18.1	45.0	14.5	2.0
C1	vertical	1.1 ft / 1.5 s	12.6	1.1	13.7	1.0	14.0	1.5
C2	vertical	1.1 ft / 1.5 s	12.6	1.1	12.6	N/A	13.5[2]	1.0
D	2.5H:1V	4.2 ft / 3.8 s	12.6	5.7	18.3	28.0	15.0	2.5
E	2.5H:1V	4.3 ft / 3.8 s	12.6	5.7	18.3	29.0	15.0	2.5

Notes: l/s/m = liter per second per meter of structure; N/A = not applicable;

1. Structure slope is based a conceptual Waterwalk structure in this location and is subject to change in later phases of design.
2. Crest elevation is lower for C2 because flood protection is setback from vertical wall of marina along the landward side of the parking lot.

4 Concept Development

4.1 FLOOD PROTECTION CONCEPTS

The flood protection concepts developed for each segment of the project alignment are a combination of grading, fill, and new structures, with the structure crest set per the recommendations discussed in Section 3. The flood protection and Waterwalk alignments were developed together although they are not coincident throughout the project area. The goal of the concept development was to provide sufficient detail to support a preliminary cost estimate for the next FEMA BRIC grant application.

To efficiently get to a preliminary cost estimate, the project alignment was divided into segments and transition zones. For each segment, a typical section was developed that could be applied with minimal modifications along that stretch of the project. In the transition zones, a non-linear solution will be required, such as a automatic flood gate or a combination of regrading, structure, landscaping, coastal protection, and habitat improvements. The transition zones at street ends and trail heads also provided opportunities for site improvements that create attractive public amenities that would be integral elements of the Waterwalk. The segments and transition zones are shown in Figure 4 and Figure 5Figure 5: Northeast Portion of Project Alignment. The concept al



Figure 4: Southwest Portion of Project Alignment



Figure 5: Northeast Portion of Project Alignment

At discrete locations along the alignment where non-linear solutions were needed, special attention was given to the associated landscape, hardscape, and environmental features, including automated flood gates.



Figure 6: Automated Flood Gate (Pedestrian)

At the head of the 300 ton and 75 ton Travelift piers, a wider automatic gate will be required, with additional reinforcing likely required.



Figure 7: Automated Flood Gate (Roadway Levee Crossing)

4.2 LANDSCAPE CONCEPTS

At the street ends along the project alignment, and adjacent to the Boat Haven haul-out wash pad, landscaping concepts were developed to illustrate how the flood protection and Waterwalk elements of the project could be integrated to provide attractive public amenities. These areas could feature seat walls, boardwalks, gateways,

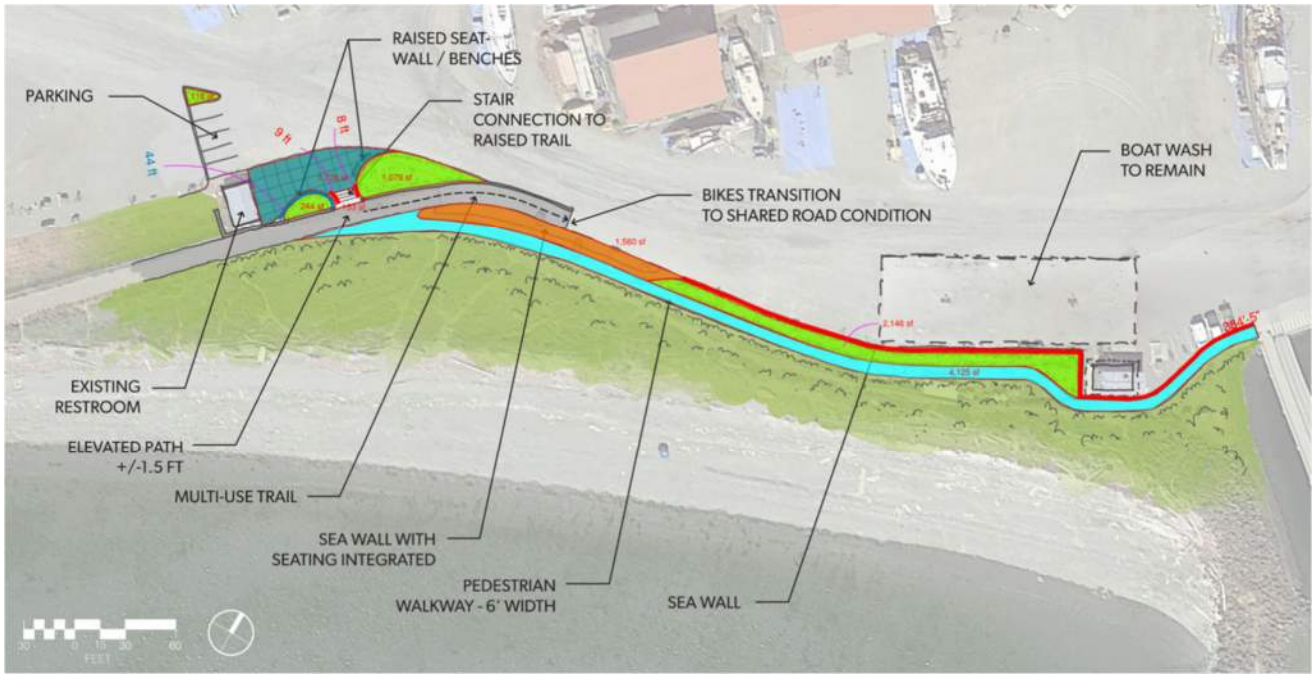


Figure 8: SLR & Waterwalk Concept at LST Trailhead & Wash Pad

4.3 ENVIRONMENTAL ASSESSMENT

The environmental assessment for the project included definition of the baseline conditions, a review of the like permitting and mitigation requirements, a more detailed regulatory compliance review on a segment-by-segment basis, an overall compliance and mitigation strategy, and estimate of the probable mitigation costs. The baseline condition is a highly modified shoreline along the length of the 1.2 mile project, with critical habitat for bull trout, Puget Sound Chinook Salmon, steelhead, and rockfish present within the project area.

For the in-water work, defined as occurring below the Mean High Tide line, the following agency reviews will be required:

- Federal:
    - Federal lead agency: NEPA compliance
        - DAHP: Section 106 of the NHPA
        - Services (NMFS and USFWS): including Section 7 of the ESA
    - Corps: Section 404 of the CWA and Section 10 of the RHA
    - Tribal Consultation
- State:
    - State lead agency: SEPA review
    - Ecology: Section 401 of the CWA
    - Ecology: CZMA
    - Ecology: NPDES or Stormwater General Permit
    - WDFW: HPA
- Local:
    - City of Port Townsend: SSDP/ CUP/ Shoreline Variance

Environmental permits and authorizations needed for upland work (i.e., no in-water work required):

- Federal:
    - Federal lead agency: NEPA compliance
        - DAHP: Section 106 of the NHPA\
        - Services (NMFS and USFWS): including Section 7 of the ESA
    - Tribal Consultation
- State:
    - State lead agency: SEPA review
    - Ecology: NPDES or Stormwater General Permit
- Local:
    - City of Port Townsend: SSDP/ CUP/ Shoreline Variance

In-water work may result in at least 5 additional permits and authorizations and working with additional resource agencies. Keeping work and structures above jurisdictional boundaries would significantly reduce the level of effort and complexity of obtaining environmental permits.

To compensate for the environmental impacts of the project, mitigation strategies will include avoidance, minimization, and mitigation/compensation. To avoid in-water impacts, many of the flood protection system improvements are located above the HTL. There are opportunities for on-site mitigation along the project alignment, particularly around the start of the Larry Scott Trail and the boat yard wash pad, where improvements above the high tide line can support the adjacent sand lance spawning area. There are also a number of derelict piles around Indian Point that could be removed for additional credit. If the final design of the project is not self-mitigating, it may be necessary to buy mitigation credits, with the number of credits required based on the Puget Sound Nearshore Conservation Calendar.

A holistic approach to regulatory compliance including NEPA/SEPA, permitting, and mitigation would ultimately reduce cost and provide more schedule certainty. The first component of the permitting strategy for the Port's Waterwalk project is to create a collaborative process that will provide certainty and reduce regulatory review timelines. Early engagement meetings to introduce the project, determine agency jurisdiction, and identify permits needed for the project will aid in the permit application and review process. A complimentary permitting strategy includes preparing a robust mitigation package that provides balance between mitigation needs and project costs. The NMFS nearshore habitat conservation calculator (v1.6) can be used as a tool to estimate mitigation requirements and costs.

4.4 STORMWATER SYSTEM CONCEPTS

The existing stormwater system was assessed for risks associated with back flow through the storm drains during high water events and to ensure adequate drainage during high water events so that the protected area is not filled with rainwater that cannot discharge.

5 Cost Estimate

5.1 BASE COST

5.1.1 Civil and Structural Costs

The primary approaches to providing a structure with the recommended crest elevation are adding fill to raise the existing elevation, constructing a concrete flood wall, or using a combination of sheet pile, cast-in-place concrete, and added fill to reinforce and raise the existing sea wall and shore protection systems.

5.1.2 Landscape Costs

Landscaping costs include special surface treatments for the Waterwalk, seat walls and other furnishings at street ends and trail gateways, plantings, access walkways, and signage.

5.1.3 Environmental Costs

The NMFS calculator (v1.6) was used to estimate debits and credits as a proxy to identify mitigation needs (i.e., number of debits) and costs. There is also a program available to applicants that use the Salish Sea Nearshore Programmatic (SSNP) consultation through the Puget Sound Partnership (PSP). This program allows an applicant to buy nearshore conservation credits that can be used to balance mitigation needs identified through the NMFS calculator. The current rate is $1,411 per credit (PSP 2024). This program is only available for projects where the Corps is the federal lead, but the costs generated from mitigation debits in the NMFS calculator and associated cost per credit can provide a conservative estimate for the Port's Waterwalk project.

5.1.4 Stormwater System Costs

Stormwater system improvement costs include additional protection of existing outfalls, adding tide gates to prevent back-flow flooding, and additional conveyance elements.

5.2 ADJUSTMENTS

5.2.1 Escalation

The base cost was escalated assuming the mid-point of construction would be 5 years out. The rate of escalation was the average of the past three years as reported by the Engineering News Record, which is 5.40% per year.

5.2.2 Taxes

The sales tax rate was based on the standard Washington State sales tax plus local sales tax, totaling 9.40%.

5.2.3 Contingency

A range of contingency factors was applied based guidance from the American Association of Cost Estimators. Give the very low percentage of design at this point, the project cost estimate could be considered Class 4 or 5. Class 5 is based on up to 2% design and is uses parametric models, with a contingency range of (-)20% to 30% or (+) 30% to100%; Class 4 is based on 1% to 15% design and generally uses equipment factored or parametric models, with recommended contingencies from (-)15% to 30 and (+)20% to 50%. Based on the level of detail in out estimate, experience, and professional judgement, we used a low contingency of (-)10% and a high contingency of (+)50%. This range represents the lower and upper bounds of the probable construction cost.

5.2.4 Soft Costs

Soft costs include the non-construction costs associated with project delivery. These costs are based on a percentage of the escalated construction cost without taxes or contingencies. The assumed costs were as follows:

- Engineering, permitting, and professional services 15%
- Construction and project management 8%
- Owner management 3%

5.3 TOTAL PROJECT PROGRAM COST

The total program cost for the Sea Level Rise and Waterwalk project is most likely to be between $38.5 million and $59.9 million, based on base cost of $23,9 million and additional costs as shown below.

Table 6: Estimated Total Program Cost

Total Estimate of Probable Construction Cost		**$ 23,912,000**	
Cost w/Escalation (yr/yr)	5.40%	$ 31,104,194	Assuming 5 years, average excalation from ENR over previous 3 years
Cost w/Escalation and Taxes	9.40%	$ 34,027,988	WSST + Local
Cost w/Contengicy (Low Range)	-10%	**$ 30,625,189**	AACE Class 4/5 Estimate for Study/Concept Screeing
Cost w/Contengicy (High Range)	50%	**$ 51,041,982**	AACE Class 4/5 Estimate for Study/Concept Screeing
Engineering/Professional Services	15%	$ 4,665,629	Design, permitting, & engagement
Construction and Project Mgmt	8%	$ 2,488,336	
Port Management	3%	$ 777,605	
Total Soft Costs		$ 7,931,569	
Program total cost (low)		$ 38,556,759	
Program total cost (high)		$ 58,973,552	

The cost per segment of the alignment is shown in Appendix D.

Appendix A

Economic Analysis Memo

Port of Port Townsend

SEA LEVEL RISE ECONOMIC IMPACT ANALYSIS

INTERIM DISCUSSION DRAFT

November 21, 2023

Submitted by:

HIGH PEAK STRATEGY

Submitted to:

kpff

PORT OF PORT TOWNSEND



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KEY FINDINGS

- There are 79 employers and 43 sole proprietor businesses operating in the Boat Haven and Flats areas of Port Townsend, including a large cluster of boatyards and related services.
- These businesses in 2023 directly supported 1,040 jobs, income (wages & salaries plus benefits) of $51.8 million, business revenues of $166.1 million in gross revenues and net profits, pre-tax, of $17.7 million. Boatyards and independent contractors in ship and boat maintenance and repair generated an estimated $44 million in gross revenues in 2022.
- The total economic impact of these operations in Jefferson County in 2022 summed to 1,490 jobs, $74.8 million in labor income, and $186.5 million in business output.
- The road in front of ACI is built on earthen fill. Severe flooding can severely compromise the structural integrity of the road, forcing a temporary pause in use of one or more of the travel lifts.
- The greatest economic costs occur with the confluence of a king tide and a storm surge. If another flood event occurs in the future similar in magnitude to the 2019 king tide flood, the immediate impact would be at least one full day of cleanup, inoperability of one or more of the travel lifts, and a pause in standard business operations among boatyards located within Boat Haven. Based on an estimated total boatyard employment of 145 and an average loaded wage of $45 per hour, losses from diversion of workers away from revenue-generating activities would sum to $52,000 per day. If boatyard operations were disrupted for five days due to flooding, the cost impact would be $261,000.
- There are other potential costs from flood-based disruptions to operations. These include the cost of repairs to flood-damaged materials and equipment to facilities closest to the coastline (and vulnerable to the highest level of temporary inundation) and delayed orders due to these disruptions (resulting in contract-based penalties and/or lost future business).

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INTRODUCTION

The Port of Port Townsend is determining whether to invest in sea level rise mitigation to protect businesses and communities in the Port's Boat Haven region and adjacent Flats area. This analysis was commissioned by the Port and KPFF to assess the economic value of existing business activities within the affected areas. Analysis below details: 1) a baseline scenario of existing activities for year 2022 for businesses and business activities in the study area; and 2) preliminary scenarios for assessing the economic costs to these businesses and activities from future flooding and damage caused by a rising sea level and storm surges, in the absence of mitigation measures being proposed.

Data and Methods

This report leverages the following sources: 1) public datasets on employment, wages, and business revenues published by the U.S. Bureau of Labor Statistics, Washington State Employment Security Department, and Washington State Department of Revenue; 2) business lists and directories for operations identified as within the affected contiguous Boat Haven and Flats regions; and 3) stakeholder feedback. Indirect and induced economic impacts are computed using the Washington State Input-Output Model.

Direct employment was estimated based on a custom data request of unified business identifier (UBI) codes for businesses within the defined study area, submitted to the Washington State Employment Security Department. These counts—for covered employment and wages—were augmented with estimated jobs and labor income among additional sole proprietors operating within Boat Haven and the Flats. Revenues and profits were computed based on interviews, business directory data, ratios of output-to-worker by industry in Washington state, and estimated value added, less labor income, as a percentage of total sales by industry sector.

ECONOMIC BASELINE AND DIRECT ACTIVITIES

The study area includes Boat Haven and the adjacent Flats (**Exhibit 1**). This combined region is home to 79 employers and 43 sole proprietors. These businesses combined represented an estimated 1,040 workers with income (wages & salaries plus benefits) of $51.8 million, or an average of $48,200 per worker. Businesses located in the study area generated an estimated $166.1 million in gross revenues and net profits, before tax, of $17.7 million (**Exhibit 2**).[1]

Boatyards span multiple industry categories, including manufacturing and in some cases retail and wholesale operations. These firms combined generated an estimated $44.0 million in gross sales in 2022. Examples of commercial

[1] Net profits were estimated based on interview feedback and value-added excluding labor income by industry reported in the Washington State Input-Output Model (Washington State Office of Financial Management, 2022).

boatyards include Peter Stein Shipwrights, ACI, Port Townsend Rigging, Inc., Port Townsend Shipwrights Co-op, and Haven Boatworks. There are also numerous independent contractors who may be based outside the port but do most or all of their work at one or more of the port's boatyards, including as subletters for space at existing facilities. Boatyards and independent contractors span a wide range of services and technical expertise—including for upkeep, maintenance, repair, and upgrading— in woodwork, electronics, refrigeration systems, propulsion systems, heating and cooling, mechanics, painting, and metal fabrication.

The Port of Port Townsend Boat Haven is a unique public asset as a working boatyard. Unlike other boatyards, Boat Haven allows private vessel owners to do their own maintenance and repair work at the port. Owners for a fee can schedule a travel lift service to haul a vessel out of the water to transfer to a reserved private maintenance spot or commercial yard and use the same service to launch a drydock vessel back into the water. Even owners who do their own maintenance will often hire independent contractors for specific technical maintenance and repair work. The port has four travel lifts—three smaller capacity lifts (one able to handle up to a 70-ton vessel and two able to handle up to a 75-ton vessel) and a 300-ton-capacity travel lift for hauling and launching larger vessels, e.g., commercial fishing ships, Kitsap Transit ferries, larger yachts.

After hauling a vessel out of the water, the travel lift first transports the vessel to a concrete wash pad directly west of the breakwater. After removing crustaceans and other matter from the vessel hull, the travel lift then transports the vessel to either a reserved drydock space further west of the wash pad or one of the boatyards at the port; or, in some cases, to be picked up by a boatyard operating outside the port. During the peak summer season, the 75-ton travel lifts typically move between 14-20 vessels per day (either hauling out of the water or launching back in), while the 300-ton travel lift moves on average two vessels per day. West of the wash pad area, there are 130 drydock spots for the 75-ton travel lift and roughly 28 for the 300-ton travel lift.

As discussed below, some of these roadways, including Washington Street in front of ACI, are vulnerable to flooding and structural damage to the fill underneath the roadway asphalt. There is also a private vehicle traffic along Washington Street, creating congestion and the need for flaggers to manage traffic when one or more of the travel lifts are operating on the same roadway.

Exhibit 1. Boat Haven and Flats Areas Contiguous Study Region, Port Townsend, Washington



Exhibit 2. Boat Haven and Flats Areas Direct Activities, 2022

Sector	Workers	Total Income *$ 000s*	Gross Sales *$ 000s*	Net Revenues *$ 000s*
Construction	5	$370.7	$1,537.9	$18.4
Manufacturing	105	$4,214.4	$29,317.9	$2,931.8
Wholesalers	30	$1,855.3	$5,950.0	$1,555.8
Retailers	615	$26,708.9	$67,283.8	$2,018.5
Transportation and Warehousing	0	$48.4	$3,665.8	$366.6
Finance and Insurance	30	$1,756.7	$9,322.6	$5,761.9
Professional, Scientific, and Technical Services	5	$133.1	$212.0	$22.1
Health Care and Social Assistance	50	$3,006.6	$6,781.5	$197.2
Arts, Entertainment, and Recreation	40	$3,242.0	$10,103.9	$2,057.4
Accommodation and Food Services	110	$3,083.8	$9,610.8	$1,956.9
Other Services (Including Maintenance and Repair)	90	$7,409.8	$22,273.2	$795.4
Total	**1,080**	**$51,829.7**	**$166,059.3**	**$17,681.9**

Sources: Washington State Employment Security Department (2023); Washington State Department of Revenue (2023); Washington State Office of Financial Management (2022); U.S. Bureau of Labor Statistics (2023); U.S. Bureau of Economic Analysis (2023).
Note: employment figures have been rounded to the nearest 5.

ECONOMIC IMPACTS

Businesses within Boat Haven and the Flats support additional statewide and regional economic activity through upstream business-to-business transactions (indirect effects) and spending of direct business and supplier worker earnings on household goods and services (induced effects). Indirect impacts include purchases of boatyard components, machinery, various supplies, equipment, and professional services. The purchase of these inputs creates additional jobs and economic activity among other businesses located throughout Jefferson County and Washington state.

Induced impacts include the share of income earned within the study area and among suppliers which is then re-spent on household consumption goods and services throughout the economy. Examples of induced impacts include additional jobs, income, and revenues generated at grocery stores, entertainment venues, and restaurants from spending by workers employed among businesses in the study area.

These two effects—indirect and induced—are measured as additional revenues, jobs, and income; these combined effects are referred to as "total economic impacts." These impacts are based only on those purchases—by businesses and employees—made within Washington state; the remainder are treated as imports, either domestic or foreign, and do not spur additional economic activity in the state. The primary tool for assessing these broader economic impacts was the Washington State Input-Output Model, an input-output model custom-built by the Washington State Office of Financial Management to reflect the unique intra- and inter-industry transactions and household spending within the Washington state economy.

In 2022, the total economic impact of businesses within the study area within the State of Washington summed to 1,840 jobs, $96.0 million in labor income (including the monetary value of supplemental benefits), and $250.7 million in business output, or revenues (**Exhibit 3**). Each direct job within the study area was associated with a total of 1.7 jobs across the state economy. By comparison, the statewide jobs multiplier for aerospace is 2.4, 3.2 for ship and boat building, and 4.7 for "Software Publishers, Data Processing & Internet Service Providers" (Washington State Office of Financial Management, 2022).

Exhibit 3. Boat Haven and the Flats Businesses Total Statewide Economic Impact, 2022

	Direct	Indirect	Induced	Total
Employment	1,080	190	570	1,840
Labor Income (mils $)	$51.8	$13.0	$31.1	$96.0
Output (mils $)	$117.3	$39.4	$94.0	$250.7

Sources: Washington State Office of Financial Management (2022); U.S. Bureau of Labor Statistics (2023); U.S. Bureau of Economic Analysis (2023).
Note (a): employment figures have been rounded to the nearest 10.
Note (b): in input-output modeling, gross revenues or sale are adjusted based on gross margins for retail and wholesale activities. This explains the difference between direct output presented in the table above and total gross sales reported in Exhibit 2.

The total economic impact of these operations in Jefferson County in 2022 summed to 1,490 jobs, $74.8 million in labor income, and $186.5 million in business output (**Exhibit 4**).

Exhibit 4. Boat Haven and the Flats Businesses Total Jefferson County Economic Impact, 2022

	Direct	Indirect	Induced	Total
Employment	1,080	120	290	1,490
Labor Income (mils $)	$51.8	$7.6	$15.4	$74.8
Output (mils $)	$117.3	$22.8	$46.4	$186.5

Sources: Washington State Office of Financial Management (2022); U.S. Bureau of Labor Statistics (2023); U.S. Bureau of Economic Analysis (2023).
Note (a): employment figures have been rounded to the nearest 10.
Note (b): in input-output modeling, gross revenues or sale are adjusted based on gross margins for retail and wholesale activities. This explains the difference between direct output presented in the table above and total gross sales reported in ***Exhibit 2****.*

Importance of Boat Haven and Linkages to Countywide Marine Trades

Boatyards and maintenance operations at the Port of Port Townsend belong to a countywide cluster of maritime trades activities. A report commissioned by the Port Townsend Marine Trades Association (2018) found that in 2018, boat building, maintenance, and repair activities directly supported an estimated 405 jobs and an additional 474 jobs through indirect and induced impacts. Backward linkages from boatyards include revenues and jobs supported among suppliers of materials, equipment, and other various inputs into boat construction and maintenance services. Some of these services exist at the Port of Port Townsend or in close proximity, such as Admiral Ship Supply, Marine Thrift, and Port Townsend Henery Hardware.

Boat Haven is also home to a strong, dynamic ecosystem of businesses and service providers. These businesses thrive on the presence of other similar operations and enjoy synergies and the positive externalities associated with cluster dynamics. For example, according to interviewees, businesses often share resources with one another, work with many of the same independent contractors specializing in specific aspects of construction and maintenance, utilize the same infrastructure systems. These firms regularly communicate with each other and share multigenerational skills in the marine trades.

Operations at Boat Haven represent roughly 25% of the countywide marine trades cluster. However, even boatyards five to ten miles away from Boat Haven depend on access to the travel lifts to haul and launch vessels. Any temporary pause in travel lift operations due to flooding, however brief, could thus impact marines trades businesses across the county.

Boat Haven boatyard at the Port of Port Townsend is internationally renowned. According to multiple interviewees, there is no boatyard anywhere on the West Coast that has the combined talent, capability, and facilities to provide maintenance and repair work on the vessels they work on, including for the fishing fleet, the recreational fleet, and wooden boat heritage fleet. According to one interviewee, the closest comparator is the

working marina in Belfast, Maine, but this is just one company, whereas Boat Haven is a collection of businesses. In Seattle, these skills are scattered, whereas Boat Haven is a consolidated one-stop shop for people who want their boat restored, repaired, and/or basic maintenance, and is recognized nationwide as such.

The importance of Boat Haven comes in the backdrop of greater pressures waterfronts throughout the Salish Sea. According to interviewees, there is growing pressure across the region to rezone and replace working waterfronts with more profitable non-industrial land uses, such as commercial real estate.

POTENTIAL IMPACT SCENARIOS

Types of disruptive impacts on local businesses

We spoke with businesses in the impacted study area to understand the potential costs from a future flood event, and how these costs could be avoided through the advent of a sea level rise mitigation project. The firms we spoke with are all in the boat manufacturing and maintenance sector. Interviewees primarily referred back to the 2019 king tide flooding event as a useful comparator for understanding the future economic costs of a major flooding event.

Interviewees pointed to the following vectors by which flooding could destabilize operations and create significant economic costs. These include:

Immediate damage from still water inside a shop floor

The presence of water would increase the risk of an electrical accident, especially for shops that use electrical devices. Water can also damage expensive shop floor equipment, such as computer numerical control (CNC) machines, and materials stacked on the floor.

Labor costs during temporary shutdown

During a temporary shutdown of operations due to flooding, businesses would still need to bear the cost of underemployed or redeployed workers, creating a "production gap." Some of the cleanup would be for removing fish and kelp that collect inside a building structure, as happened to at least one manufacturer during the 2019 king tide flood. According to one firm, the typical loaded cost per worker is $45 per hour. As a hypothetical example, with 30 employees, the "burn rate" for a full day of labor costs that are redeployed for cleanup and not for vessel construction or maintenance work would be 8 hours * 30 workers * $45/hour = $10,800. This does not include overhead costs, such as electricity and other inputs.

Delays in work and deliveries and the travel lift

Operating the travel lift is critical to boatyard businesses. However, a flooding event could render one or more travel lifts inoperable out of safety and maintenance concerns. A flood of between 6-12 inches of water could

compromise the integrity of the road surface along Washington Street, due to the large amount of fill used underneath the asphalt and roadway "slumping" from water inundation. Flooding also hides potential hazards that could damage the travel lift, such as debris and potholes. According to one interviewee, in the past a flooding event resulted in the travel lifts not operating for nearly an entire week, creating havoc for many businesses; a similar scenario could occur in the future with rising sea levels.

A pause in the operation of the travel lifts or business operations due to flooding would also potentially result in delayed completion of orders and reverberate in a backlog of projects, some of which may be subject to penalties and/or loss of future business. Boatyards operating in Boat Haven oftentimes have 12-18 vessels underwork at any given time. The inability to move completed vessels from the drydock facility back to a pier, clearing space for new clients, could aggravate project backlogs and potentially make businesses liable contract breach penalties. Repeated delayed project completions may also impair a firm's customer relations and competitiveness for new work.

Impacts to the marine trades ecosystem

Beyond the immediate impacts to individual businesses, the Boat Haven area is a maritime ecosystem that thrives on a confluence of skills and capabilities, businesses, and port infrastructure. The loss of one or more participants in this ecosystem could have detrimental impacts on the economic viability of remaining firms. For example, some firms we interviewed spoke of strong collaborative relationships between and amongst resident businesses, including sharing of resources and equipment. While these positive externalities or synergies within the local Boat Haven ecosystem are difficult to quantify or measure, they are nonetheless critical to the collective economic vitality of all resident firms.

Potential scenarios

The collective impact of these disruptions can be quite significant for local firms. For example, one business we spoke with disclosed that the 2019 king tide flood resulted in a production gap of $20,000, due to diversion of paid labor and overhead costs from boat construction and maintenance to clean up or other non-production tasks. This costs may be further aggravated by penalties due to delinquency in vessel project completions and deliveries. For example, according to one firm, penalties for delayed project completions can run up to $1,000 a day or $20,000 a week, depending on the vessel and contract.[2] Delays can also severely impact customers; scheduled maintenance work on a fishing vessel that cannot be completed on-time due

[2] Firms can, in some instances, argue for a force majeure event, i.e., an unprecedented, unforeseen event completely outside the agency of the company and which significantly hinders or precludes their ability to do work as planned. However, firms generally wish to avoid having to make this argument.

to flooding may result in the vessel owner entering late or completely missing a fishing derby or harvesting window.

Based on an estimated boatyard employment of 145 and an average loaded wage of $45 per hour, losses from diversion of workers away from revenue-generating activities would sum to $52,000 per day. If a more severe flood resulted in a five day halt to operations, the impact would be $261,000.

These estimates are purely hypothetical and intended to help illustrate the relative magnitude of operating costs associated with delays, but do not capture potential penalties and other costs from delayed and/or disrupted work and operations, nor potential repair costs.

APPENDIX

Appendix A. Summary of Data Sources

This report makes intensive use of multiple data sources. These include the following:

- Washington State Employment Security Department processed an aggregation of unified business identifier (UBI) codes for all businesses in the study area, reporting 2022 covered employment and wages (before benefits) for these businesses. Data aggregations were generated from the Quarterly Census of Employment and Wages and reported in total and by two-digit North American Classification System (NAICS) category.
- *The Washington State 2012 Input-Output Model*. Published by the Washington State Office of Financial Management (2022). The model is built to represent the intra- and inter-industry transactions and household consumption patterns in the Washington state economy. The most recent version of the model includes industry-specific price deflators through 2021.
- Washington State Department of Revenue *Gross Business Income data series*. The data series reports gross receipts by NAICS code for all businesses in Washington state.
- U.S. Bureau of Labor Statistics (2023) *Quarterly Census of Employment and Wages*, which reports covered employment estimates by NAICS code. Employment counts by industry were used to compute Jefferson County industry location quotients, which were then used to adjust the Washington State Input-Output Model to reflect Jefferson County intra- and inter-industry transaction patterns.
- *U.S. Bureau of Labor Statistics Longitudinal Employer-Household Dynamics* (U.S. Census Bureau, 2021) data series, which includes estimates commuting patterns across counties. This data was used to adjust induced impact estimates at the substate level for this analysis.

Appendix B. Input-Output Modeling Explanation

The Washington State Input-Output (I-O) Model was used to compute indirect and induced impact estimates in this report. The Washington State Input-Output Model is a modeled representation of the Washington state economy broken out into 52 industries and industry groupings, including production functions by industry, sales by industry, and sources of final demand by industry (personal consumption expenditures, investment, gross exports, government purchases).

Input-output modeling is a technical approach that estimates additional spillover effects of a modeled direct economic activity through two mechanisms: 1) upstream, supplier chain business-to-business transactions, referred to as "indirect" effects; and 2) the spending of employment-based income earned among workers in direct and indirect activities on household

goods and services, referred to as "induced." Together, the sum of direct, indirect, and induced impacts is referred to as the "total economic impact." All impacts are measured in jobs, labor income (wages & salaries plus supplemental benefits), and business output, or what is more commonly described as sales or revenues.

Input-output models are static models that measure a discrete single-period change in the economy, e.g., the increase or decrease in boatyard sales. The direct impact being modeled is called final demand, and may represent or be composed of household consumption, investment, exports, and government spending.

Statewide Impacts

Statewide economic impacts used total revenues, labor income (wage & salary outlays plus employer-provided benefits), employment headcounts, and estimated business expenses in Washington state as primary inputs.

Jefferson County Impact Estimates

To compute Jefferson County-level impacts, we adjusted the state I-O model through three steps: 1) calculation of location quotients for Jefferson County for each of the 52 I-O sectors and applied these to the direct requirements matrix within the model; 2) adjusted labor income inputted into the model to reflect only earnings for Jefferson County place-of-residence employees; and 3) use of commuting patterns data in the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (U.S. Census Bureau, 2021) data series to modify induced (household spending) impacts to reflect only those impacts retained within Jefferson County. (For example, adjusting for household spending by retail workers who live outside the county.)

Appendix C. Interviews

We corresponded with the following businesses and organizations for this project:

- Carrie Fiore, ACI Boats
- Carol Hasses, Port of Port Townsend Commissioner
- Blaise Holly, Haven Boatworks, LLC.
- Pam Petranek, Port of Port Townsend Commissioner
- Chris Sparks, Port of Port Townsend
- Peter Stein, Peter Stein Shipwrights
- Dave Thompson, Thompson Boat
- Anonymous, Port Townsend Shipwrights Co-op

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Appendix B

Design Water Level Analysis Memo

BLUE COAST ENGINEERING

TECHNICAL MEMORNADUM

Date:	March 22, 2024
To:	Andy Bennett, PE, KPFF
From:	Kathryn Ketteridge, PhD, PE, Greg Curtiss, PE, and Kyle List, PE
Project:	Port of Port Townsend, Waterwalk and Sea Level Rise Study
Subject:	Coastal Engineering Evaluation; Design Water Levels

1 Overview

This technical memorandum summarizes coastal engineering support provided by Blue Coast Engineering LLC (Blue Coast) for the KPFF team on the Port of Port Townsend (PoPT) Waterwalk and Sea Level Rise Study. The PoPT is planning to submit an application to FEMA for a Building Resilient Infrastructure and Communities (BRIC) grant to improve flood protection along a 1.4-mile stretch of shoreline that stretches from Water Street west through the Boat Haven Marina area to the Larry Scott Trail (see Figure 1). Blue Coast, in support of the grant application cost benefit analysis, evaluated design water levels along the project shoreline and provided input to the design team on the development of shoreline protection/flood protection concepts.



Figure 1. Site Location Map

2 Design Standards

Design standards and guidance documents used to develop conceptual level design criteria at the Project site are listed below:

- Coastal Engineering Manual (CEM) (USACE 2006)
- EurOtop Manual on wave overtopping of sea defences and related structures (EurOtop 2018).
- Extreme Coastal Water Level in Washington State: Guidelines to Support Sea Level Rise Planning. (Raymond et al. 2020)
- Projected Sea Level Rise for Washington State – A 2018 Assessment (Miller et al. 2018)

3 Site Topography and Bathymetry

Topo-bathymetric elevation data were acquired from NOAA Digital Coast. The 1887-2017 USGS CoNED Topobathy DEM (Compiled 2020): Puget Sound, WA was downloaded and imported to GIS. To reduce overall file size and increase processing efficiency, a subset of the full DEM extents was extracted for the model domain. A review of the data was conducted by visual examination of the plan and profile views of the elevation model. During this examination, an approximately 100′ wide band of abrupt and consistent change in slope and elevation at the estimated interface of the topo-bathymetry data was identified and determined to be an artifact of the topo-bathymetry data creation/mosaic process. To correct this effect, the data were smoothed by extracting the portion of affected DEM and replacing it with elevations interpolated from opposite edges of removed area. Following the interpolation smoothing, data were resampled and exported to points at a 5′ x 5′ raster resolution and a 10′ x 10′ raster resolution for use along the nearshore/upland area and offshore areas, respectively.

4 Tides, Storm Surge and Sea Level Rise (SLR)

Water levels in Puget Sound are influenced by astronomical tides (mixed semi-diurnal), localized, short-term fluctuations due to meteorological conditions (storm surge), and long-term changes in mean sea level resulting from climatic variation and vertical land motion. This section documents the following to help understand the frequency and level of inundation along the shoreline at the project site under existing conditions and for various sea level rise scenarios:

- Site tidal datums and extreme water levels, including coastal flood mapping and storm surge estimates (excluding wave run-up).
- Frequency analysis for predicted tides at the site.
- Projections for sea level rise (SLR).

4.1 Tides and Observed Water Levels

Characteristic tidal datum elevations are available from the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) water level station at the ferry dock in Port Townsend (#9448576) for the 1983 to 2001 tidal epoch (Table 1). The station is located at 48° 6.7′ N and 122° 45.6′ W, approximately 0.5 miles east of the eastern extent of the project shoreline. Hourly water level data are available for 1979 through present (2023) and 6-minute water level data are

available for 1996 through present (2023). Mean higher high water (MHHW) at Port Townsend is 7.4 feet NAVD88 and the Highest Astronomical Tide (HAT, highest predicted tide over two tidal epochs or 40 years) is 8.9 feet NAVD88.

A NOAA-NOS analysis of the water level record at the Port Townsend water level station #9497130 (the nearest long-term station) provides extreme water levels relative to the 1983 to 2001 epoch with projections to 2018 based on the linear historic trend in mean sea level (NOAA-NOS 2020). The extreme water levels (1-year, 2-year, 50-year, and 100-year return interval) based on the analysis are provided in Table 1. The extreme water levels presented in Table 1 include fluctuations due to astronomical tide, storm surge, wind and wave setup, but do not include wave run-up. The 1-year water level, which has a 100% chance of occurrence in 1 year, is 8.8 feet NAVD88 while the 100-year water level is 10.8 feet NAVD88.

Table 1. Summary of water level elevations at Port Townsend (NOAA NOS station #944490).

Datum / Elevation	Elevation (feet MLLW)	Elevation (feet NAVD88)[2]
FEMA BFE (1% AEP)[1]	13.1-18.1	Varies from 12 to 17
FEMA Stillwater elevation (1% AEP)	12.6	11.5
December 27, 2022 observed[2]	12	10.9
January 7, 2022 observed[2]	11.4	10.4
100-year water level (1% AEP)[3]	11.9	10.8
10-year water level (10% AEP)[3]	11.5	10.4
2-year water level (50% AEP)[3]	10.9	9.8
1-year water level (99% AEP)[3]	9.9	8.8
Highest Astronomical Tide (HAT)[4]	10.0	8.9
High Tide Line[4]	9.8	8.7
Mean Higher High Water (MHHW)[4]	8.5	7.4
Mean High Water (MHW)	7.8	6.8
Mean Tide Level (MTL)	5.2	4.1
Mean Sea Level (MSL)	5.0	3.9
Mean Low Water (MLW)	2.5	1.4
Mean Lower Low Water (MLLW)	0	-1.1

Notes: Conversion to NAVD88 from NOAA VDatum online tool for the project site.

1. Total water level including wave run-up
2. Verified 6-minute water level from NOAA-NOS station #944490
3. NOAA-NOS extreme water level trend analysis for 2018
4. Average of highest annual predicted tide elevations at Port Townsend from 2024 to 2034 (10 years)

A frequency analysis was completed for the Port Townsend hourly water level observations. Frequency of occurrence and percent exceedance curves were calculated for the dataset using 1-foot elevation bin sizes. After binning the data records into 1-foot bins, the frequency distribution and percentiles were determined in order to calculate frequency of occurrence and percent exceedance curves of water levels at the project site (Figure 2, Table 2).

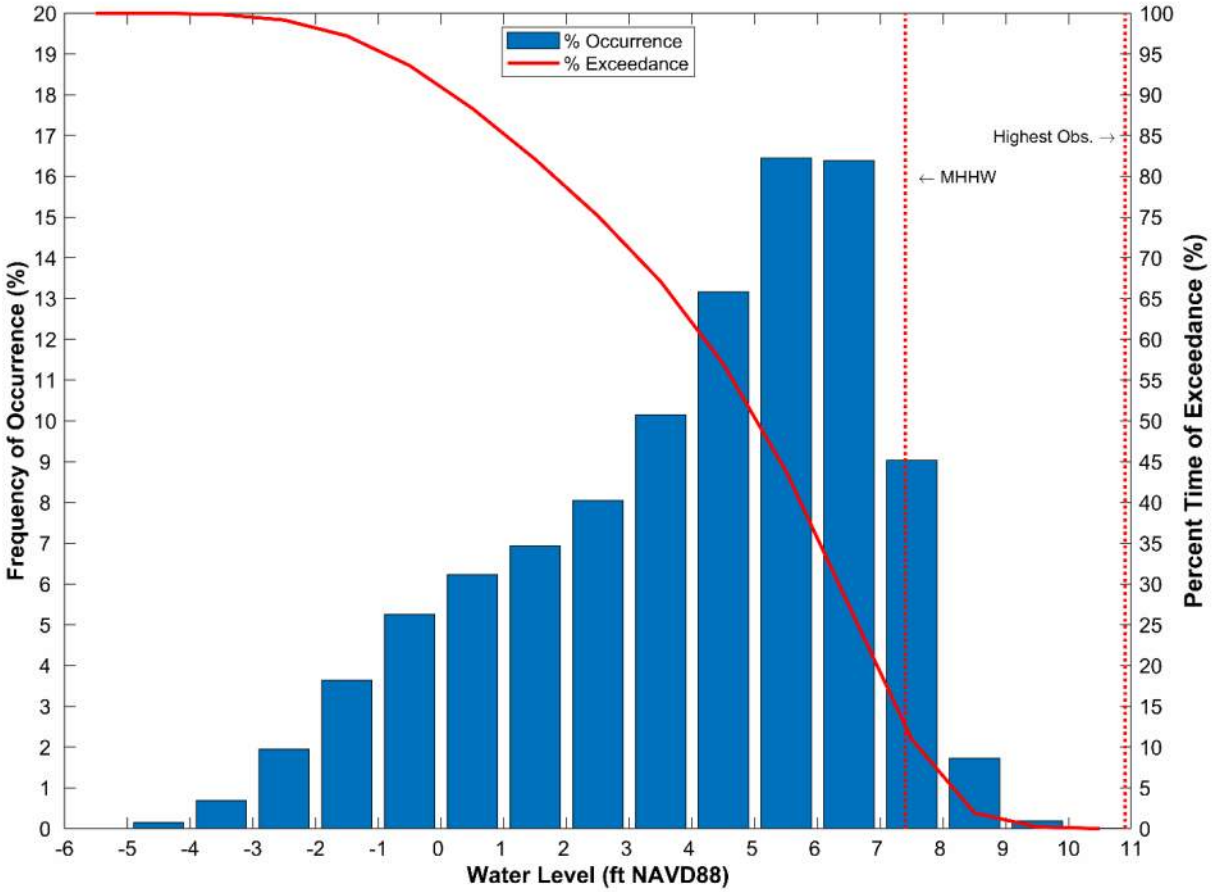


Figure 2. Frequency of occurrence histogram and percent exceedance curve for Port Townsend hourly water level observations (NOAA-NOS station #944490, 1979 to 2023).

Table 2. Frequency of occurrence and percent exceedance statistics for Port Townsend hourly water level observations (NOAA-NOS station #944490, 1979 to 2023).

1-foot bin elevation range (feet MLLW)	Percent Time of Exceedance (%)[1]	Frequency of Occurrence (%)
-6 to -5	100.00	0.0
-5 to -4	99.99	0.1
-4 to -3	99.84	0.7
-3 to -2	99.16	1.9
-2 to -1	97.21	3.6
-1 to 0	93.56	5.3
0 to 1	88.31	6.2
1 to 2	82.08	6.9
2 to 3	75.14	8.0

1-foot bin elevation range (feet MLLW)	Percent Time of Exceedance (%)[1]	Frequency of Occurrence (%)
3 to 4	67.09	10.1
4 to 5	56.95	13.2
5 to 6	43.78	16.4
6 to 7	27.34	16.4
7 to 8	10.96	9.0
8 to 9	1.92	1.7
9 to 10	0.19	0.2
10 to 11	0.01	0.0

Notes: 1. Exceedance is calculated based on lower bin range;

4.2 Coastal Flood Mapping

The Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP) provide Flood Insurance Rate Maps (FIRM) for Jefferson County which includes the project site and are based on the Flood Insurance Study (FIS) for Jefferson County (FEMA 2019c). The FIRM maps (FEMA 2019a; 2019b) show special flood hazard zones characterized by the Base Flood Elevation (BFE) and provide the level of risk for flooding for that zone. The BFE is a total water elevation which is the sum of the stillwater level and wave run-up. FEMA (2019c) reports the 100-year stillwater level for coastal transects along Port Townsend Bay to be 11.5 feet NAVD88 (Table 1) based on water leveling modeling. This is higher (more conservative) than the 100-year water level for Port Townsend reported by NOAA (10.8 feet NAVD88) and the highest observed water levels at the water level station (since 1979).

The FIRMs locate the project site across several coastal BFE zones (Figure 3). The BFE zones range from Zone AE 12 to 13 (NAVD88) across the eastern portion of the shoreline including the marina to Zone VE 17 (NAVD88) along the western portion of the shoreline waterward of the trail. VE zones are considered higher energy zones where wave energy is large enough to cause structural damage, whereas AE zones are more sheltered, gradually sloping shorelines which do not meet the VE velocity zone criteria.

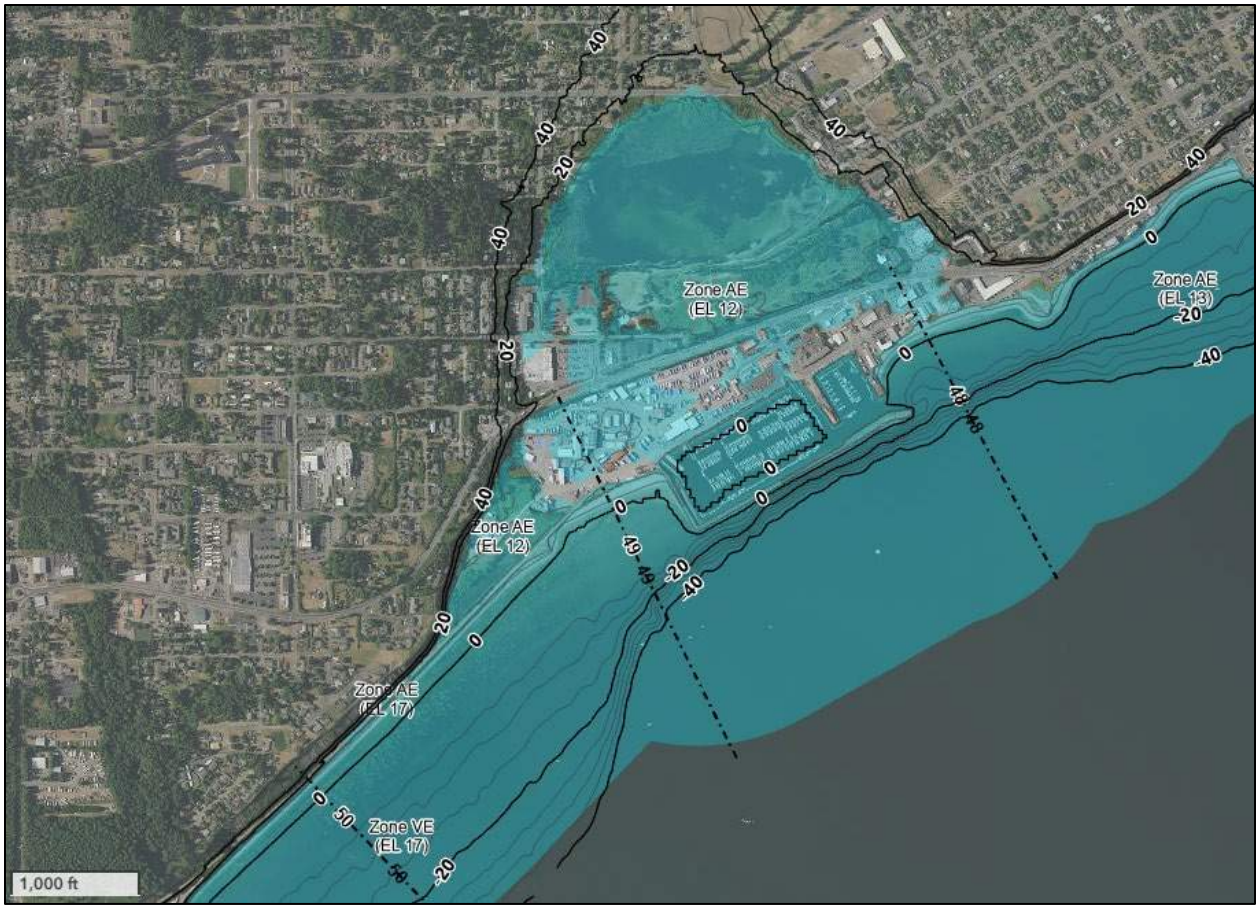


Figure 3. FEMA FIRM for project area.

4.3 Storm surge

Localized, short-term fluctuations in water level from the predicted tide due to meteorological conditions is known as storm surge. Storm surge at the site was estimated by finding the difference (or residual) between the 6-minute verified water levels at the Port Townsend water level station (#944490) and the 6-minute tidal predictions for 1996 to 2023. This non-tidal portion of a water level observation is generated by winds and low pressure, and therefore is not included in the tidal prediction data. Individual storm surge events were identified in the time series by performing a peaks-over-threshold (POT) analysis (Goda 1988) to extract storm surge values exceeding 2 feet for a minimum of 2 hours. This resulted in 34 events with a maximum observed storm surge since 1979 of 2.8 feet (on January 1, 1997). An extreme value analysis of the storm surge record was completed to fit the events to a Weibull extreme value probability distribution for (Figure 4, Table 3). The 100-year return interval storm surge is estimated to be 2.9 feet. This is consistent with estimates from other estimate of storm surge for Port Townsend and Puget Sound:

- 100-year storm surge: 3.1 feet (Petersen et al. 2015).
- Average maximum storm surge for Puget Sound: 2.5 to 3 feet (Miller et al. 2019).

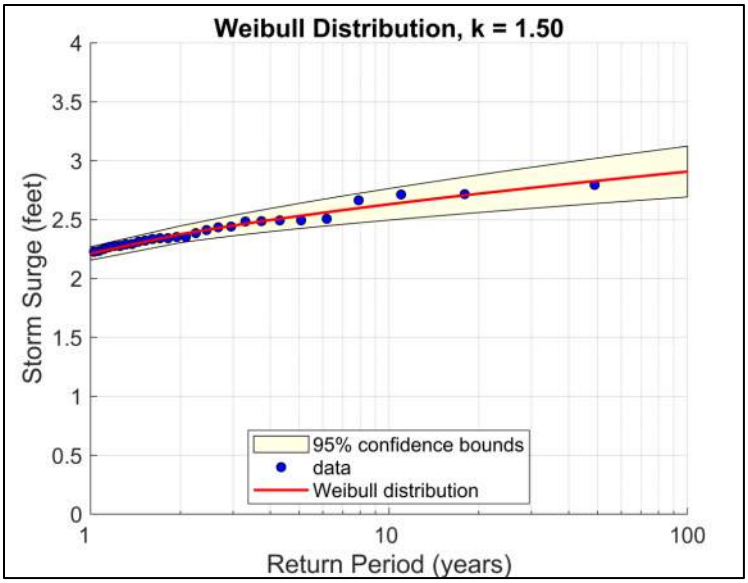


Figure 4. Extreme value distribution curve for the Port Townsend water level station storm surge record (NOAA-NOS station #944490, 1996 to 2023).

Table 3. Extreme value storm surge events the Port Townsend water level station.

Return Interval (years)	Storm Surge (feet)	95% Confidence Interval (feet)		
1	2.2	2.2	to	2.3
2	2.4	2.3	to	2.4
5	2.5	2.4	to	2.6
10	2.6	2.5	to	2.8
25	2.7	2.6	to	2.9
50	2.8	2.6	to	3.0
100	2.9	2.7	to	3.1

4.4 Sea Level Rise

Long-term mean sea level in Puget Sound has increased over the past century and is predicted to increase versus historical rates of SLR because of climate change related impacts. NOAA-NOS analyzed relative sea level trends at the Port Townsend water level station for the record from 1979 to 2022 and calculated a rate of change of 0.6 feet in 100 years, or 0.3 feet in the last 50 years[1] (1.75 mm/year).

Miller et al. (2018) provides projections of relative SLR at coastal locations in Puget Sound and Washington for various planning horizons. The Puget Sound projections are based on global SLR projections for low and high greenhouse gas scenarios known as Representative Concentration

[1] https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=9444900

Pathways (RCP) 4.5 and RCP 8.5, respectively. These were defined by the Intergovernmental Panel on Climate Change (IPCC) Working Groups I and II.

The most recent update from Working Group III of the IPCC (2023) more narrowly defines the greenhouse gas scenarios from Very Low (limit warming to 1.5°C) to Very High (exceed warming of 4°C). The earlier RCP 4.5 and RCP 8.5 scenarios are equivalent to the Intermediate and Very High scenarios, respectively (Figure 5). The Intermediate (RCP 4.5) scenario assumes GHG emissions remain around the current levels through the middle of the century whereas the Very High scenario (RCP 8.5) assumes a doubling of emissions by 2050.

Category in WGIII	Category description	GHG emissions scenarios (SSPx-y*) in WGI & WGII	RCPy** in WGI & WGII
C1	limit warming to 1.5°C (>50%) with no or limited overshoot***	Very low (SSP1-1.9)	
C2	return warming to 1.5°C (>50%) after a high overshoot***		
C3	limit warming to 2°C (>67%)	Low (SSP1-2.6)	RCP2.6
C4	limit warming to 2°C (>50%)		
C5	limit warming to 2.5°C (>50%)		
C6	limit warming to 3°C (>50%)	Intermediate (SSP2-4.5)	RCP 4.5
C7	limit warming to 4°C (>50%)	High (SSP3-7.0)	
C8	exceed warming of 4°C (>50%)	Very high (SSP5-8.5)	RCP 8.5

Figure 5. Summary of greenhouse gas emissions scenarios (from IPCC 2023)

There is considerable uncertainty in the SLR predictions because of the many unknowns related to future socioeconomic development assumptions as well as climate policies. As can be expected, the uncertainty increases with time from the present day. A comparison of the median estimates for RCP 4.5 and RCP 8.5 is provided in Figure 6. There is little difference between the two scenarios up to 2050 when they begin to diverge. At year 2100, there is a difference between the two of 0.4 feet (Table 4). For shoreline protection planning purposes, Blue Coast recommends using the median (50% exceedance probability) estimates for SLR provided by Miller et al. (2018) for the RCP 8.5 greenhouse gas scenario. The median value is recommended by the Washington Climate Impacts group (Raymond et al. 2020) for users who want the most likely future values and are not particularly risk-averse or risk-tolerant. In addition, it is reasonable to use the more conservative greenhouse gas scenario for shoreline protection planning given the difference between the two at 2100 is only 0.4 feet and sea levels are likely to continue rising beyond 2100 (Figure 6).

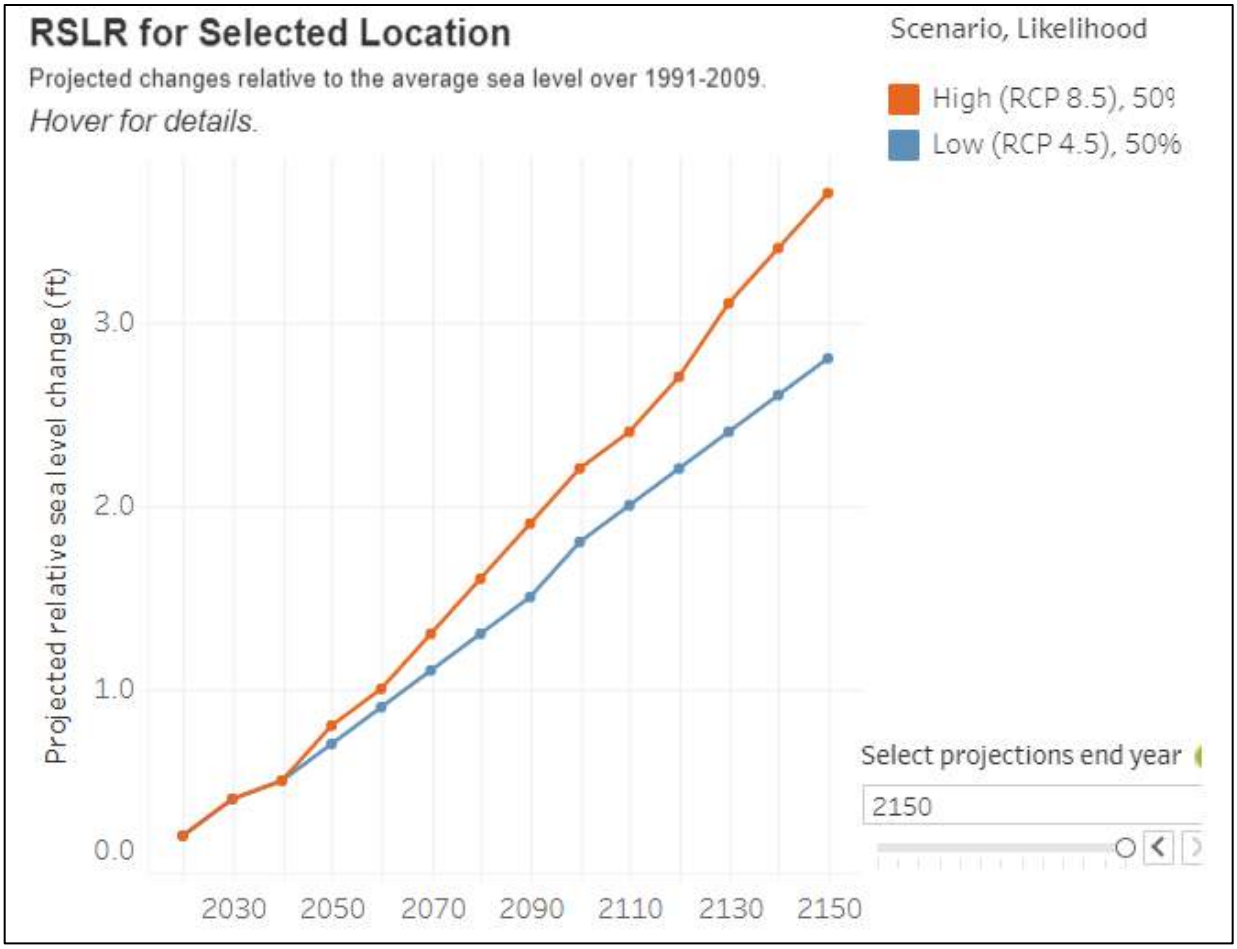


Figure 6. Projected median sea level rise for the coastal area in the vicinity of Port Townsend for RCP 4.5 and RCP 8.5 (Miller et al. 2018), 2020 to 2150.

Table 4. Projected median sea level rise for different time horizons and greenhouse gas scenarios for the coastal area near Port Townsend relative to average sea level over 1991-2009.

Year	Greenhouse Gas Scenario	Sea level rise magnitude (feet), central estimate (50% probability exceedance)
2050	Low (RCP 4.5)	0.7
2050	High (RCP 8.5)	0.8
2080	Low (RCP 4.5)	1.3
2080	High (RCP 8.5)	1.6
2100	Low (RCP 4.5)	1.8
2100	High (RCP 8.5)	2.2

Notes: Estimates from Miller et al. (2018)

5 Wave Modeling

Understanding how waves transform from offshore, interact with the bathymetry in Puget Sound, and how they impact the shoreline is a critical part of quantifying the potential for coastal flooding. Numerical wave modeling was used to predict the wave conditions along the PoPT project shoreline. The following sections describe the model development and scenarios used to estimate wave parameters along the shoreline, as well as the results used in this evaluation.

5.1 Model Development

The model Delft3D-WAVE, based on the SWAN modeling framework, was used to predict the phase-averaged significant wave height and direction within Puget Sound and Port Townsend Bay. The southeast facing shoreline of the PoPT shoreline is susceptible to strong southerly and westerly winds. The model was developed with two computational grids: a coarse grid covering Puget Sound from Admiralty Inlet to the Straight of Juan de Fuca and a nested nearfield grid covering Port Townsend Bay. Bathymetry for the model is based on the USGS CoNED regional digital elevation model for Puget Sound (See Section 3).

The PoPT marina breakwater was added into the model geometry as an earthen-dam type feature. The breakwater effectively blocks all wave energy from the south and the crest height is high enough to prevent stillwater overtopping. Although generally very small, the local formation of wind-generated waves within the marina were also predicted using the model.

5.2 Wind Conditions

The longest fetch is from the South along the length of Port Townsend Bay (approximately 5 miles). Historical wind data from 2009 to current were analyzed from the Port Townsend NOAA Station #9444900). The data used for this study are 6-minute interval data of sustained wind speed and direction. The data were processed with extremal statistics to determine the 2- through 250-year return interval wind speeds in this region of Puget Sound. The predicted wave results from the model for the 100-year wind speeds from the southerly direction were used for the design water levels as described in Section 5.

5.3 Model Scenarios

Table 5 below summarizes the wind-generated wave event scenarios that were evaluated as part of this study. Scenarios were completed for HAT and HAT plus SLR to model a range of possible high water levels when wave heights at the shoreline will be at a maximum (over the range of conditions considered).

Table 5. Wave model results for HAT (8.9′ NAVD88), 100-year wind from south.

Wave Model Scenario	Water Level (ft NAVD88)	Wind Speed (mph)	Wind Direction[1]
#1 - HAT, 2-year Wind from S	8.9	46.8	180
#2 - HAT, 10-year Wind from S	8.9	51.1	180
#3 - HAT, 50-year Wind from S	8.9	55.8	180

Wave Model Scenario	Water Level (ft NAVD88)	Wind Speed (mph)	Wind Direction[1]
#4 - HAT, 100-year Wind from S	8.9	57.7	180
#5 - HAT, 250-year Wind from S	8.9	60.1	180
#6 - HAT+2.2 ft SLR, 10-year Wind from S	11.1	51.1	180
#7 - HAT+2.2 ft SLR, 100-year Wind from S	11.1	57.7	180

Note:
1. Wind direction refers to the wind "blowing from" convention in degrees clockwise from North.

5.4 Model Results

Figure 7 shows the model-predicted significant wave heights (color shading) and mean wave directions (vector arrows) for scenario #4 (see Table 5) with HAT tidal conditions and the 100-year southerly wind speed. Figure 8 shows the model-predicted significant wave height and mean wave direction for scenario #7 with HAT and SLR, combined with the 100-year wind speed from the South. The figures also show the location of cross-shore sections A through E, where wave heights and periods were extracted from the model and used to calculate wave run-up and overtopping (Section 6).

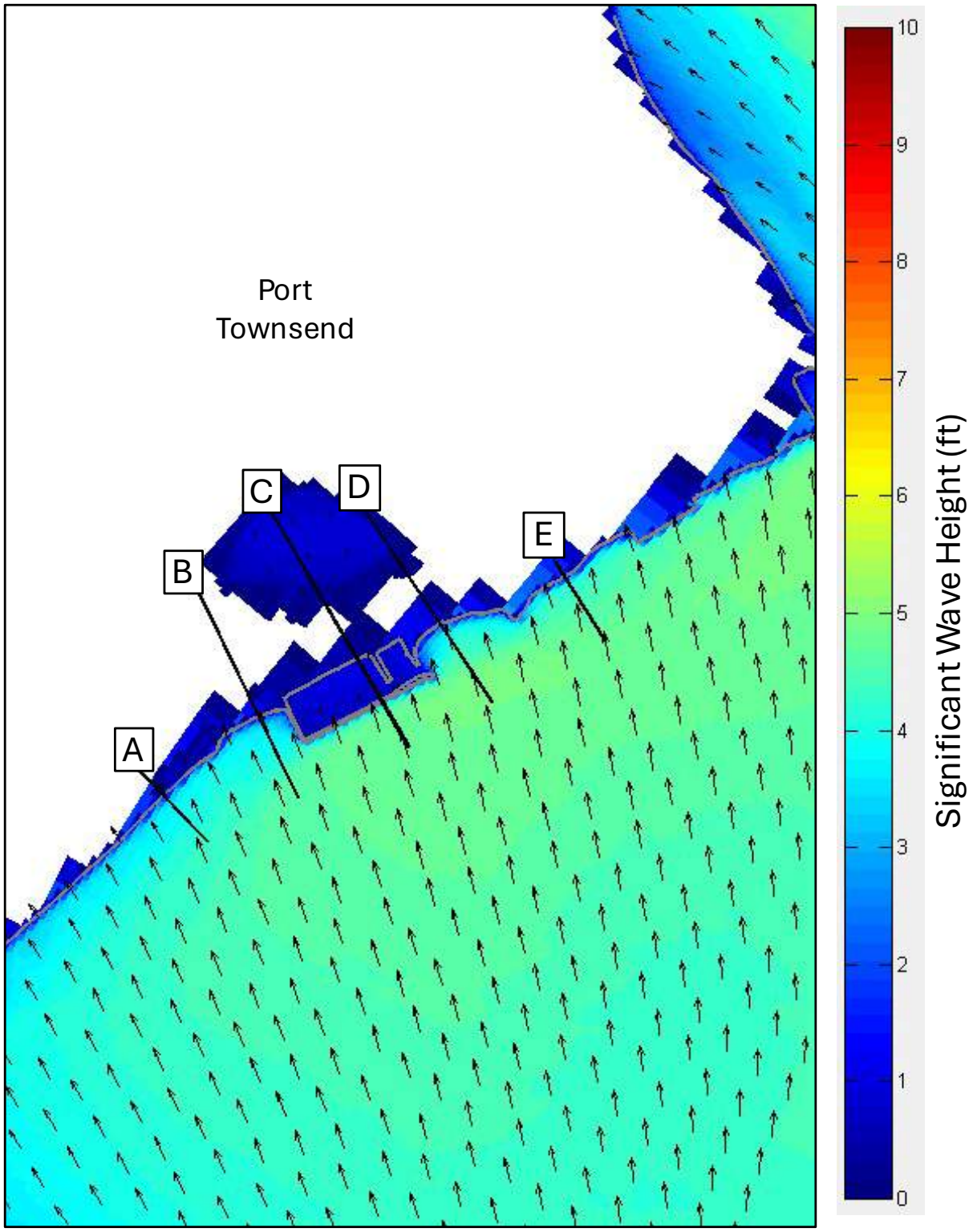


Figure 7. Wave model results for Scenario 4 - HAT (8.9' NAVD88), 100-year wind from South.

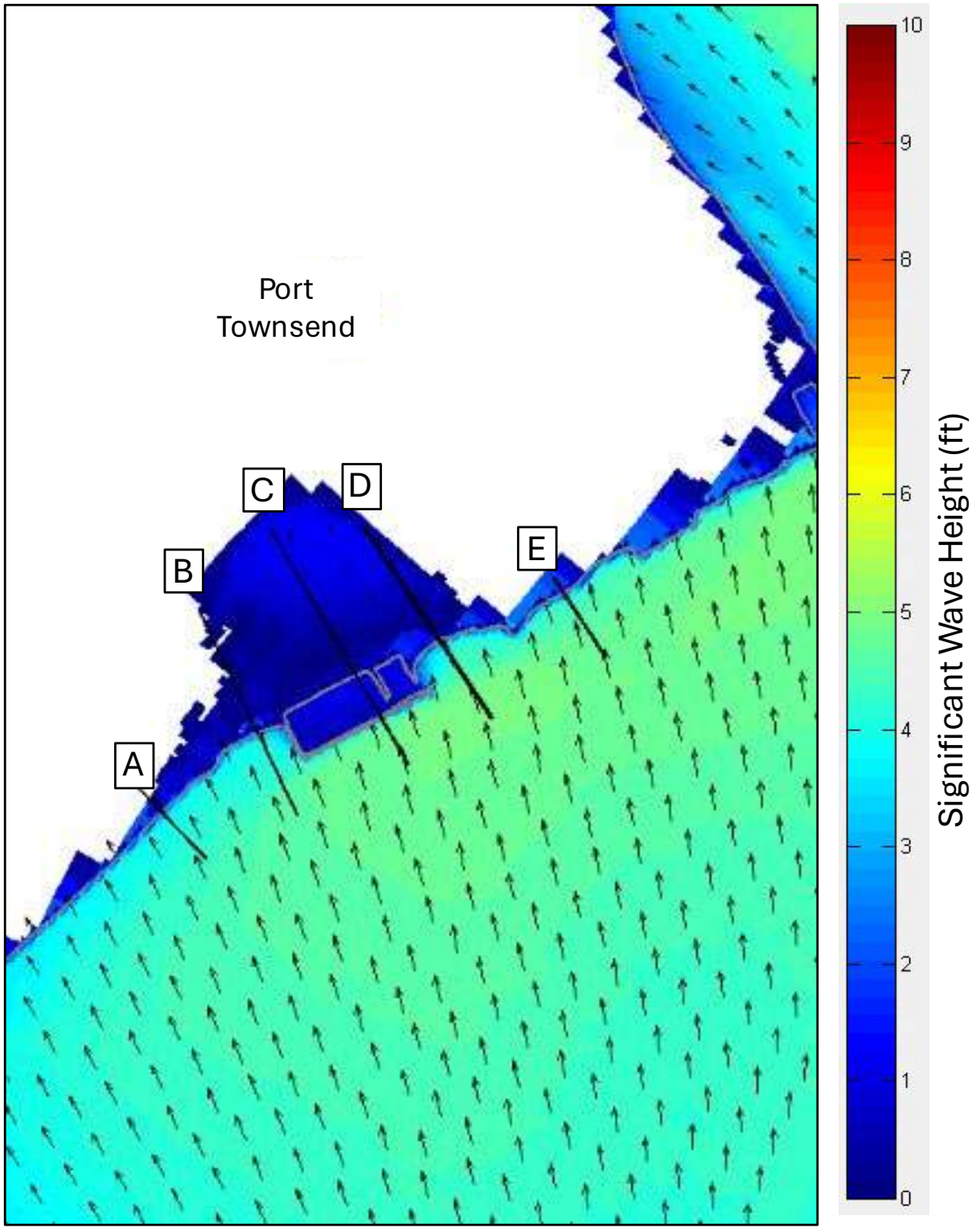


Figure 8. Wave model results for Scenario 7 - HAT (8.9' NAVD88) plus SLR (2.2 ft), 100-year wind from South.

Predicted significant wave height and wave period were extracted along each transect and are summarized in Tables 6 and 7. These wave heights represent the wave climate prior to wave breaking

on the shoreline, which is required for calculations of wave run-up and overtopping (Section 5). Predicted wave heights (apart from within the sheltered area of the marina) for scenario 4 ranged between 3.7 and 4.3 feet with a period of 3.8 seconds. SLR conditions result in deeper water depths in the nearshore (scenario 7), resulting in slightly higher predicted wave heights (between 3.9 and 4.4 feet). Wave heights predicted for the areas inside the marina were 1.1 feet with a period of 1.5 seconds based on localized wind-wave generation within the sheltered marina.

Table 6. Wave model results for HAT (8.9' NAVD88), 100-year wind from south.

Transect	Wave Height (Hs)	Wave Period (Tp)
A	3.7	3.7
B	3.6	3.8
C (inside marina)	1.1	1.5
D	4.1	3.8
E	4.3	3.8

Table 7. Wave model results for HAT+2.2 ft surge (11.1' NAVD88), 100-year wind from south.

Transect	Wave Height (Hs)	Wave Period (Tp)
A	3.9	3.7
B	4.0	3.8
C (inside marina)	1.1	1.5
D	4.2	3.8
E	4.4	3.8

6 Design Water Levels

Information developed in Sections 3 through 5 related to tides, storm surge, storm waves, wave run-up, and sea level rise was used to develop design water levels and crest elevations for the proposed Waterwalk.

6.1 Design Concepts

For the purpose of evaluating conceptual flood protection measures within the FEMA cost benefit analysis grant framework the shoreline was divided into six distinct lengths of shoreline for evaluation of design criteria for the Waterwalk (wave run-up, overtopping, and total water level). The six shoreline lengths also correspond to the transects where wave parameters were extracted from the wave modeling (Section 5). The shoreline lengths are show in Figure 9 and are described briefly as follows:

A. Larry Scott Trail from bluff to trail mile 0;

B. Low-sloped beach between end of Larry Scott Trail and marina, waterward of the wash pad;

C1. Western half of marina upland (driveway);

C2. Eastern half of marina upland (parking lot)

D. Aladdin Inn to Indian Point;

E. Indian Point to eastern terminus at Water St.



Figure 9. Site map showing location of transects for evaluation of wave run-up, overtopping and total water level.

6.2 Wave Run-up, Overtopping, and Total Water Level

Coincidence of high water levels and storm-induced wind-waves can result in flooding along the shoreline. Wave run-up and overtopping were evaluated for the six shoreline lengths to inform the minimum crest elevation of flood protection structures based on the total water level (TWL). TWL is the summation of still water level (SWL) and wave run-up. Wave overtopping is the average volume of water discharged over the crest of a structure and is an important consideration in structure safety and the safety of traffic (pedestrian and vehicular) behind a structure.

For this analysis two SWL scenarios were evaluated, one extreme and one more typical of annual "king"[2] tide events:

- Extreme case, exceeds 100-year water level: **12.6 feet NAVD88**
    - Highest Astronomical Tide (HAT), 8.9 feet NAVD88;
    - 1-year storm surge (2.2 feet);

[2] A king tide is a popular, non-scientific term people often use to describe exceptionally high tides

    - SLR in 50 years (2075), Very High (RCP 8.5) emissions scenario (1.5 feet).

- "King tide" case, annual event: **10.4 feet NAVD88**:
    - HAT, 8.9 feet;
    - No storm surge;
    - SLR in 50 years (2075), Very High (RCP 8.5) emissions scenario (1.5 feet).

Wave run-up and overtopping were evaluated based on an assumed generalized structure type for each shoreline length, either a vertical wall or a sloped structure (revetment or berm) with a 2.5H:1V (horizontal to vertical) slope. Wave run-up and overtopping calculations were derived from the EurOtop (2018) manual on wave overtopping of sea defenses and related structures. EurOtop equations are empirically derived based on a wide range of data (university research and government agencies). Design criteria for wave run-up and overtopping were set as follows:

- Minimum freeboard[3] (calculated from SWL), extreme case: 1.0 feet;
- Minimum freeboard (calculated from SWL) "king' tide case: 2.0 feet;
- Allowable overtopping rate;
    - Vertical structure (sections C1 and C2): 1 liter per second per meter (l/s/m);
    - Sloped revetment (sections A, B, D, & E): 50 l/s/m.

The allowable overtopping rates are based on guidance from EurOtop (2018) and from the CEM (USACE 2006). EurOtop recommends that for urban defenses with buildings immediately shoreward of the shoreline protection a mean wave overtopping discharge of 1 l/s/m should be used. This is applied to the shoreline within the marina area where the shoreline protection was assumed to be a vertical structure with infrastructure immediately landward of it and a lower tolerance for flooding due to the businesses located here.

A higher threshold, recommended by the CEM for the start of damage to revetments of 50/l/s/m (Table VI-5-6) is used for the shoreline protection outside of the marina. These shorelines are generally gentler sloping beaches or a composite slope (beach + rock armoring). For the trail cross-section (A) a crest width reduction factor was included to account for the reduction in overtopping due to the width of the armor and trail.

The allowable overtopping rates are based on structural safety. Stricter allowable overtopping rates are recommended in the design guidance for pedestrian safety. These were not applied as the goal of the evaluation at this design and planning stage was to optimize the elevation of the wall height to avoid flooding and it is a reasonable assumption that the Waterwalk will be closed to pedestrian and vehicle traffic during extreme events.

Based on the wave run-up and overtopping analysis, total water levels and recommended minimum structure crest elevations were developed for the six lengths of shoreline along the project shoreline (Tables 8 and 9). Structure crest elevations range from 13.5 feet NAVD88 at the west end of the project

[3] Vertical distance from the SWL to the structure crest elevation.

to 15.0 feet NAVD88 at the eastern end of the project. Crest elevations are consistent with larger wave exposure from west to east.

Table 8. Design total water level scenarios for Port Townsend (Extreme water level)

Shoreline Length / Wave Transect	Structure Slope[1]	100-year wave height and period	Total water level (feet NAVD88)	$R_{2\%}$	Total water level (feet NAVD88)	Overtopping (l/s/m)	Structure Crest Elevation (feet NAVD88)	Freeboard (feet above SWL)
A	2.5H:1V	3.9 ft / 3.7 s	12.6	5.3	17.9	52	13.5	1.0
B	2.5H:1V	4 ft / 3.8 s	12.6	5.5	18.1	45.0	14.5	2.0
C1	vertical	1.1 ft / 1.5 s	12.6	1.1	13.7	1.0	14.0	1.5
C2	vertical	1.1 ft / 1.5 s	12.6	1.1	12.6	N/A	13.5[2]	1.0
D	2.5H:1V	4.2 ft / 3.8 s	12.6	5.7	18.3	28.0	15.0	2.5
E	2.5H:1V	4.3 ft / 3.8 s	12.6	5.7	18.3	29.0	15.0	2.5

Notes: l/s/m = liter per second per meter of structure; N/A = not applicable;

1. Structure slope is based a conceptual Waterwalk structure in this location and is subject to change in later phases of design.
2. Crest elevation is lower for C2 because flood protection is setback from vertical wall of marina along the landward side of the parking lot.

Table 9. Design total water level scenarios for Port Townsend ("king" tide water level)

Shoreline Length / Wave Transect	Structure Slope	100-year wave height and period	Total water level (feet NAVD88)	$R_{2\%}$	Total water level (feet NAVD88)	Overtopping (l/s/m)	Structure Crest Elevation (feet NAVD88)	Freeboard (feet above SWL)
A	2.5H:1V	3.7 ft / 3.7 s	10.4	5.2	15.6	<1	13.5	3.0
B	2.5H:1V	3.6 ft / 3.8 s	10.4	5.2	15.6	2.0	14.5	4.0
C1	vertical	1.1 ft / 1.5 s	10.4	1.1	11.5	<1	14.0	3.5
C2	vertical	1.1 ft / 1.5 s	10.4	1.1	10.4	N/A	13.5[2]	2.0

Shoreline Length / Wave Transect	Structure Slope	100-year wave height and period	Total water level (feet NAVD88)	$R_{2\%}$	Total water level (feet NAVD88)	Overtopping (l/s/m)	Structure Crest Elevation (feet NAVD88)	Freeboard (feet above SWL)
D	2.5H:1V	4.1 ft / 3.8 s	10.4	5.6	16.0	1.0	15.0	4.5
E	2.5H:1V	4.3 ft / 3.8 s	10.4	5.7	16.1	2.0	15.0	4.5

Notes: l/s/m = liter per second per meter of structure

1. Crest elevation is lower for C2 because flood protection is setback from vertical wall of marina along the landward side of the parking lot.

7 Limitations

The structure crest elevations presented in this technical memorandum are based on conceptual options and coarse assessment using six typical transects with generalized slopes and toe elevations and are subject to change in future phases of design.

The typical sections are applied across a 1.4-mile stretch of shoreline which has significant variability within and across each shoreline length. The slopes and elevations of the existing ground are based on publicly available LiDAR data and not on a detailed topographic survey (which is not currently available).

The crest elevations were developed only for the purpose of providing input in support of the FEMA BRIC grant application cost benefit analysis and should not be used for engineering design without further refinement.

8 Closure

This document has been prepared by Blue Coast Engineering LLC. in accordance with generally accepted engineering practices and is intended for specific application to the Port of Port Townsend in Port Townsend, WA. The contents of this document are not to be relied upon or used, in whole or in part, by or for the benefit of others without specific written authorization from Blue Coast Engineering LLC. No other warranty, expressed or implied, is made. Blue Coast Engineering LLC. and its officers, directors, employees, and agents assume no responsibility for the reliance upon this document or any of its contents by any parties other than the KPFF and the Port of Port Townsend in Port Townsend, WA. The information in this document is to be used for planning purposes and is not intended for design or construction.

9 References

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Appendix C1

Flood Protection Improvements Alignment and Typical Sections

NOTES

1. SURFACE PROFILE REFERENCES:
   a. TOPOGRAPHIC MAPPING COMPLETED BY KENNEDY JENKS CONSULTANTS, INC DATED MARCH 13, 2023
   b. TOPOGRAPHIC SURVEY FOR WESTERN BOAT YARD EXPANSION PROJECT COMPLETED BY REID MIDDLETON DATED JANUARY 24, 2023
   c. LIDAR DATA DOWNLOADED FROM WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES GIS OPEN DATA
2. HIGH TIDE LINE ELEVATION CALCULATED AS MATHEMATICAL AVERAGE OF THE PREDICTED HIGHEST ASTRONOMICAL TIDE ELEVATIONS (AT NOAA STATION 9444900, PORT TOWNSEND WA) FOR THE NEXT 10 YEARS.
3. SCE = SUGGESTED CREST ELEVATION

DRAFT



LEGEND

- STANDARD SECTION 1
- STANDARD SECTION 2
- STANDARD SECTION 3
- TRANSITION AREA
- SECTION CALLOUT (X / SHTX)
- HIGH TIDE LINE, ELEV = 8.7' (NAVD88), SEE NOTE 2

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PORT OF PORT TOWNSEND
WATERWALK AND SEA LEVEL RISE
PRELIMINARY STANDARD SECTIONS

DATE: 2024-03-29	SCALE: 1' = 250'
DRAWN BY: NJM	SHT 1 OF 8

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X:\2023\10042300514 Port Townsend Waterwalk & Sea Level Rise\6.01 Drawings\Exhibits\2024-02-09 Preliminary Standard Sections\POPT Waterwalk and SLR - Preliminary Standard

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LEGEND

STANDARD SECTION 3	STANDARD SECTION 9
STANDARD SECTION 4	STANDARD SECTION 10
STANDARD SECTION 5	STANDARD SECTION 11
STANDARD SECTION 6	STANDARD SECTION 12
STANDARD SECTION 7	STANDARD SECTION 13
STANDARD SECTION 8	STANDARD SECTION 14

TRANSITION AREA

SECTION CALLOUT (X / SHTX)

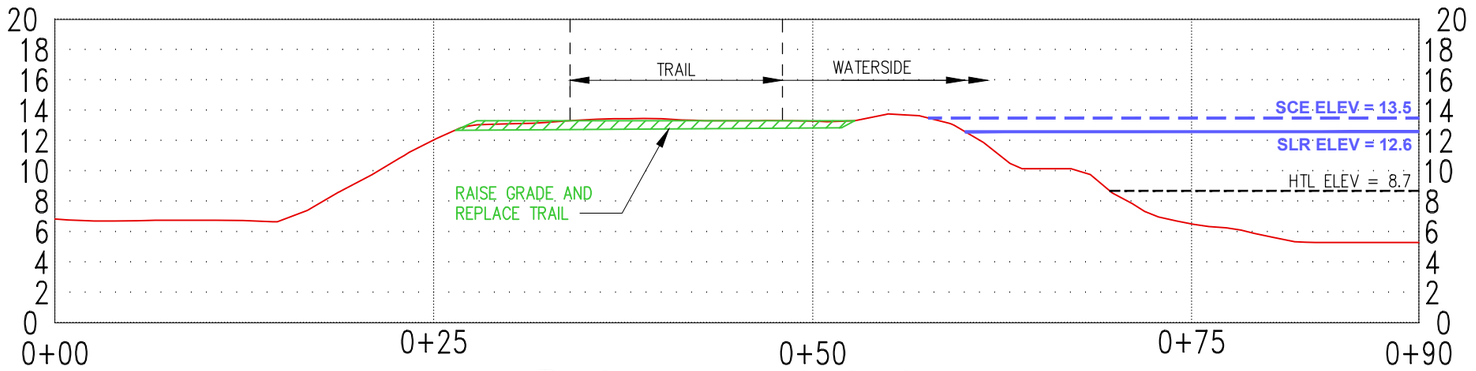
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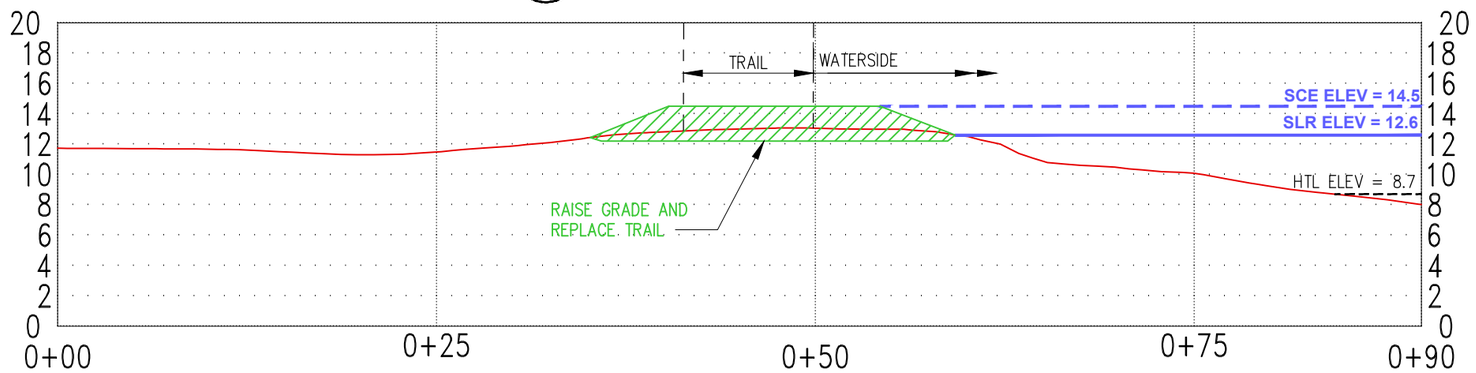
PORT OF PORT TOWNSEND
WATERWALK AND SEA LEVEL RISE
PRELIMINARY STANDARD SECTIONS

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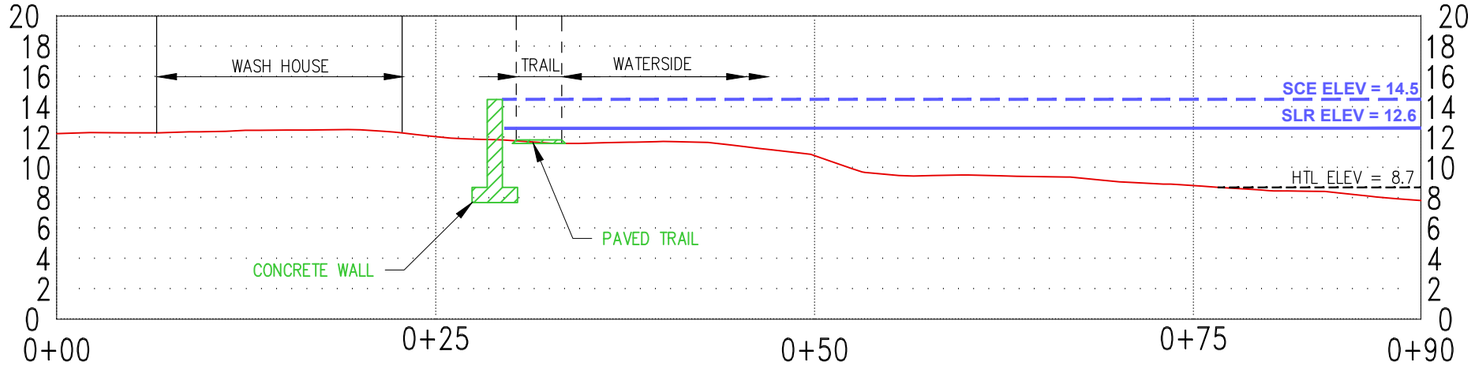
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A **STANDARD SECTION 1A**



B **STANDARD SECTION 1B**



C **WASH PAD SECTION**

DATUM
NAVD88

LEGEND

- EXISTING GRADE BASED ON PUBLICLY AVAILABLE LIDAR
- SUGGESTED CREST ELEVATION (SCE), INCLUDING WAVE RUNUP
- SEA LEVEL RISE (SLR) ELEVATION, ELEV = 12.6' (NAVD88)
- HIGH TIDE LINE (HTL), ELEV = 8.7' (NAVD88)

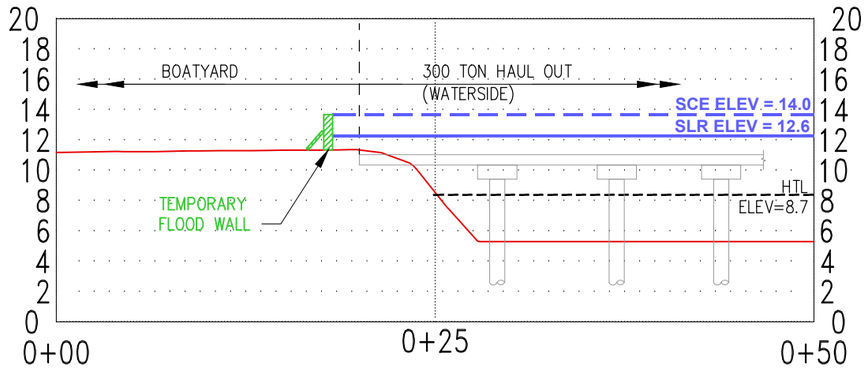
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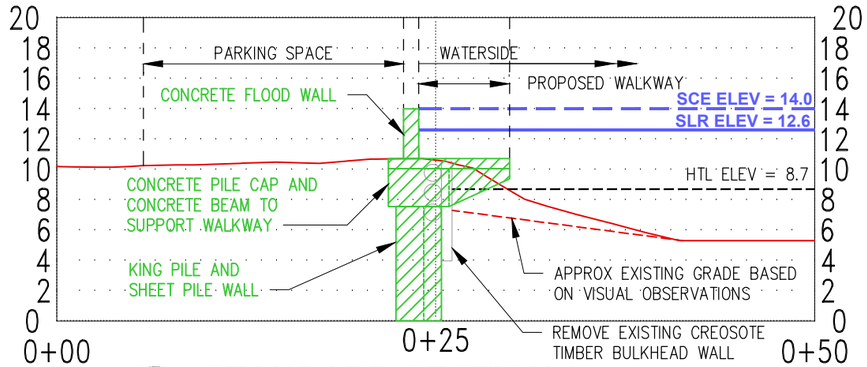
PORT OF PORT TOWNSEND
WATERWALK AND SEA LEVEL RISE
PRELIMINARY STANDARD SECTIONS

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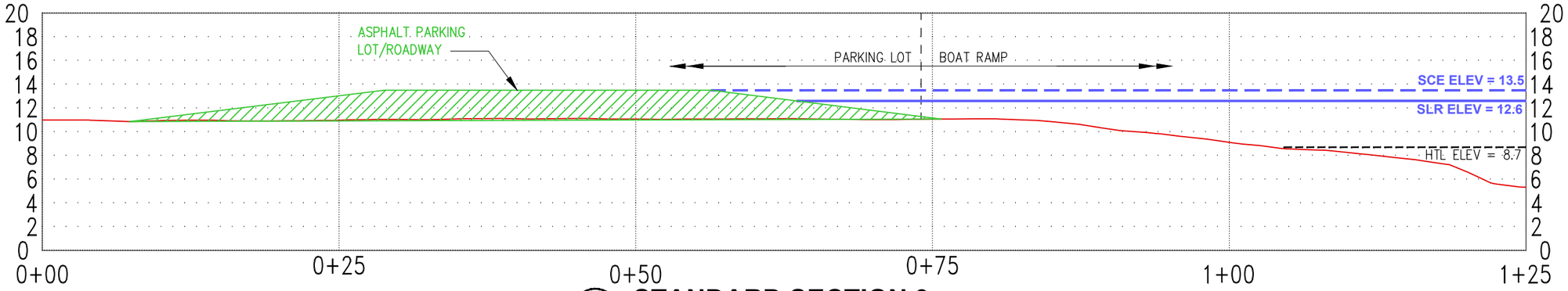
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D GANGWAY/PIER STANDARD SECTION



E STANDARD SECTION 2



F STANDARD SECTION 3

DATUM
NAVD88

LEGEND

- EXISTING GRADE BASED ON PUBLICLY AVAILABLE LIDAR
- SUGGESTED CREST ELEVATION (SCE), INCLUDING WAVE RUNUP
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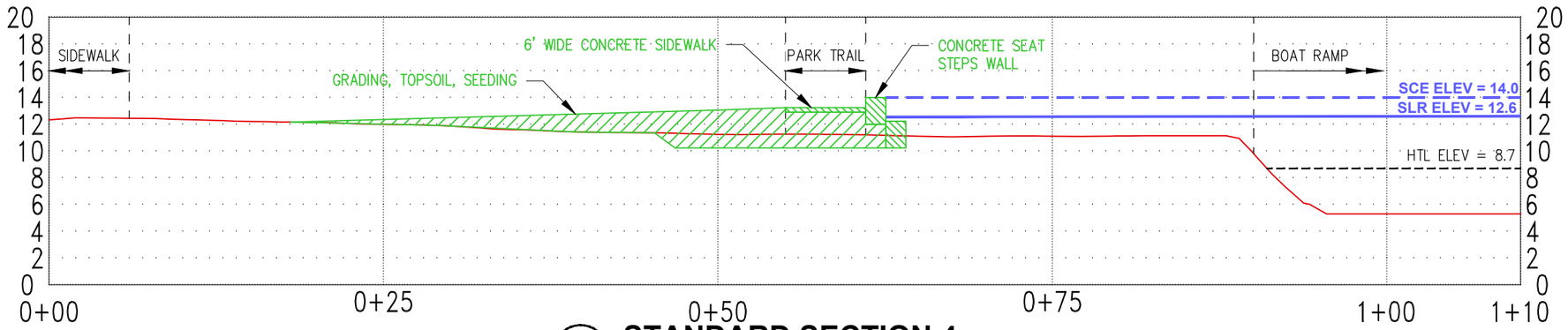
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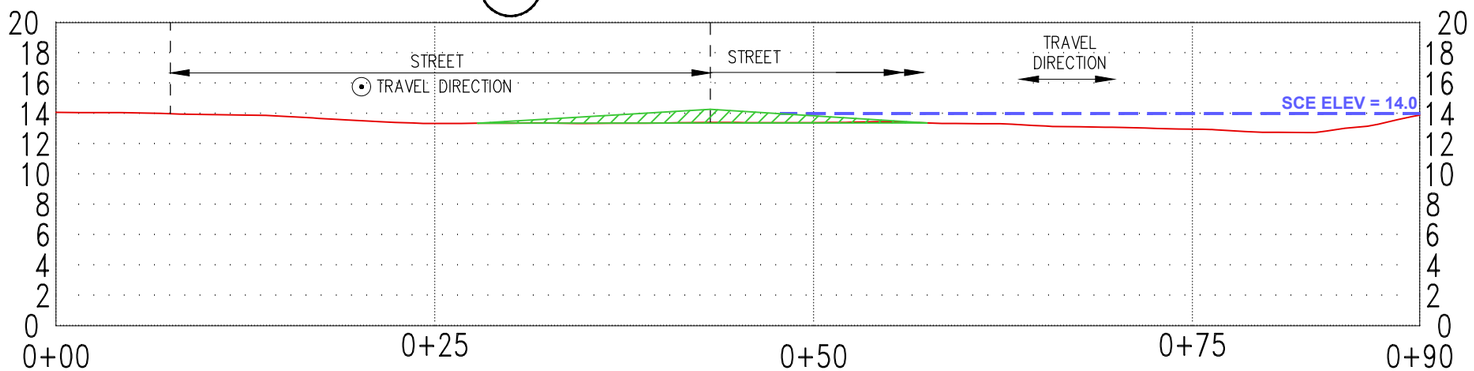
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WATERWALK AND SEA LEVEL RISE
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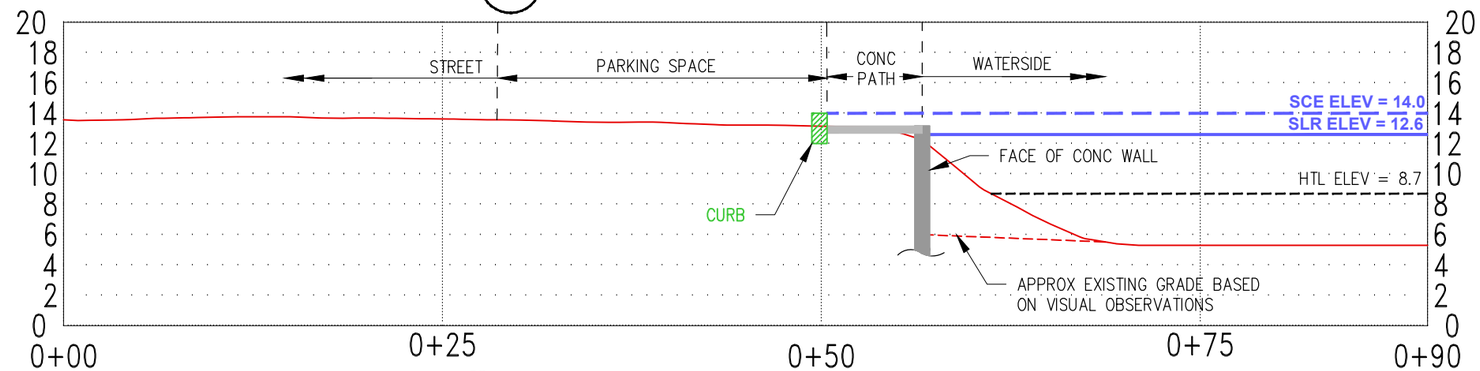
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G **STANDARD SECTION 4**



H **STANDARD SECTION 5**



I **STANDARD SECTION 6**

DATUM
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LEGEND

- EXISTING GRADE BASED ON PUBLICLY AVAILABLE LIDAR
- SUGGESTED CREST ELEVATION (SCE), INCLUDING WAVE RUNUP
- SEA LEVEL RISE (SLR) ELEVATION, ELEV = 12.6' (NAVD88)
- HIGH TIDE LINE (HTL), ELEV = 8.7' (NAVD88)

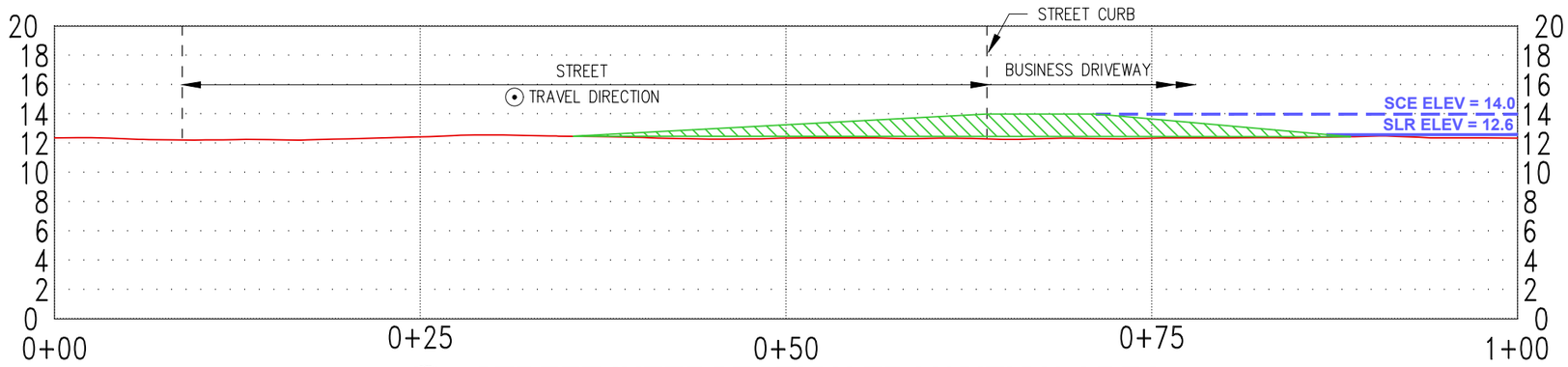
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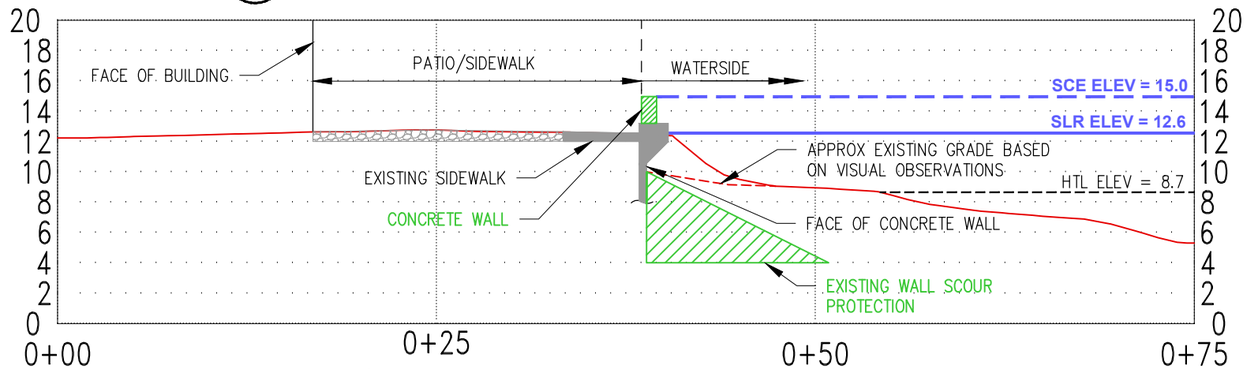
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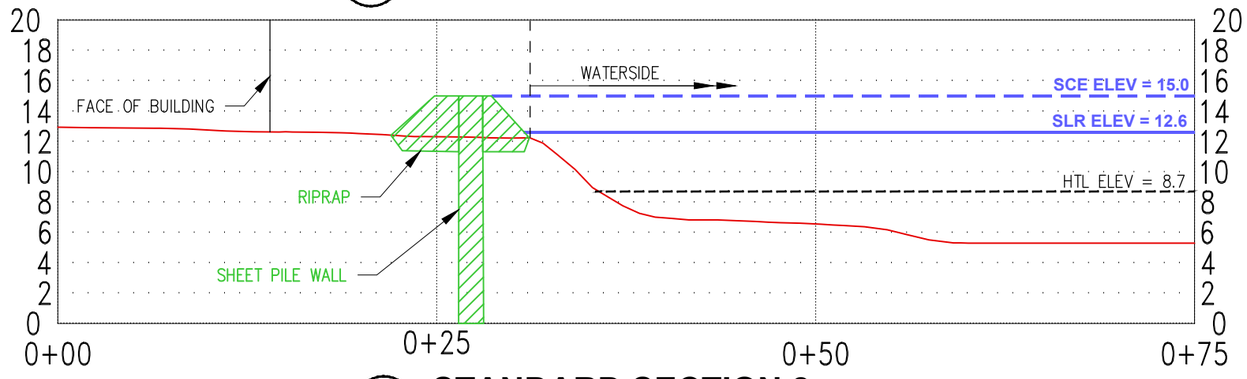
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J **STREET INTERSECTION TRANSITION AREA**



K **STANDARD SECTION 7**



L **STANDARD SECTION 8**

LEGEND

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- HIGH TIDE LINE (HTL), ELEV = 8.7' (NAVD88)

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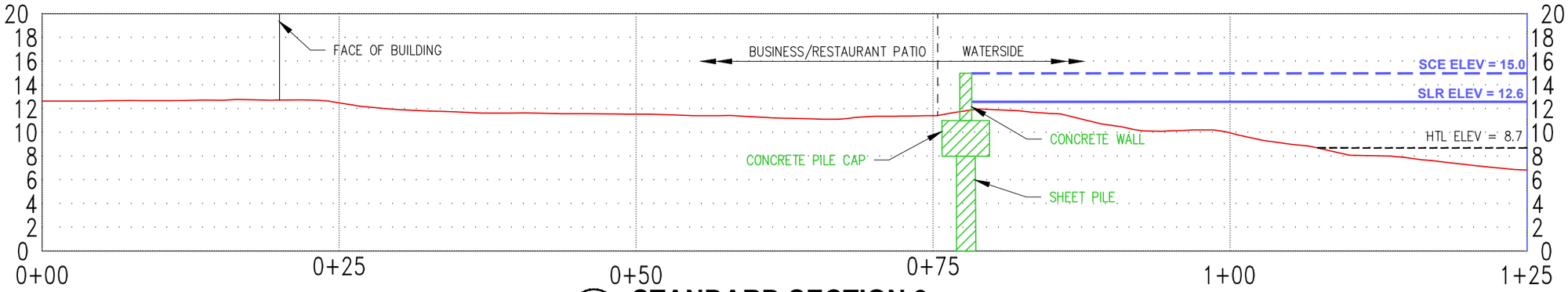
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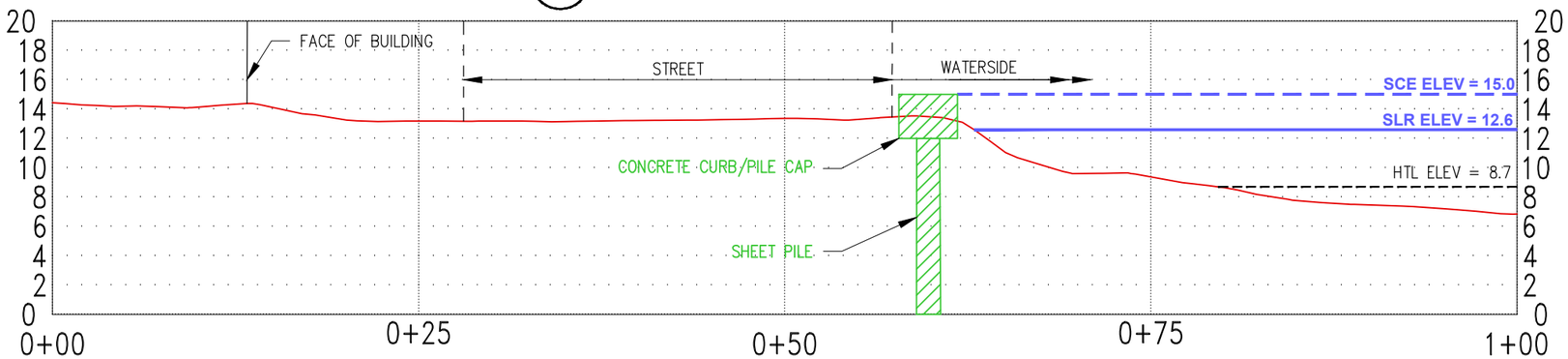
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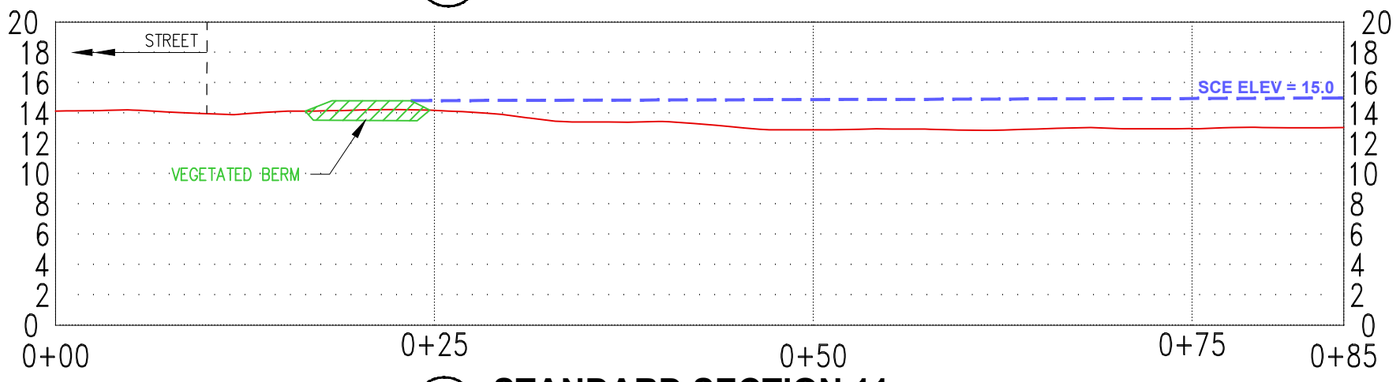
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M STANDARD SECTION 9



N STANDARD SECTION 10



O STANDARD SECTION 11

LEGEND

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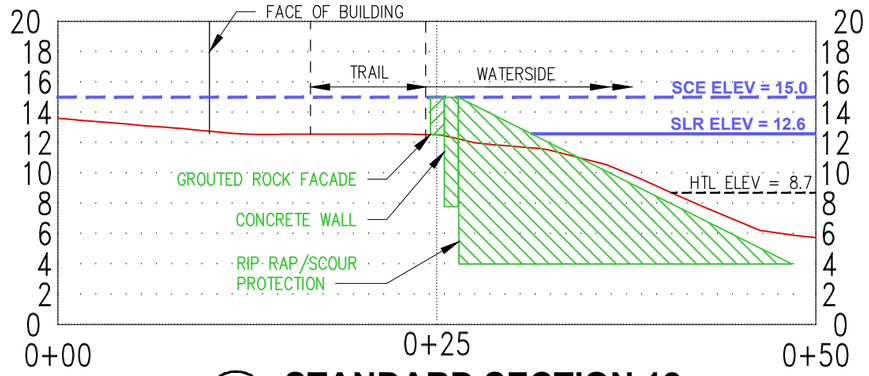
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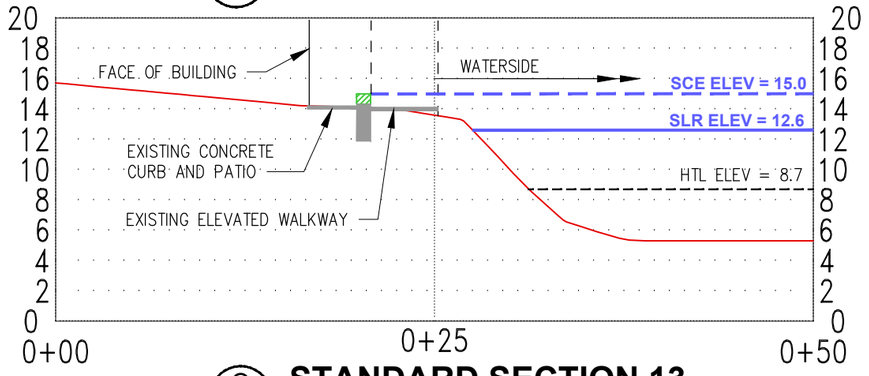
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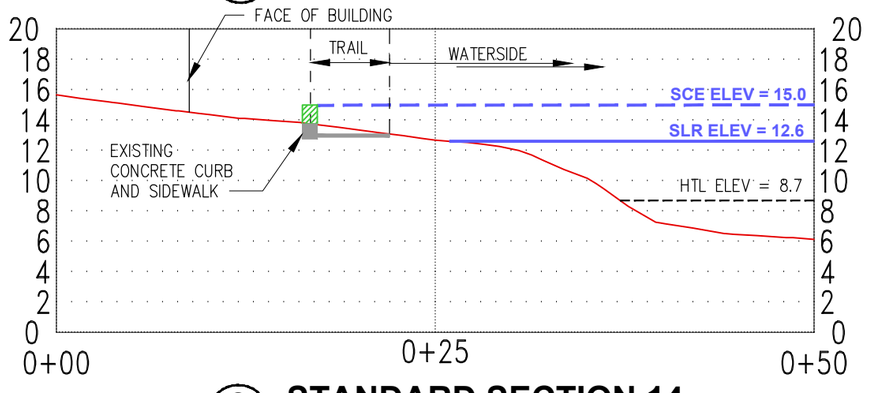
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P STANDARD SECTION 12



Q STANDARD SECTION 13



S STANDARD SECTION 14

LEGEND

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Appendix C2
Landscape Concepts and Sketches

ZONES OF EXPERIENCE

Beach!
Ecology & Wetland

Soft Edge

Boats!
Boathaven and Port

Hard Edge

Community!
Neighborhood / Street Ends

Soft / Hard Edge



PEDESTRIAN WATER WALK LANDSCAPE ENHANCEMENTS

Wetland Trail
- Potential Estuary Enhancements w/ Bridge
- View Opportunities
- Interpretive Opportunities

Trailhead & Beach Access
- Washpad, Beach, and Trailhead Enhancements *
- Pedestrian Access(Stairs, Handrails, etc)*
- Signage *
- Enhanced Ecology *

Marina Promenade
- Water Walk Intergrated with Flood Barrier *
- Enhance Existing Seating Area *

Park Space
- Existing Park Regrading and Reconstruction *
- Enhanced Sea Wall/Seating *

* Included in Project Cost Estimate



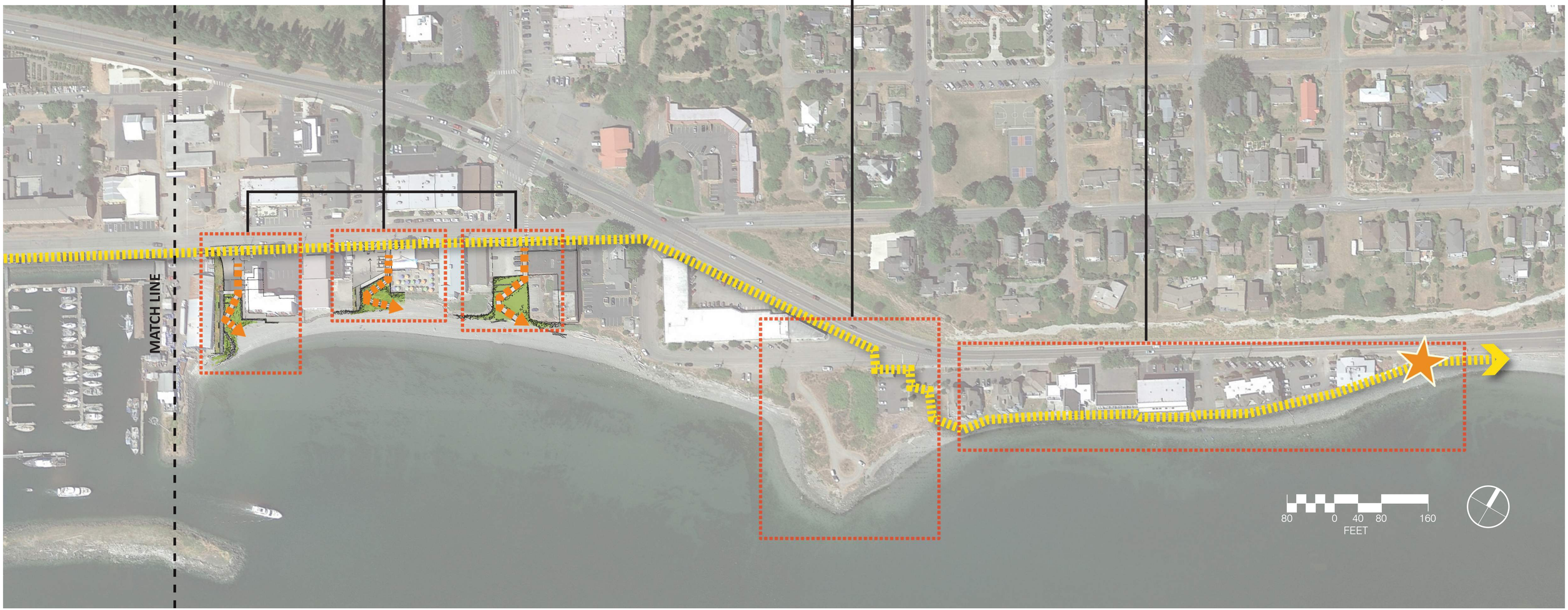
PEDESTRIAN WATER WALK LANDSCAPE ENHANCEMENTS

Streetscape Water Walk
- Connections to Street Ends Embraced for Recreation and Nature *
- Beach Connections *
- Enhanced Ecology *

Indian Point
- Recreational Opportunities
- Ecology Opportunities
- Interpretation
- Build a Better Beach

Water Walk Connector
- Enhanced trailhead at sidewalk connection with signage, seating and landscape *

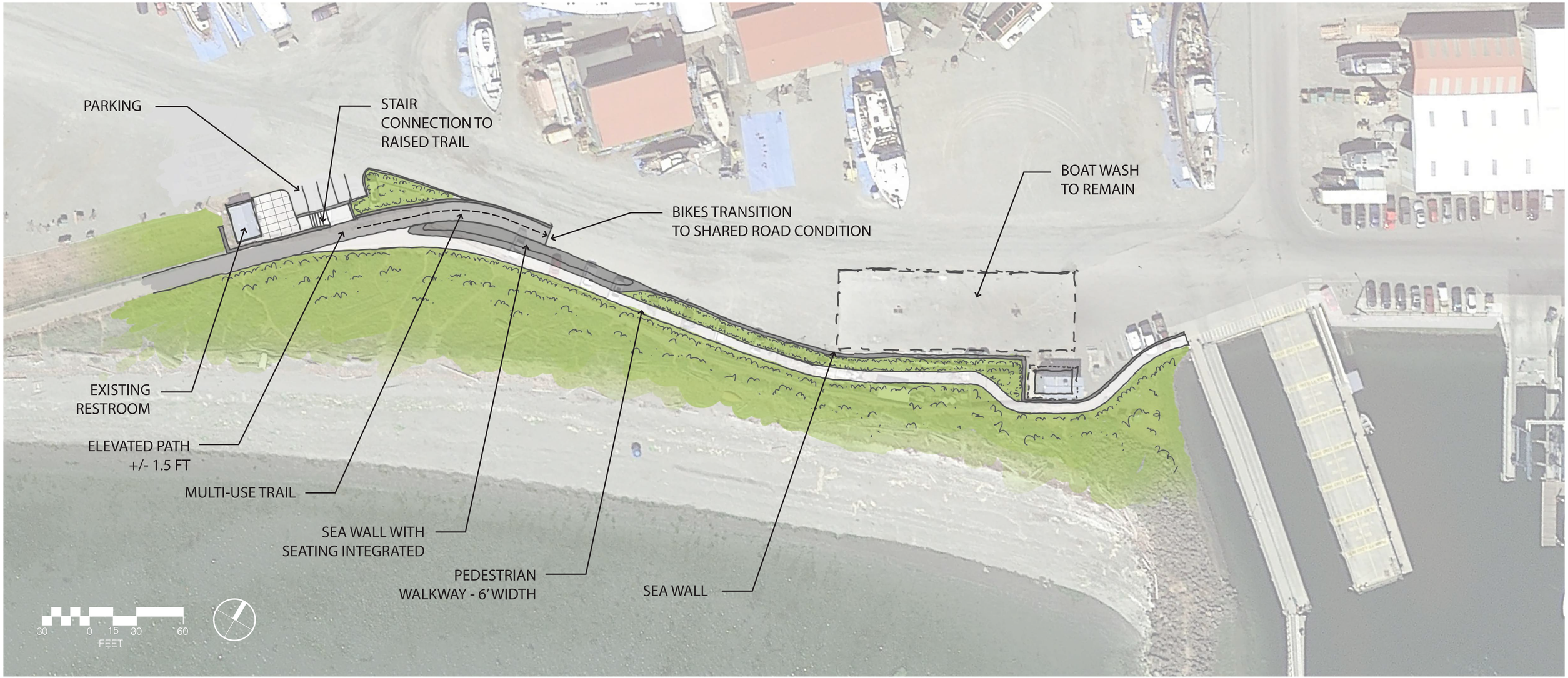
* Included in Project Cost Estimate



ENLARGEMENT - BEACH / TRAILHEAD

ALTERNATE 1

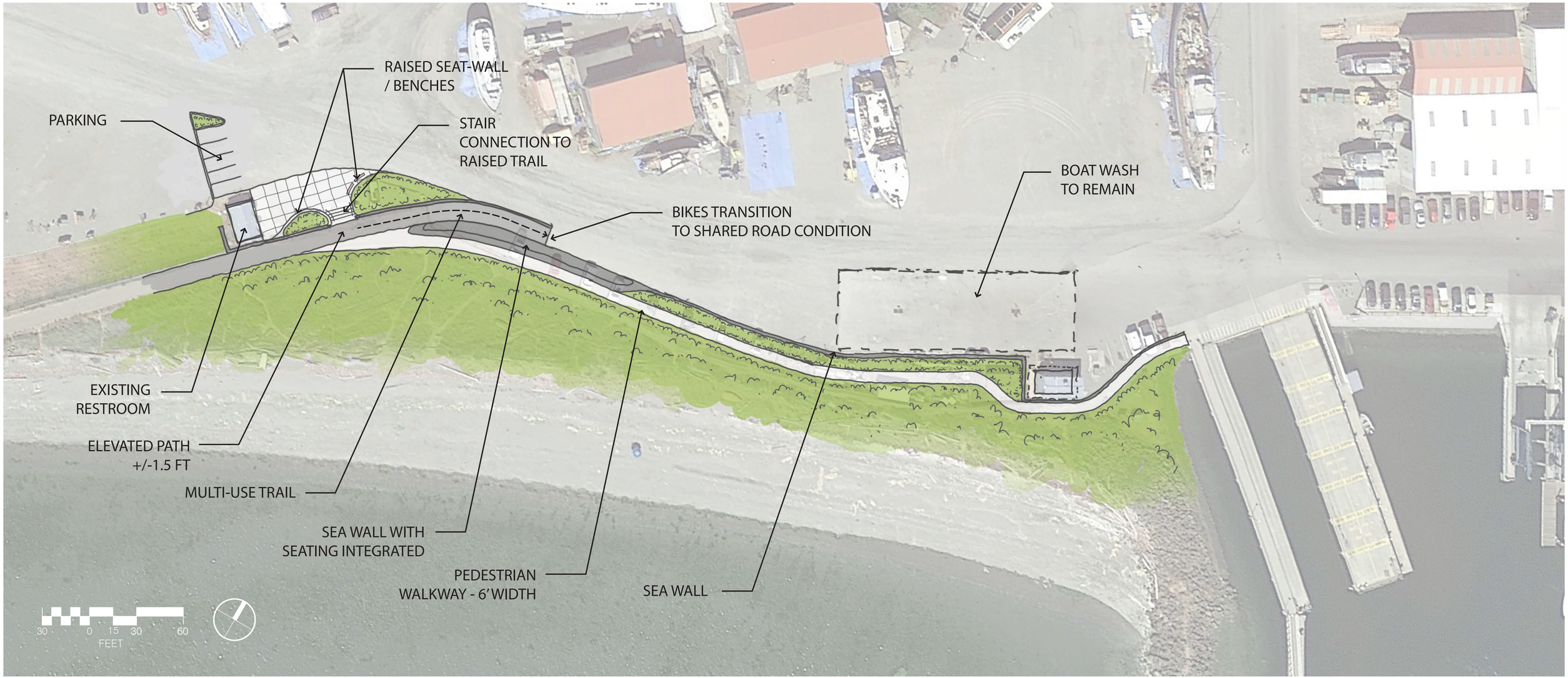
- Parking in front of trail access, small paving space in front of restroom
- 5 parking stalls
- No impacts to boat storage area



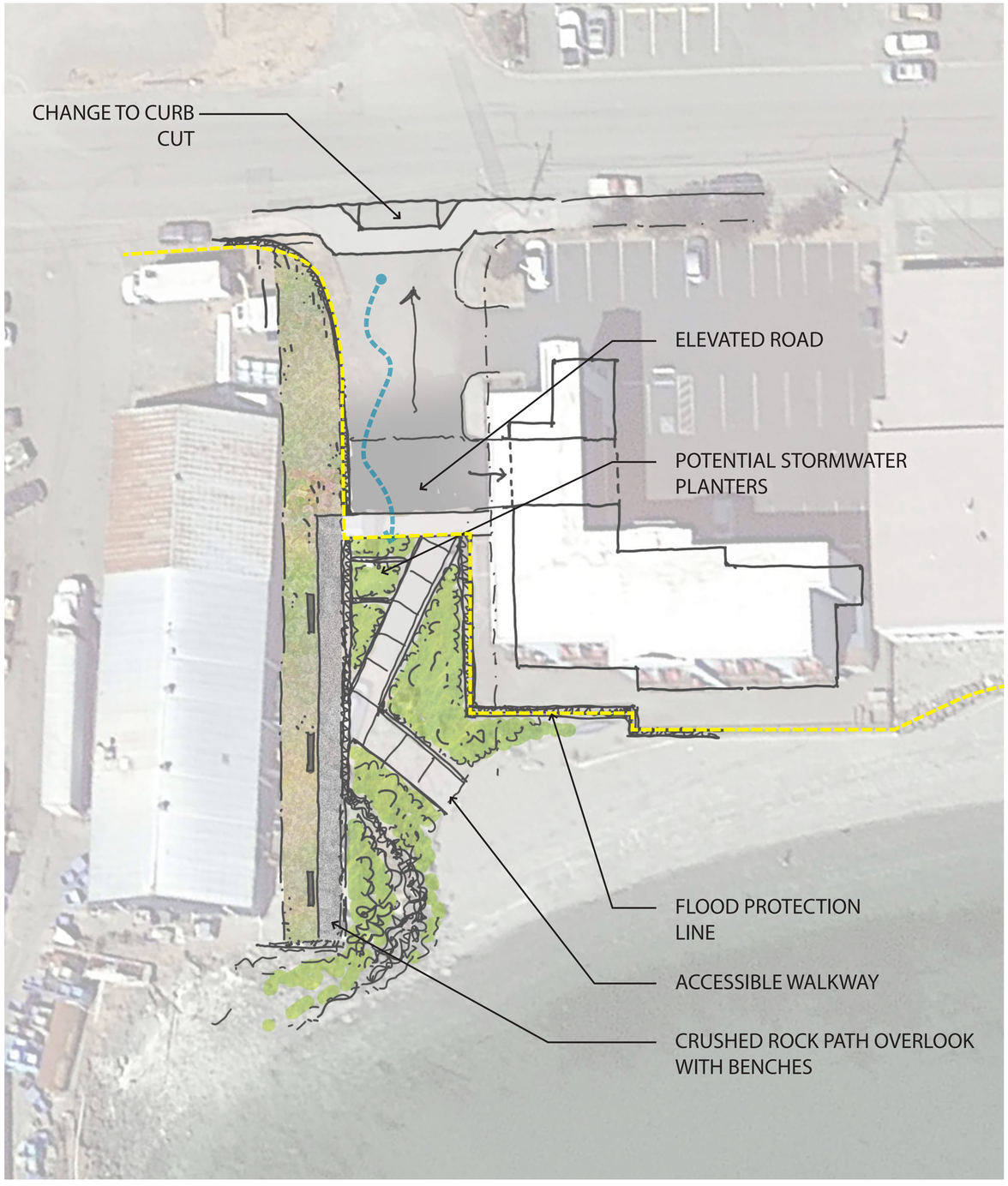
ENLARGEMENT - BEACH / TRAILHEAD

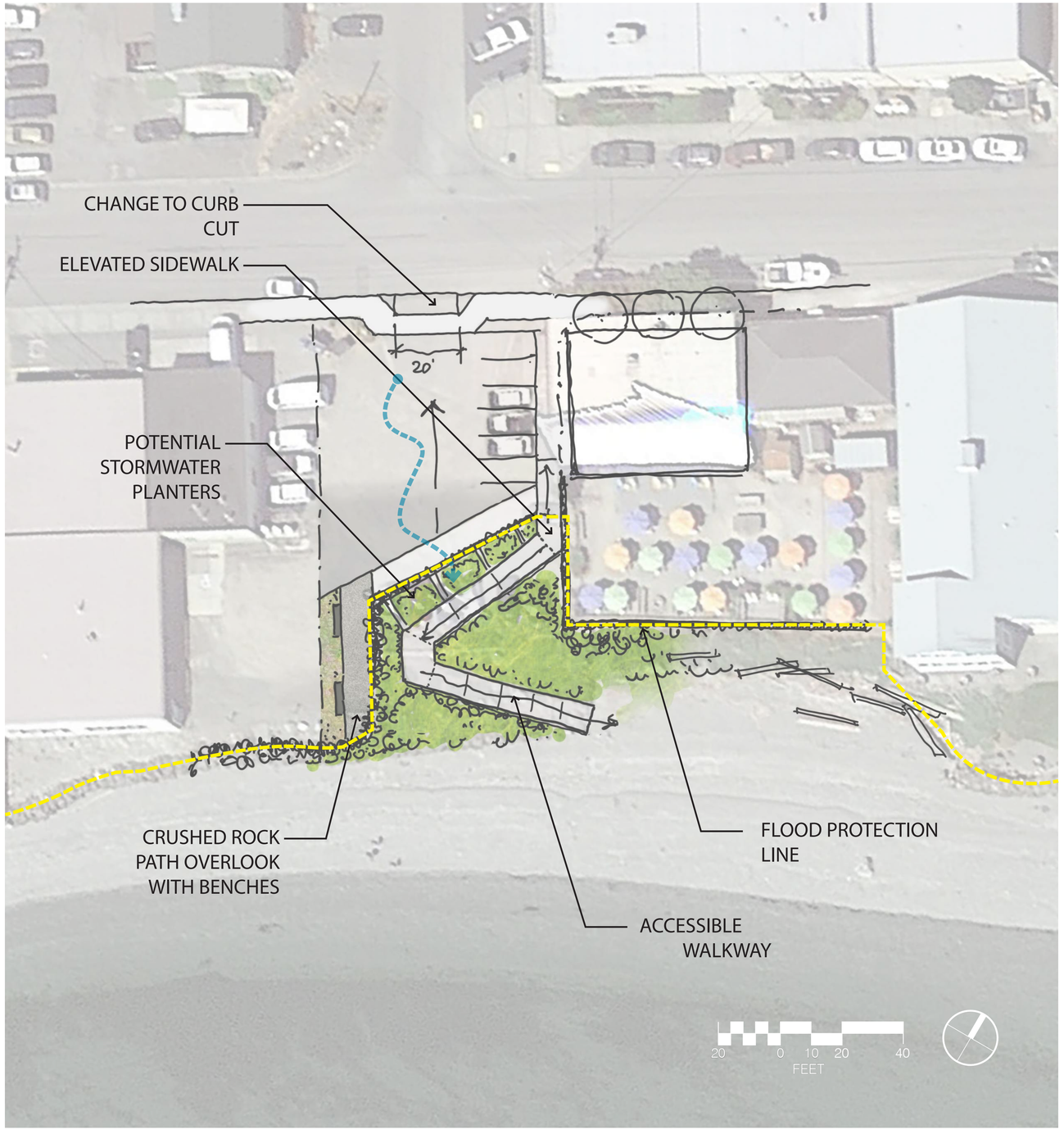
ALTERNATE 2

- Stronger trailhead visibility with small paved area at restroom for seating / signage
- 5 parking stalls
- Impacts to boat storage space



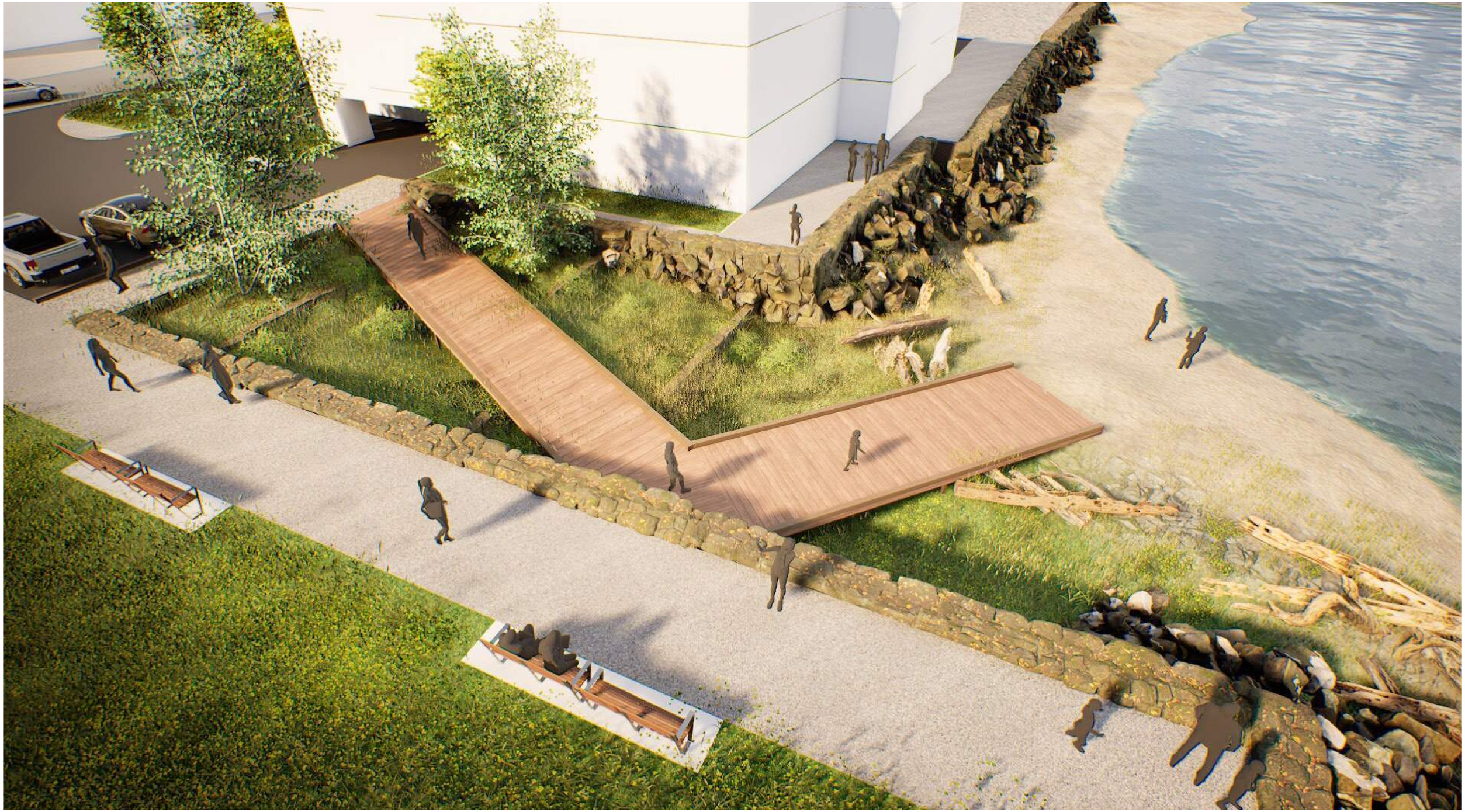
STREET END STUDIES





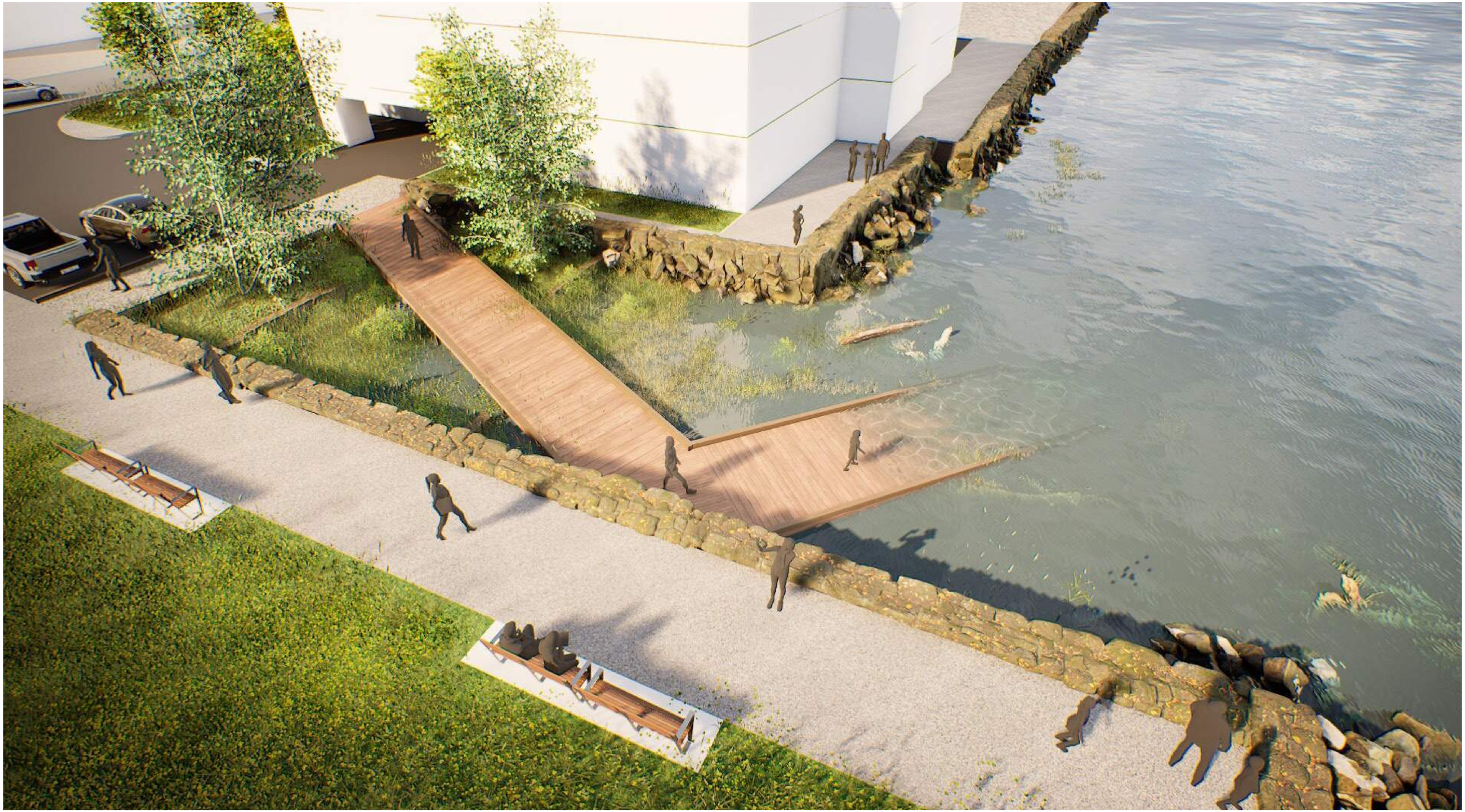
STREET END CONCEPT SKETCH

LOW/MID TIDE CONDITION



STREET END CONCEPT SKETCH

HIGH TIDE CONDITION



Appendix C3
Environmental Assessment

CONFLUENCE
ENVIRONMENTAL COMPANY

Port of Port Townsend Waterwalk and Sea Level Rise
DRAFT ENVIRONMENTAL ASSESSMENT

Prepared for:

KPFF

March 2024





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Port of Port Townsend Waterwalk and Sea Level Rise
DRAFT ENVIRONMENTAL ASSESSMENT

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March 2024

This report should be cited as:

Confluence (Confluence Environmental Company). 2024. Port of Port Townsend waterwalk and sea level rise: Environmental assessment. Prepared for KPFF, Seattle, Washington, by Confluence, Seattle, Washington.

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ACRONYMS AND ABBREVIATIONS

Berger	Berger Partnership
BMPs	best management practices
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DNR	Washington State Department of Natural Resources
DPS	Distinct Population Segment
Ecology	Washington State Department of Ecology
ESA	Environmental Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
HCA	habitat conservation areas
HPA	Hydraulic Protect Approval
HTL	high tide line
KPFF	KPFF Consulting Engineers
LID	low impact development
MHHW	mean higher high water
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MBTA	Migratory Bird Treaty Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMFS calculator	NMFS Puget Sound Nearshore Habitat Conservation Calculator
PHS	Priority Habitats and Species
Port	Port of Port Townsend
PSP	Puget Sound Partnership
PTMC	Port Townsend Municipal Code
SAV	submerged aquatic vegetation
SF	square feet
SLR	sea level rise
SSDP	shoreline substantial development permit
SSNP	Salish Sea Nearshore Programmatic
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
Waterwalk project	Waterwalk and Sea Level Project
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

The Port of Port Townsend (the Port) Waterwalk and Sea Level Project (the Waterwalk project) is an assessment to evaluate potential sea level rise (SLR) adaptations in Port Townsend, Washington. The assessment includes information on design elevation, costs, and permitting requirements and strategies. This information will be used to support pursuing funding opportunities for future project development. The Waterwalk project site extends from the bluff at the west end of the Boat Haven Marina to the bluff near the intersection of Water Street and East Sims Way (Figure 1). A key component of this project is the integration of a pedestrian waterwalk with the SLR adaptations.

The Waterwalk project site is located in a Federal Emergency Management Agency (FEMA) flood zone AE, which means that the site has a high flooding risk due to low elevations and proximity to a major water body (i.e., Puget Sound). During recent king tide events in 2022, flooding occurred throughout the Boat Haven Marina and associated roadways, storm drains, and other locations resulting in damage to Port infrastructure. Rising sea level due to climate change will increase the intensity (e.g., storm waves) and frequency of flooding events.

The purpose of the information in this document is to aid the Port in obtaining federal grant funding for the project. The following information provides baseline environmental conditions, potential impacts from suggested SLR adaptation, mitigation opportunities within the Waterwalk project site, and anticipated environmental permits needed to construct SLR adaptations and address future climate resiliency. Environmental permitting cost estimates are included to support the Port's goal of obtaining funding opportunities for future project development phases.

The following information reviews SLR adaptations provided by KPFF Consulting Engineers (KPFF 2024) and pedestrian designs provided by Berger Partnership (Berger 2024). The KPFF (2024) document divides the Port's Waterwalk project site into a series of smaller sections and transition areas, which are discussed in this document (Figure 2). The various sections and transition areas are identified based on the SLR adaptation proposed. As would be expected in a complex waterfront, there is not one consistent solution to address SLR and coastal flooding along the entirety of the Port's waterfront. The identified solutions are a combination of engineering, stormwater, environmental, and landscaped approaches.

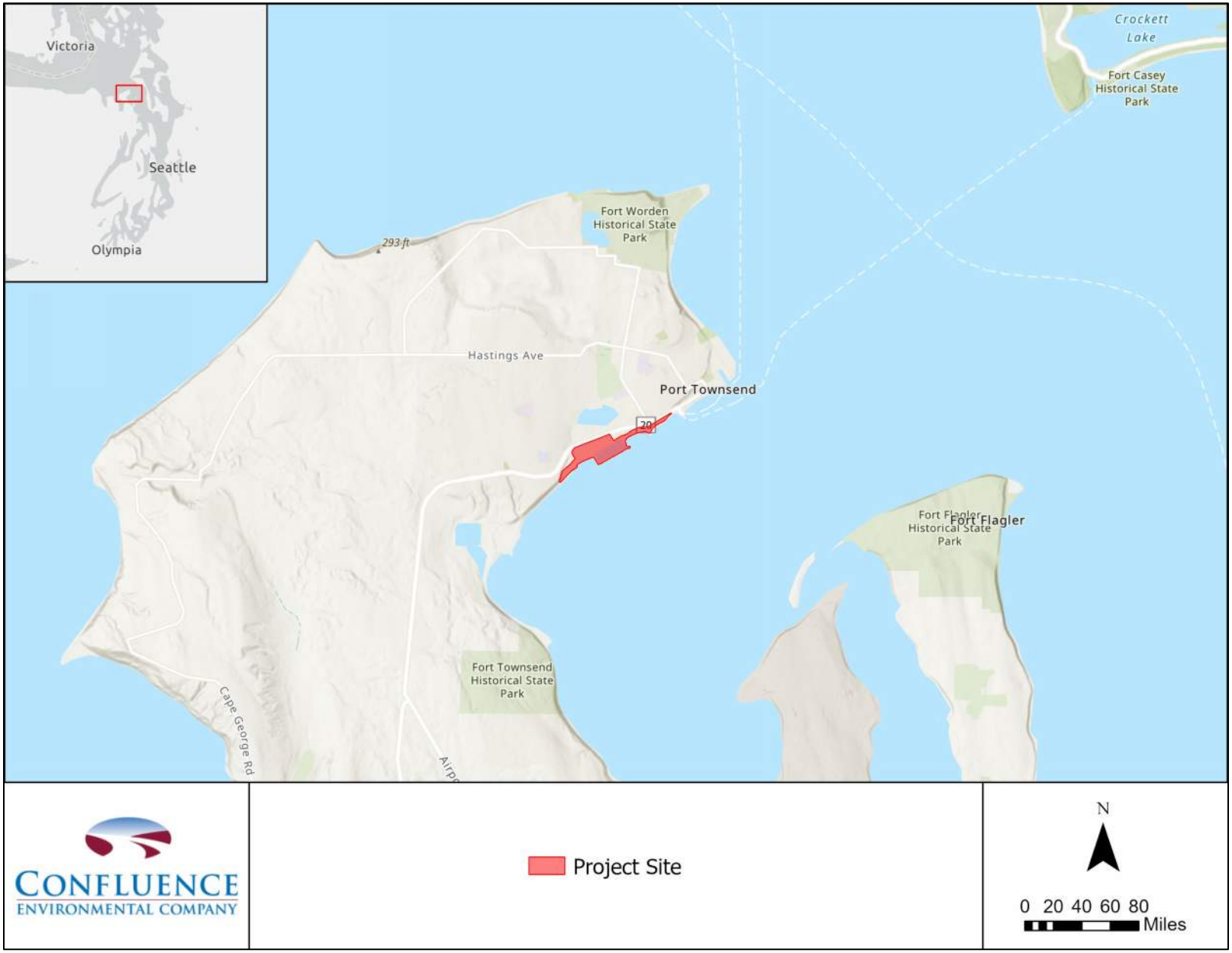


Figure 1. Port of Port Townsend Waterwalk project site and shoreline.



Figure 2. Sections and Transition Zones used to describe and organize SLR adaptations.

2.0 ENVIRONMENTAL BASELINE

The 1.2-mile shoreline associated with the Port's Waterwalk project site is characterized as one of the most highly modified shorelines in the City of Port Townsend (Port Townsend 2024). Prominent features along the shoreline include the Larry Scott Trail at the western end, armored beach, a jetty protecting the Boat Haven Marina, Jetty Walkway, Indian Point, and several street-end parks (Figure 3). The project site is used for commercial, recreational, and industrial Port-related purposes.

The environmental baseline within the Port's Waterwalk project site is summarized in Table 1. Information in the table is based on a site visit conducted on January 11, 2024, and existing aerial imagery (e.g., Ecology 2024; Jefferson County 2024). Values presented in the table are not based on a detailed site investigation and are only provided for planning purposes.

Elements of the environmental baseline identified in Table 1 fall into the following main categories: (1) upland conditions and soils, (2) substrate and sediment quality, (3) aquatic vegetation and critical areas, (4) fish and wildlife, and (5) Environmental Species Act (ESA)-listed critical habitat. Details for these components are discussed below.

2.1 Upland Conditions and Soils

The upland area is mostly characterized by commercial use, with around 75% commercial land use and 25% residential land use (Port Townsend 2024). The vast majority of the upland area is comprised of high intensity development, including the Boat Haven Marina (Ecology 2024a). The exception is the palustrine wetland west of the marina. Indian Point east of the marina is an area that is modified with shoreline armoring but is not developed with infrastructure. There is very little vegetative canopy cover in the upland area due to the high level of development in the area (PNPTC 2009).

Soils in the upland area are predominately historical fill material and loam (USDA NRCS 2024).

2.2 Substrate and Sediment Quality

Historically, the area to the south adjacent to the palustrine wetland and to the north just past Indian Point were characterized by feeder bluffs (Ecology 2024a), but shoreline modifications as well as the placement of fill material has moved the shoreline away from the edges of these feeder bluffs (Port Townsend 2024). Shoreline sediment movement is controlled by a drift cell moving from west to east along the Port's shoreline (Ecology 2024a). Due to this, sediments tend to accumulate on the west side of the Boat Haven Marina as they come into contact with the western jetty.



Figure 3. Environmental baseline hardscape elements in the Port's Waterwalk project site.

Table 1. Port of Port Townsend Waterwalk and environmental baseline features within each section and transition zone of the project.

Section or Transition Area Label	Environmental Baseline Features Included
Section 1	▪ Larry Scott Trail with 2-acre freshwater wetland adjacent to trail ▪ ~1,300 feet of existing rip-rap armoring ▪ Eelgrass along the western portion of the shoreline (adjacent to freshwater wetland) ▪ Documented sand lance spawning areas
Wash Pad Transition Area	▪ Section of the Larry Scott Trail that transitions to a 5-foot-wide pedestrian trail ▪ Saltmarsh vegetation and large woody material within a pocket beach ▪ Documented sand lance spawning beach ▪ Wash pad for boats and boat storage areas
300-ton Travel Lift Transition Area	▪ Transition from beach to the Boat Haven Marina protected by a jetty ▪ Saltmarsh vegetation and macroalgae present ▪ Two sections with a 180-foot long dock for boat lift operations ▪ Total overwater structure is about 10,200 SF
Section 2	▪ ~700 feet of concrete sidewalk in marina area supported by a creosote wall bulkhead ▪ ~28, 10- to 12-inch creosote pilings* ▪ Saltmarsh and SAV areas along the shoreline
75-ton Travel Lift Transition Area	▪ ~60 feet of concrete sidewalk in marina area supported by a concrete wall bulkhead ▪ Pier, gangway, and floats associated with the marina ▪ No pilings observed/estimated for this area ▪ Saltmarsh and SAV areas along the shoreline
C-dock Gangway Transition Area	▪ ~10 feet of concrete sidewalk in marina area supported by a concrete wall bulkhead ▪ Pier, gangway, and floats associated with the marina ▪ No pilings observed/estimated for this area ▪ Saltmarsh and SAV areas along the shoreline
Section 3	▪ Marina area/parking lot and boat ramp area with graded floats ▪ ~340 feet of concrete sidewalk supported by creosote wall bulkhead ▪ ~10, 10- to 12-inch creosote pilings* ▪ Saltmarsh and SAV areas along the shoreline
Section 4	▪ Marina area/parking lot ▪ Boat ramp area with solid floats adjacent to small park
Section 5	▪ Street/Waterwalk follows roadway ▪ Fill area supported by rip-rap armoring along Benedict Street ▪ Saltmarsh and SAV areas along the shoreline
Commercial Dock Gangways Transition Area	▪ U.S. Coast Guard Pier ▪ Fill area supported by rip-rap armoring ▪ Saltmarsh and SAV areas along the shoreline
Section 6	▪ ~280 feet of concrete path along water supported by concrete bulkhead and rip-rap armoring; transitions to the street sidewalk ▪ ~3 old creosote pilings ▪ Saltmarsh and SAV areas along the shoreline ▪ Bull kelp in the wrack along the shoreline
Fishery Driveway Transition Area	▪ Port Townsend Yacht Club building ▪ Fill area supported by rip-rap armoring ▪ Saltmarsh and SAV areas along the shoreline
Motel Street End Transition Area	▪ ~100 feet of concrete bulkhead supporting the Aladdin Inn ▪ ~70 feet of rip-rap armoring ▪ ~1000 SF of existing asphalt and concrete with stairs down to the beach ▪ Large woody material and grasses in the backshore zone ▪ SAV areas along the shoreline

Section or Transition Area Label	Environmental Baseline Features Included
Section 7	▪ ~100 feet of concrete path along water supported by a concrete bulkhead ▪ SAV areas along the shoreline ▪ Pocket beach habitat ▪ Documented sand lance spawning beach
Section 8	▪ ~250 feet of shoreline supported by large boulder rip-rap armoring ▪ SAV areas along the shoreline ▪ Documented sand lance spawning beach in pocket beach area ▪ Waterwalk transitions to the street
Decatur Street End Transition Area	▪ ~70 feet of rip-rap armoring ▪ ~800 SF of existing asphalt and concrete ▪ Large woody material and grasses in the backshore zone ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline ▪ Documented sand lance spawning beach in pocket beach area
Kearney Street end Transition Area	▪ ~100 feet of rip-rap armoring ▪ ~550 SF of existing asphalt and concrete ▪ Large woody material and grasses in the backshore zone ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline ▪ Pocket beach area
Section 9	▪ Pour House patio with ~100 feet of shoreline without any armoring ▪ Large woody material and grasses in the backshore zone ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline ▪ Pocket beach area
Section 10	▪ ~300 feet of roadway along Water Street – eroding into the shoreline ▪ Concrete debris and asphalt located along the backshore zone ▪ Shoreline protected by large boulder rip-rap armoring ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
Section 11	▪ Indian Island peninsula area with dirt path along the peninsula ▪ Shoreline protected by large boulder rip-rap armoring ▪ ~35 creosote pilings and concrete debris along the shoreline ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
Section 12	▪ ~400 feet of concrete path along water supported by a rip-rap armoring ▪ Large woody material and grasses in the backshore zone ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
Example Beach Stairs Transition Area	▪ Bay Vista Condominiums ▪ Example of concrete stairs from waterwalk path to the water ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
Section 13	▪ Bay Vista Condominiums ▪ ~100 feet of gravel/concrete path along water supported by rip-rap armoring ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
Water Street Trail Access Transition Area	▪ Street end access ▪ ~100 feet of elevated path above water ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
Section 14	▪ Bay Vista Condominiums II ▪ ~100 feet of concrete path along water supported by rip-rap armoring ▪ SAV areas along the shoreline and bull kelp in the wrack along the shoreline
*no census of pilings was collected; numbers are used for planning purposes. SAV = submerged aquatic vegetation; SF = square feet	

2.3 Aquatic Vegetation and Critical Areas

The entire project area is within the shoreline jurisdiction and a FEMA flood zone. Critical areas are defined under the Port Townsend Municipal Code (PTMC) 19.05. The shoreline in Section 1 also includes the following critical areas: (1) landslide hazard area, (2) soil erosion area, (3) soil seismic area, (4) unstable shoreline area, (5) Washington State Department of Natural Resources (DNR) fish habitat, (6) critical aquifer recharge area, and (7) seawater intrusion protection zone (Jefferson County 2024). Critical areas that continue along the shoreline into other sections of the project site include estuarine wetlands, soil erosion and seismic areas (outside of the marina), critical aquifer recharge area, and seawater intrusion protection zone. There are also areas that have more sensitive resources (Figure 4). For example, there is a 1.7-acre palustrine wetland located north of the Larry Scott Trail in Section 1 and estuarine wetlands along the shoreline (Jefferson County 2024; USFWS 2024a). The palustrine wetland was historically connected to the estuarine wetlands but was cutoff during construction of the railway.

Vegetated estuarine areas are considered wetlands under the Cowardin classification system (FGDC 2013) and PTMC 19.05.110. If these areas also contain native eelgrass (*Zostera marina*) and kelp (Order Laminariales) – also known as submerged aquatic vegetation (SAV) – then they are considered a higher value for critical habitat under the ESA and essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The Washington State Department of Ecology (Ecology) conducted eelgrass surveys that occurred between 1994 to 2000 along the Port Townsend shoreline (Berry et al. 2001). The data indicated that patchy eelgrass and kelp are located along the shoreline (Figure 4). Eelgrass was observed by DNR (DNR 2024a) along the north side of Port Townsend and along Indian Island but not along the project site shoreline. There is also bull kelp (*Nereocystis luetkeana*) located in the wrack within the pocket beach habitats, but no identified bull kelp bed is located close to the project site. There is a large bull kelp bed identified on the north side of Port Townsend (DNR 2024b).

2.4 Fish and Wildlife

Common fish species in north Puget Sound include several species of forage fish (Pacific herring [*Clupea pallasii*], Pacific sand lance [*Ammodytes hexapterus*], surf smelt [*Hypomesus pretiosus*]), various species of sculpin (family Cottidae), various species of flatfish (English sole [*Parophrys vetulus*], starry flounder [*Platichthys stellatus*], Pacific sanddab [*Citharichthys sordidus*]), three-spined sticklebacks (*Gasterosteus aculeatus*), and various species of surfperch (family Embiotocidae), among others (Miller et al. 1980; Beamer et al. 2004; Mitchell et al. 2005).



Figure 4. Critical habitat elements in the Port's Waterwalk project site.

According to the Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species database (WDFW 2024a), there is Pacific sand lance spawning documented within pocket beach habitat and waterfowl concentrations (e.g., brant and harlequin ducks) along the shoreline (Figure 4). Chimacum Creek is the closest stream with spawning salmonids (WDFW 2024b). Species that use this area include steelhead (*Oncorhynchus mykiss*), chum salmon (*O. keta*), coho salmon (*O. kisutch*), and pink salmon (*O. gorbuscha*). Chinook salmon (*O. tshawytscha*) likely use the area as a migration corridor. Rockfish in the area include copper (*Sebastes caurinus*), quillback (*S. maliger*), and brown (*S. auriculatus*) rockfishes living south of Port Townsend (Tonnes 2011). The ESA-listed bocaccio (*S. paucispinis*) and yelloweye rockfish (*Sebastes ruberrimus*) are also expected to occur in rocky areas close to Port Townsend.

Threatened and endangered species and their designated critical habitat are identified through the ESA under the purview of the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) – collectively called "the Services." ESA-listed species and critical habitat that may occur in the area are provided in Table 2. This information is based on information compiled from the NMFS (2024a) and USFWS (2024b).

Port Townsend also considers fish and wildlife habitat conservation areas (HCAs) as a critical area as defined under the Washington Administrative Code (WAC) 365-190-130. Fish and wildlife HCAs contribute to the state's biodiversity. Relevant species that are supported by these HCAs are also included in Table 2. Fish and wildlife HCAs that are identified along the Port Townsend shoreline include commercial and recreational shellfish areas, kelp and eelgrass beds, forage fish spawning areas, seabird habitat areas, and habitats where endangered, threatened, and sensitive species have a primary association.

Table 2. Species and critical habitat considered in this assessment report

Common Name	Scientific Name	State Status	Federal Status	PHS	Critical Habitat	Potential Habitat Use
ESA-Listed Fish						
Bull trout (PS/Coastal DPS)	*Salvelinus confluentus*	C	T		Yes*	Migration and foraging, but unlikely
Chinook salmon (PS ESU)	*Oncorhynchus tshawytscha*	C	T		Yes	Migration, juvenile rearing, foraging
Steelhead (PS ESU)	*O. mykiss*	None	T	X	Yes	Migration, smolt rearing, foraging
Bocaccio rockfish (PS/GB DPS)	*Sebastes paucispinis*	C	E		Yes	Foraging, but unlikely (deepwater)
Yelloweye rockfish (PS/GB DPS)	*S. ruberrimus*	C	T		Yes	Foraging, but unlikely (deepwater)
Green sturgeon (Southern DPS)	*Acipenser medirostris*	None	T		Yes*	Migration and foraging, but unlikely
Forage Fish						
Pacific sand lance	*Ammodytes hexapterus*	P	None	X	N/A	Potential spawning, foraging
Other Marine Fish						
Coastal cutthroat trout	*O. clarki clarki*	None	Co		N/A	Migration, rearing, foraging
Coho salmon (PS/SG ESU)	*O. kisutch*	None	Co	X	N/A	Migration, rearing, foraging
Chum salmon (PS/SG ESU)	*O. keta*	None	Co	X	N/A	Migration, rearing, foraging
Canary rockfish (PS/GB DPS)	*Sebastes pinniger*	C	None		N/A	Foraging, but unlikely (deepwater)
Birds						
Marbled murrelet (CA/OR/WA)	*Brachyramphus marmoratus*	T	T		Yes*	Foraging
Bald eagle	*Haliaeetus leucocephalus*	S	Co		N/A	Foraging
Great blue heron	*Ardea herodias*	M	None		N/A	Foraging
Osprey	*Pandion haliaetus*	M	None		N/A	Foraging
Black brant	*Branta bernicla*	None	MBTA		N/A	Foraging
Marine Mammals						
Southern resident killer whale	*Orcinus orca*	E	E		Yes*	Foraging
Harbor seal	*Phoca vitulina*	M	None		N/A	Foraging
California sea lion	*Zalophus californianus*	M	None		N/A	Foraging

PHS - Priority Habitats and Species; DPS - Distinct Population Segment; ESU - Evolutionarily Significant Unit; MBTA – Migratory Bird Treaty Act; E - Endangered; T - Threatened; P - Priority; C - Candidate; Co - Concern; S - Sensitive; M - Monitored, CA - California; GB - Georgia Basin; OR - Oregon; NP - North Pacific; PS - Puget Sound; SG - Strait of Georgia; WA - Washington
*Critical habitat has been identified, but does not occur within the proposed Project area.

2.5 ESA-Listed Critical Habitat

Critical habitat is present in the project area for bull trout, Puget Sound Chinook salmon, steelhead, and rockfish. The relevant physical or biological features for each species are presented in Table 3.

Table 3. Physical or biological features relevant to the proposed action area.

ESA-Listed Species	Relevant PBF
Puget Sound Chinook salmon and Puget Sound steelhead	Nearshore marine areas that provide appropriate: ▪ Migratory corridor ▪ Water quality ▪ Food resources ▪ Water flow ▪ Water depth ▪ Natural cover
Bull trout	▪ Migration habitats with minimal impediments ▪ Abundant food base ▪ Complex habitat ▪ Low water temperatures ▪ Water quantity and quality ▪ Nonnative predator species
Sources: 65 FR 7764; 70 FR 52630; 75 FR 63898; 84 FR 49214	

3.0 ENVIRONMENTAL REVIEW

Projects with a federal nexus are required to comply with the National Environmental Policy Act (NEPA) environmental review process. A federal nexus can include federal funds or issuance of federal permits and approvals. Federal agencies with potential involvement may include FEMA, the U.S. Army Corps of Engineers (Corps) or other federal agencies. Each federal agency has its own regulations and processes to implement NEPA. Similarly, projects without a federal nexus are required to comply with the State Environmental Policy Act (SEPA), which also follows a prescribed environmental review process similar to NEPA.

There are different levels of environmental review, including abbreviated processes such as Categorical Exclusions (CEs) that do not include public comment periods and more comprehensive documents such as Environmental Assessments (EAs) and Environmental Impact Statements (EISs) that include varying levels of public review and comment. An alternatives analysis may need to be conducted in these higher levels of NEPA review (particularly EISs), and the evaluation presented in this document can assist in the development of an alternatives analysis. The federal lead agency will determine the type of environmental review required.

Developing a clear strategy, including identifying likely federal funding, permits, and approvals is important in early planning and project development. Early planning should include evaluating groupings of smaller SLR adaptations or other actions into a single environmental review document or reviewing and permitting individual SLR adaptations or other actions that have independent utility[1], if appropriate, as compared to keeping all of the actions grouped as one larger project.

3.1 Environmental Permits

The number of permits required for the Port's Waterwalk project depends on the location of the SLR adaptations (e.g., upland or in-water) and other regulatory triggers. For example, in-water work requires more federal and state permits and authorizations than projects staying above the jurisdictional boundaries of state and federal permit agencies.

Based on preliminary concepts prepared for the Waterwalk project, the following environmental permits and approvals are likely to be required. However, as design is advanced, this list of required environmental permits should be updated.

1 Independent utility means a project that stands on its own and functions independently of any other project. Actions are defined as connected if they (40 CFR 1508.25): (i) Automatically trigger other actions which may require environmental impact statements. (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously. (iii) Are interdependent parts of a larger action and depend on the larger action for their justification.

- Federal:
  - Federal lead agency: NEPA compliance
    - DAHP: Section 106 of the NHPA
    - Services (NMFS and USFWS): including Section 7 of the ESA
  - Corps: Section 404 of the CWA and Section 10 of the RHA
  - Tribal Consultation

- State:
  - State lead agency: SEPA review
  - Ecology: Section 401 of the CWA
  - Ecology: CZMA
  - Ecology: NPDES or Stormwater General Permit
  - WDFW: HPA

- Local:
  - City of Port Townsend: SSDP/ CUP/ Shoreline Variance

Environmental permits and authorizations needed for upland work (i.e., no in-water work required):

- Federal:
  - Federal lead agency: NEPA compliance
    - DAHP: Section 106 of the NHPA
    - Services (NMFS and USFWS): including Section 7 of the ESA
  - Tribal Consultation

- State:
  - State lead agency: SEPA review
  - Ecology: NPDES or Stormwater General Permit

- Local:
  - City of Port Townsend: SSDP/ CUP/ Shoreline Variance

In-water work may result in at least 5 additional permits and authorizations and the need to work with additional resource agencies. The number of resource agencies also depends on the state and federal SEPA/NEPA leads. Triggers for these various permits and authorizations are more thoroughly identified in Table 4. Keeping work and structures above jurisdictional boundaries would significantly reduce the level of effort and complexity of obtaining environmental permits.

Table 4. Triggers for various permits and authorizations needed.

	Agency	Type of Permit/Authorization	Permit/Authorization Triggers
Federal	Federal Lead Agency	National Environmental Policy Act (NEPA) Compliance	Federal agencies are required to assess the environmental effects of a proposed action (e.g., issuing a permit) prior to making decisions.
	Department of Archeology and Historic Preservation (DAHP)	Section 106 of National Historic Preservation Act (NHPA)	Trigger by a federal nexus; potential for ground disturbance or effects on historic properties or cultural resources.
	National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) and Magnuson-Stevens Fishery Conservation and Management Act (MSA) Consultation	Triggered by a federal nexus; potential to affect ESA-listed species or critical habitat. Potential to affect essential fish habitat under the MSA is reviewed by NMFS and is typically combined with an ESA consultation.
	U.S. Army Corps of Engineers (Corps)	Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act	- Section 404: Discharging material in US waters (Puget Sound). Includes disturbance. - Section 10: Any work in, or affecting, navigable waters of the US (Puget Sound).
	Multiple Tribes	Tribal Coordination	Potential impacts within a reservation, areas of cultural significance, or Usual and Accustomed (U&A) fishing areas.
State	State Lead Agency	State Environmental Policy Act (SEPA) Compliance	State and local agencies are required to address the environmental effects of a proposed action (e.g., project action, funding action, permitting action, etc.) Required for activities which are not considered exempt from SEPA (Chapter 43.21C RCW and WAC 197-11); requires an assessment of environmental effects similar to NEPA.
	Washington State Department of Ecology (Ecology)	Section 401 Water Quality Certification (WQC)	Projects with the potential to affect waters of the US require review. Federal agencies cannot issue a license or permit before Ecology makes a determination on a WQC request or waives the right to review.
	Ecology	Coastal Zone Management Act (CZMA) Consistency	Activities and development affecting coastal resources which involve federal licenses or permits require written CZM federal consistency determinations by Ecology.
	Ecology	National Pollutant Discharge Elimination System (NPDES) or Stormwater General Permit (SWGP)	Discharge to surface waters.
	Washington Department of Fish and Wildlife (WDFW)	Hydraulic Project Approval (HPA)	Work that uses, diverts, obstructs, or changes the natural flow or bed or bank of state waters (Puget Sound).
Local	City of Port Townsend	Shoreline Substantial Development Permit (SSDP), Conditional Use Permit (CUP), or Shoreline Variance	Activities proposed near or within critical areas, shoreline areas, or their buffer(s). Process includes an environmental review, which is required for any proposal which involves a government action (i.e., issuing of permits).

3.2 Mitigation

In addition to requiring a greater number of permits and approvals, placement of structures in water typically requires mitigation to offset impacts from the project. Each regulatory agency has mitigation requirements, but agencies generally require a project to follow a prescribed process of mitigation sequencing. Mitigation sequencing involves:

Avoidance: This includes designing the project to avoid habitat impacts altogether through engineering, placement or location of structures, or other processes such as reducing the project footprint.

Minimization: If avoidance is not feasible, the next step is to minimize impacts through design modifications or other means. Minimization aims to reduce the magnitude or extent of potential adverse effects.

Mitigation/Compensation: If impacts cannot be avoided or minimized, agencies require they are mitigated through habitat preservation, enhancement, restoration or creation. Mitigation can be completed on-site near the impact, or off-site. Most agencies have policies and regulations specifying their preference for selection of mitigation actions and locations.

4.0 REGULATORY COMPLIANCE

Both SLR adaptation options and options for a pedestrian walkway are being evaluated to provide climate resiliency for the Port's Waterwalk project. These potential options create the need for regulatory compliance and generate potential mitigation needs. The following information reviews SLR adaptation designs and pedestrian walkway designs provided by KPFF (2024) and Berger (2024) by the Waterwalk section and transition zones identified in Figure 2 above. For each section and zone impacts, mitigation needs, and mitigation opportunities are discussed for the Port's Waterwalk project.

The main focus of information presented below is whether the SLR adaptations will trigger work in federally regulated areas, which is includes work located at or below the high tide line (HTL) as defined under 88 FR 61964 o. HTL is estimated as the average of the highest astronomical (predicted) tides from each year from 2024 to 2034. There are biological markers that can be used to determine the HTL, but no formal survey was conducted at this planning level. It is notable that many of the proposed SLR adaptation options are engineered solutions specifically located above HTL to reduce potential impacts and regulatory hurdles. This approach serves two purposes: (1) provides avoidance and minimization of impacts to species and habitat, and (2) reduces overall mitigation costs for the project.

For purposes of this evaluation, the NMFS Puget Sound Nearshore Habitat Conservation Calculator (the NMFS calculator) was used as the primary tool for estimating mitigation needs and opportunities for the Port's Waterwalk project. The NMFS calculator is a spreadsheet with formulas that converts changes in habitat caused by a project into a currency that represents impacts as debits and improvements/mitigation actions as credits. Projects can offset debits by reducing impacts through design, and by adding an equivalent number of credits through onsite or offsite habitat mitigation. The version of the NMFS calculator that was used for planning purposes is v.1.6 provided on March 8, 2024 (NMFS 2024b). The debits (impacts) and credits (improvements or mitigation opportunities) generated by the NMFS calculator were used to develop a framework for mitigation needs and associated costs.

The information below is divided into potential impacts (debits) and mitigation opportunities (credits) by the section and transition areas identified in Figure 2. The intention is not to balance credits and debits section by section but rather to understand the mitigation needs generated by each section so that offsetting mitigation actions can be developed on a project-wide basis. A summary of how the Port's Waterwalk project is balancing in terms of potential impacts and mitigation opportunities at this planning level is provided in Report Section 6.2.

4.1 Section 1

4.1.1 Potential Impacts

The existing Larry Scott Trail within Section 1 is at an elevation of 12 feet NAVD88. The existing grade of the trail is proposed to be raised by approximately 1 foot to compensate for SLR in this section. Raising the trail would occur approximately 15 feet landward of the HTL, which may avoid federal permitting and mitigation requirements. State mitigation requirements through WDFW (i.e., HPA) and Ecology (i.e., Section 401 of the CWA) are also likely to be avoided. Additionally, the trail is intended for pedestrians and bicycles, which do not generate the same types of pollutants as vehicles thereby limiting potential impacts related to stormwater. Information on stormwater and associated flow path towards areas where water will infiltrate may be required during the permitting process.

4.1.2 Mitigation Opportunities

Mitigation opportunities in this section include enhancement of the existing 1.7-acre palustrine wetland located adjacent to the trail. Mitigation would primarily be completed through the removal of invasive species and planting of native species to increase species diversity. Both removal of invasive grasses (e.g., reed canarygrass) and native plantings (various sedges and grasses) fit into the credit/debit method for wetland mitigation, which can increase the value of the mitigation compared to the riparian improvements under the NMFS calculator. Based on the NMFS calculator, which only accounts for basic categories like changes to the area of trees, shrubs, and herbaceous vegetation, there is only the potential for approximately 11 mitigation credits (NMFS 2024b). Trees and shrubs could be planted in this area. However, the efficacy of planting trees and shrubs without a detailed wetland study is an unknown. Due to the unknowns surrounding enhancement of this wetland, and the ambiguity of the application of this enhancement to federal mitigation frameworks, these mitigation actions are best used as a backup if mitigation credits are still needed after the thorough review of mitigation actions in other sections or during local and state permitting processes.

4.2 Wash Pad Transition Area

4.2.1 Potential Impacts

The existing wash pad is at an elevation of 12 feet NAVD88. The target SLR adaptation elevation for this area is estimated to be 14.5 feet NAVD88. Proposed SLR adaptation options include raising the grade of the existing trail by approximately 2.5 feet and building a new 4-foot concrete seawall land contour to the height of the target SLR adaptation elevation. Raising the trail would occur landward of the HTL and would not likely require federal mitigation. Building a new seawall is also approximately 50 feet landward of the HTL. While federal mitigation may not be necessary in this transition area, local mitigation may be needed during

the SSDP process. In addition, stormwater would likely need to be addressed during permitting and construction. This includes the various BMPs used to control and treat pollutants to minimize or avoid impacts to water quality before discharging to Puget Sound. There is an existing stormwater treatment system located within the footprint of the Boat Haven Marina boatyard that supports facility compliance under the Boatyard General Permit issued by Ecology. Maintaining proper stormwater treatment for the boatyard facility is imperative, as boatyard activities on-site can produce run-off with higher pollutant loading than is acceptable to discharge to U.S. surface waters or surface waters of the state (e.g., Puget Sound). This is also a major concern for ESA consultations, as described more thorough in Report Section 6.3.

4.2.2 Mitigation Opportunities

Mitigation opportunities in this section include improvements within the pocket beach next to the Wash Pad Transition Area. Current concepts from Berger (2024) show a decrease in impervious surface area that could be converted to both saltmarsh and riparian areas. Estuarine wetland enhancement could include up to 105 mitigation credits from conservation actions in this area, depending on species planted and more detailed review of existing conditions. These mitigation actions could also be established using a conservation easement, which would increase the value to 460 mitigation credits. The need for a conservation easement could be justified for this location because of the habitat benefits to prey for ESA-listed species (e.g., forage fish and invertebrates) and juvenile salmonid use.

Mitigation assumptions:

- Approximately 7,000 square feet (SF) of impervious surface area or unvegetated area could be removed and converted to riparian area or green space.
- Approximately 8,925 SF could be planted with native trees and shrubs within the riparian area (130 feet landward of HTL).
- Approximately 2,500 SF of previous impervious surface area could be planted with saltmarsh vegetation and additional enhancements to 22,575 SF of salt marsh habitat could be provided.
- Saltmarsh vegetation is considered cutoff from the shoreline based on existing conditions but connected post-mitigation actions.

As indicated above, the value of this habitat is higher because of potential use by forage fish and juvenile salmonids. Based on data from WDFW (2024c), there is documented sand lance spawning areas in the pocket beach adjacent to the Wash Pad Transition Area. However, substrate enhancement to support forage fish spawning is not allowed in this location as a mitigation opportunity in the NMFS calculator because the site is within an accretion shoreform (Ecology 2024a; NMFS 2024b). While federal mitigation is not likely to be necessary for this transition area, the value of the mitigation opportunity could be used for the Port's Waterwalk project overall.

4.3 Travel Lift Transition Areas and C-Dock Gangway Transition Area

4.3.1 Potential Impacts

These areas mark the transition from the pocket beach to the marina and include locations where the public and Port can access the marina infrastructure. Existing infrastructure in this area include the 300-ton and 75-ton boat lifts, and gangways, piers, and floats in the marina. SLR adaptation option include building a 3-foot temporary flood wall to protect the existing infrastructure from storm events. This flood wall would be landward of the HTL. Federal and state mitigation is not likely to be required for the creation of the temporary flood wall, although mitigation may be needed during the local SSDP process.

4.3.2 Mitigation Opportunities

No mitigation opportunities are identified in these transition areas.

4.4 Section 2

4.4.1 Potential Impacts

Existing structures within Section 2 include a creosote bulkhead at an elevation of 11 feet NAVD88 that supports the marina parking lot and associated buildings. The proposed SLR adaptation option includes constructing a new sheetpile bulkhead directly behind (setback by 1 foot) the existing creosote bulkhead. The top of the sheetpile bulkhead targets an SLR adaptation elevation of 14 feet NAVD88. While this new bulkhead could be built behind the existing bulkhead, it would extend the life of an existing structure and may require federal mitigation. In that event, the new bulkhead could generate approximately 0.16 impact debits per linear foot, resulting in 120 impact debits for a 750 feet bulkhead. In addition to the new sheetpile bulkhead, a new pedestrian pathway would be constructed on the waterward side of the bulkhead. This would be a cantilevered walkway in a smaller section of the marina where the roadway is narrow and pedestrian access is limited. The walkway would be considered an elevated overwater structure and could result in approximately 0.03 impact debits per square foot. If the walkway is 240 feet by 6 feet, then it would result in approximately 36 impact debits.

Impact assumptions:

- The new sheetpile bulkhead would be setback about 1 horizontal foot from the location of the existing creosote bulkhead.
- Approximately 750 feet of the existing bulkhead would be replaced with a new sheetpile bulkhead.
- Horizontal distance between the toe of the bulkhead at 11 feet NAVD88 and SLR adjusted MHHW is 20.28 feet.

- Approximately 240 feet of a 6-foot-wide, grated, cantilevered walkway would be needed. The walkway could be considered an elevated overwater structure and was entered into the NMFS calculator as a pier. This walkway would be built in the Upper Shore Zone.

4.4.2 Mitigation Opportunities

Mitigation opportunities in this section include removal of the existing creosote bulkhead and pilings. Creosote removal could generate approximately 1.8 mitigation credits per ton of creosote removed (1 ton = 55 cubic feet of creosote treated material). Additional credits could be generated from the removal of an existing bulkhead and pilings (regardless of it being creosote treated timber), resulting in approximately 0.05 mitigation credits per linear foot of bulkhead removed, depending on the location relative to MHHW, and 0.3 mitigation credits per pile. Approximately 750 feet of creosote bulkhead and 28 creosote-treated piles could be removed. In total, approximately 290 mitigation credits could be generated from the mitigation opportunities in Section 2.

Mitigation assumptions:

- There are approximately 28 pilings associated with the creosote bulkhead available for removal. Piles are approximately 12 inches in diameter and 40 feet long.
- Approximately 750 feet of creosote bulkhead could be removed at 11 feet NAVD88 for a total of 120 tons of creosote. The existing creosote bulkhead is approximately 2 feet x 4 feet x 750 feet for a total of 6,000 cubic feet.
- Horizontal distance between the toe of the bulkhead at 11 feet NAVD88 and SLR adjusted MHHW is 20.28 feet.

4.5 Section 3

4.5.1 Potential Impacts

Existing structures within Section 3 include a creosote bulkhead at an elevation of 11 feet NAVD88 that supports the marina parking lot and associated buildings. No changes to the existing bulkhead are proposed in this section. The asphalt parking lot and roadway in this section could be raised to 13.5 feet NAVD88 (~2.5 feet above existing grade) to account for SLR. This work would be landward of the HTL, but may require design solutions or mitigation to ensure that stormwater BMPs are providing water quality treatment before discharging into Puget Sound. If stormwater improvements are provided, no additional mitigation should be required since there would be no changes to impervious surface area from the SLR adaptation.

4.5.2 Mitigation Opportunities

No mitigation opportunities are identified in Section 3.

4.6 Section 4 through Section 6, including Transition Areas

4.6.1 Potential Impacts

This area, including the Commercial Dock Gangways Transition Area and Fishery Driveway Transition Area, proposed SLR adaptations include solutions within upland locations. The goal is to ensure that the waterwalk is raised to an elevation of 14 feet NAVD88. These include:

- Raising the concrete sidewalk/trail elevation located at 11 feet NAVD88 by ~3 feet.
- Raising the asphalt street elevation located at 13.5 feet NAVD88 by ~0.5 feet.
- Raising the curb elevation located at 12 feet NAVD88 by ~2 feet.

These proposed SLR adaptations would occur landward of the HTL and would not increase the amount of impervious surface area. Therefore, no federal mitigation should be required. Stormwater treatment, including low impact development (LID) best management practices (BMPs), would likely need to be addressed during permitting and shown to not result in impacts to water quality.

4.6.2 Mitigation Opportunities

Mitigation opportunities in this section include removal of the existing creosote pilings that do not appear to support an existing bulkhead. Approximately 3 creosote-treated piles could be removed. In total, approximately 2 mitigation credits could be generated from the mitigation opportunities in this area. While federal mitigation is not likely to be necessary for this transition area, the value of the mitigation opportunity could be used for the Port's Waterwalk project overall.

Mitigation assumptions:

- There are approximately 3 pilings that are separate from the existing creosote bulkhead available for removal. Piles are approximately 12 inches in diameter and 40 feet long.

4.7 Motel Street End Transition Area

4.7.1 Potential Impacts

Existing structures within the Motel Street End Transition Area include a fish processing plant, Aladdin Inn, and rip-rap armoring protecting the shoreline. The asphalt parking lot and roadway in this section could be raised to an elevation of 14 feet NAVD88 (~1.5 feet above existing grade) to account for SLR. This work would be landward of the HTL, but may require mitigation to ensure that stormwater BMPs are providing water quality treatment before discharging into Puget Sound. If stormwater improvements are provided, no additional mitigation should be required for the SLR adaptations. A 627 SF access ramp is also proposed to

give public access to the pocket beach during low tide. If this feature is included in the Port's Waterwalk project, the access ramp would be expected to generate about 23 impact debits.

Impact assumptions:

- A new access ramp is treated like a boat ramp in the NMFS calculator.
- The width of the access ramp is 6 feet and the length is 104.5 feet.

4.7.2 Mitigation Opportunities

Mitigation opportunities in this section include improvements within the pocket beach next to street end park and additional improvements for pedestrian access. Current concepts from Berger (2024) show a decrease in impervious surface area that could be converted to both saltmarsh and riparian areas. Conversion of impervious surface area would result in an additional 1,673 SF of riparian area in the backshore zone. An additional 1,838 SF of salt marsh and pocket beach habitat could be enhanced in this location, by adding salt tolerant tree or shrub species. Estuarine wetland and riparian enhancement could include up to 19 mitigation credits for this area, depending on species planted and existing conditions. Use of a legal site protection such as a conservation easement could add an additional 105 mitigation credits, which may not be available for a site that is intended for public use. Additional trees and shrubs could be planted in the backshore riparian zone (instead of herbaceous vegetation) to gain additional mitigation credits without the use of a conservation easement. While federal mitigation is not likely to be necessary for this transition area, the value of the mitigation opportunity could be used for the Port's Waterwalk project overall.

Mitigation assumptions:

- Approximately 3,639 SF of impervious surface area or unvegetated area could be removed and converted to riparian area or green space.
- Previous impervious surface area could be planted with herbaceous vegetation, shrubs, and trees.
- Additional enhancements to 1,838 SF could be provided to saltmarsh areas.
- Saltmarsh vegetation is considered cutoff from the shoreline based on existing conditions but connected post-mitigation actions.

4.8 Section 7

4.8.1 Potential Impacts

Section 7 is at an elevation of 12.5 feet NAVD88. The target SLR adaptation elevation for this area is estimated to be 15 feet NAVD88. Proposed SLR adaptation options include building a new 2.5-foot concrete seawall and adding scour protection at HTL. The new seawall would be located approximately 20 feet landward of HTL. However, scour protection would be needed at

the base of the seawall to protect the new wall from erosion. The proposed SLR adaptation option above the HTL and may not require federal mitigation. Scour protection would likely take the form of a triangularly shaped wedge of rock located from the toe of the new seawall to HTL. Therefore, it could generate approximately 0.34 impact debits per linear foot of scour protection. If scour protection is only placed on the 80 feet of sea wall that is near the HTL, this would generate a total of approximately 27 impact debits.

Impact Assumptions:

- Approximately 80 feet of scour protection would be needed to protect the section of seawall that is closest to the HTL.
- The horizontal distance between the toe of the bulkhead at approximately 12.5 feet NAVD88 and SLR adjusted MHHW is 31.20 feet.

4.8.2 Mitigation Opportunities

No mitigation opportunities are identified in Section 7.

4.9 Section 8

4.9.1 Potential Impacts

Section 8 is at an elevation of 12.5 feet NAVD88. The target SLR adaptation elevation for this area is estimated to be 15 feet NAVD88. SLR adaptation options include building a new 2.5-foot concrete seawall and scour protection at HTL. The new seawall would be located approximately 5 feet landward of HTL. Federal mitigation may not be required for the new seawall. No other SLR adaptations are identified for this section.

4.9.2 Mitigation Opportunities

No mitigation opportunities are identified in Section 8.

4.10 Decatur Street End Transition Area

4.10.1 Potential Impacts

Existing structures within the Decatur Street End Transition Area include the Pour House Brewery and rip-rap armoring protecting the shoreline. The asphalt parking lot and roadway in this section could be raised to an elevation of 14 feet NAVD88 (~1.5 feet above existing grade) to account for SLR. This work would be landward of the HTL, but may require mitigation to ensure that stormwater BMPs are providing water quality treatment before discharging into Puget Sound. If stormwater improvements are provided, no additional mitigation should be required. A 693 SF access ramp is also proposed to give public access to the pocket beach during

low tide. If this feature is included in the Port's Waterwalk project, the access ramp would be expected to generate approximately 25 impact debits.

Impact assumptions:

- A new access ramp is treated like a boat ramp in the NMFS calculator but "is this a boat ramp installation" is checked no.
- The width of the access ramp is 6 feet and the length is 115.5 feet.

4.10.2 Mitigation Opportunities

Mitigation opportunities in this section include improvements within the pocket beach next to street end park and additional improvements for pedestrian access. Current concepts from Berger (2024) show a decrease in impervious surface area that could be converted to both saltmarsh and riparian areas. Estuarine wetland and riparian enhancement could include up to 20 mitigation credits for this area, depending on species planted and existing conditions. Use of a legal site protection such as a conservation easement could gain an additional 102 mitigation credits but that may not be appropriate for an area that is also intended for public access. Additional trees and shrubs could be planted in the backshore riparian zone (instead of herbaceous vegetation) to gain additional mitigation credits without the use of a conservation easement. While federal mitigation is not likely to be necessary for this transition area, the value of the mitigation opportunity could be used for the Port's Waterwalk project overall.

Mitigation assumptions:

- Approximately 3,145 SF of impervious surface area or unvegetated area could be removed.
- Previous impervious surface area could be planted with grasses, shrubs, and trees
- Additional enhancements to 2,500 SF could be provided to saltmarsh areas.
- Saltmarsh vegetation is considered cutoff from the shoreline based on existing conditions but connected post-mitigation actions.

4.11 Kearney Street End Transition Area

4.11.1 Potential Impacts

Existing structures within the Kearney Street End Transition Area include businesses along the shoreline and rip-rap armoring protecting the shoreline. Similar to other street end transition areas, the asphalt parking lot and roadway in this section could be raised to an elevation of 14 feet NAVD88 (~1.5 feet above existing grade) to account for SLR. This work would be landward of the HTL but may require mitigation to ensure that stormwater BMPs are providing water quality treatment before discharging into Puget Sound. If stormwater improvements are provided, no additional mitigation should be required.

4.11.2 Mitigation Opportunities

Mitigation opportunities have not been developed in any detail but would be similar to those described above for Decatur Street End Transition Area without the pedestrian access ramp. Current concepts from Berger (2024) for Decatur Street show a decrease in impervious surface area that could be converted to both saltmarsh and riparian areas. Estuarine wetland and riparian enhancement could include up to 20 mitigation credits for this area, depending on species planted and existing conditions. Additional trees and shrubs could be planted in the backshore riparian zone (instead of herbaceous vegetation) to gain additional mitigation credits. While federal mitigation is not likely to be necessary for this transition area, the value of the mitigation opportunity could be used for the Port's Waterwalk project overall.

4.12 Section 9 through 11

4.12.1 Potential Impacts

These sections include the Pour Hour patio, Water Street roadway, and Indian Island peninsula. These sections would likely require SLR adaptation options that occur within upland locations. The goal is to ensure that the waterwalk is protected up to an elevation of 14 feet NAVD88. The proposed SLR adaptations include:

- Building a 3-foot new seawall starting at an elevation of 12 feet NAVD88.
- Building a 3-foot curb at a starting elevation of 12 feet NAVD88 by adding a new sheet pile bulkhead.
- Raising the existing trail elevation at 14 feet NAVD88 by 1-foot.

These SLR adaptations could occur landward of the HTL and would not increase the amount of impervious surface area. There is the potential for portions of these SLR adaptations to be included in federal permitting for the project (e.g., stormwater) or a new seawall even though these SLR adaptations are landward of the HTL. Therefore, while no additional federal mitigation should be required there is the possibility that mitigation would be needed to show improvements for water quality.

4.12.2 Mitigation Opportunities

Mitigation opportunities along the Indian Island peninsula are significant but have not been developed in detail at this time. The property is not owned by the Port or the City of Port Townsend, but there is some right-of-way area available that could provide additional areas for the Port's Waterwalk. Improvements could include pulling the shoreline stabilization along Indian Island back to allow for more natural coastal processes to occur. However, development of detailed mitigation concepts for this area was outside the scope of this project.

Mitigation opportunities easily identified in this section include removal of existing creosote pilings that do not appear to support any existing structure and removal of debris along the shoreline. Part of this debris is from a failing roadway that is eroding due to problems caused by previous flooding. It is possible that approximately 35 creosote-treated piles could be removed. In total, approximately 42 mitigation credits could be generated from the mitigation opportunities in this area. While mitigation is not likely to be necessary for these sections, the value of the mitigation opportunity could be used for other areas of the Port's Waterwalk project site.

Mitigation assumptions:

- There are approximately 35 pilings available for removal that do not seem to belong to any existing structure. Piles are approximately 12 inches in diameter and 40 feet long.

4.13 Section 12

4.13.1 Potential Impacts

The target SLR adaptation elevation for this section is 15 feet NAVD88. The simple approach would be to raise the height of the existing rip-rap bulkhead by 2 feet. However, the structural integrity of this bulkhead is not known and adding to the height may not be a feasible option. Alternatively, another SLR adaptation option for this section includes replacing the existing rip-rap bulkhead. Replacing the bulkhead would require federal permitting and mitigation, as this replacement extends the life of the existing structure. Replacing this bulkhead could generate approximately 0.15 impact debits per linear foot of rip rap. With 370 feet of replaced rip rap, this would generate approximately 54 impact debits.

Impact Assumptions:

- Approximately 370 feet of the existing rip rap armoring would be replaced with new rip rap armoring.
- The horizontal distance between the toe of the bulkhead at ~12 feet NAVD88 and SLR adjusted MHHW is 27.68 feet.

4.13.2 Mitigation Opportunities

Mitigation in this section includes removal of the existing rip-rap shoreline armoring. Based on the location of the existing structure, approximately 0.07 mitigation credits could be generated per linear foot. With 370 feet of rip rap removed, 25 mitigation credits would be generated, offsetting some of the impacts discussed earlier, but not fully balancing the proposed replacement.

Mitigation Assumptions:

- Approximately 370 feet of the existing rip rap armoring would be removed.
- The horizontal distance between the toe of the bulkhead at ~12 feet NAVD88 and SLR adjusted MHHW is 27.68 feet.

4.14 Section 13 through 14, Including Transition Areas

4.14.1 Potential Impacts

This area, including the Example Beach Stairs and Water Street Trail Access Transition Areas, propose SLR adaptations that occur within upland locations. The goal is to ensure that the waterwalk is raised to an elevation of 15 feet NAVD88 by building up a 2-foot concrete curb starting at an elevation of 13 feet NAVD88. Building a new concrete curb would occur landward of the HTL. Therefore, mitigation for this action is likely not required.

4.14.2 Mitigation Opportunities

No mitigation opportunities are identified in these sections or transition areas.

5.0 ENVIRONMENTAL COMPLIANCE AND MITIGATION STRATEGY

A comprehensive approach to regulatory compliance would ultimately reduce cost and provide more schedule certainty. Development of a purpose and need statement, early agency engagement, and an emphasis on avoidance and minimization are also approaches described below.

5.1 Purpose and Need

The first recommended step for environmental compliance is to create a strong purpose and need. The purpose and need statement defines the underlying problem the Port's Waterwalk project is trying to address and defines intended objectives. A clear, well-justified purpose and need explains to the public and decisionmakers that the expenditure of funds is necessary and worthwhile and that the priority the project is being given relative to other needed projects is warranted. In addition, although environmental impacts may be expected to be caused by the project, the purpose and need section should justify why impacts are acceptable based on the project's importance. Additionally, a well justified purpose and need is essential to meet the requirements of other federal regulations including CWA Section 404 and helps define alternatives that need to be considered or why alternative are not reasonable or practicable.

NEPA/SEPA Approach

The Port should consider developing a NEPA/SEPA approach by first determining whether each SLR adaptation option has independent utility from the others, and which are dependent on the others for their justification. This will allow the consideration of whether the entire suite of SLR adaptation options needs to be reviewed as one project or if there is the opportunity to advance independent projects separately. In some cases, advancing smaller projects that have independent utility may allow earlier completion than trying to review and approve the entire suite of proposed SLR adaptations in one package.

5.2 Early Engagement

After development of design concepts and NEPA/SEPA approach, a recommended next step is to conduct early engagement meetings with the natural resource agencies to confirm their various jurisdictions and obtain early feedback on agency requirements. This ensures complete permit applications are submitted, allowing for timely review and permit issuance. This effort also encourages communication with agency experts (e.g., NMFS, WDFW, Ecology) that could avoid delays during permit review.

Many agencies have regulations that have differing and sometimes contradictory requirements. By holding a multi-agency meeting to introduce the project, the regulatory agencies can work cooperatively to provide guidance to the Port on permit application needs as well as resolve any contradictory guidance.

Mitigation Sequencing

Preliminary concepts of Waterwalk project addressed the fundamentals of mitigation sequencing: avoid, minimize, and mitigate/compensate for habitat impacts. Avoiding habitat impacts also results in avoiding and minimizing the number of permits required and the mitigation required to obtain permits.

Avoidance

The initial conceptual design created by KPFF (2024) includes SLR adaptation options that mostly avoid in-water work (i.e., within regulated areas below HTL). Avoiding in-water work and associated regulatory requirements provides more certainty for the Port's Waterwalk project schedule and cost estimates. Focusing these improvements within upland locations that are already developed avoids impacts to sensitive nearshore habitat. For example, raising the height of the Larry Scott Trail or increasing curb areas to provide protection from storm surges and king tides would locate infrastructure in areas that include existing impervious surfaces.

For portions of the project that are close to the HTL, the Port should coordinate with the resource agency to confirm whether a permit is required, and if there are further avoidance measures to eliminate the need for a permit. For example, the Port may provide documentation to the Corps on the proposed action and request a No Permit Required letter that would confirm the project successfully avoided habitat impacts and therefore the need for a Corps permit for that SLR adaptation option.

Minimization

The conceptual design for the Port's Waterwalk project has found innovative ways to approach the dual purpose of pedestrian access and mitigation opportunities. This could result in an overall reduction of impervious surface areas, new access for pedestrians, and enhanced shorelines that support ESA-listed species. In some areas, it is not possible to fully avoid in-water work for the Port's Waterwalk project. Based on the review of SLR adaptations discussed above (Report Section 4.0), the activities below would result in habitat impacts and would require additional permits and approvals:

1. Building a cantilevered overwater walkway.
2. Providing scour protection for areas that overlap with the HTL.
3. Building ramps for public access at street end parks.
4. Pursuing available mitigation opportunities along the shoreline or in wetlands.

Another action that may require federal permitting is adding a new sheetpile bulkhead behind the existing creosote bulkhead. This is because it is replacing the functions of the existing creosote bulkhead and extending the life of shoreline stabilization along the Port's waterfront. Adding a new bulkhead could be offset by removing the old creosote bulkhead.

5.3 Impacts and Mitigation

Mitigation would be required for SLR adaptations or pedestrian access options that impact habitat with an emphasis on habitat impacts below the HTL. Mitigation options include removal of impervious asphalt surface, planting salt marsh and wetland vegetation, and removing debris and creosote pilings in nearshore habitat. Table 5 presents a summary of both the potential SLR adaptations and habitat mitigation opportunities that may be available by project section, but those opportunities may be used for impact debits generated in other project sections. Table 5 also includes an estimate of mitigation credits that could be used to offset project impacts based on credits generated by the NMFS calculator (v1.6).

Note that mitigation opportunities would require federal, state, and local permitting. These opportunities would be described in a mitigation package for the Port's Waterwalk project and would be incorporated into the project's permit strategy.

Table 5. Port's Waterwalk project SLR adaptations, on-site mitigation opportunities, and assumptions.

Section or Transition Area	Potential SLR Adaptation(s)	Mitigation Opportunities	Permitting and Mitigation Assumptions
Section 1	▪ Raise 1,600 linear feet of trail by ~1 foot to an elevation of 13.5 feet NAVD88	▪ Enhance a 1.7-acre palustrine wetland	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality ▪ No mitigation needs for federal permitting, but mitigation opportunities could be used for the project as a whole
Wash Pad Transition Area	▪ Build a new 4,125 SF pedestrian path to an elevation of 14.5 feet NAVD88 ▪ Build a 4-foot concrete seawall starting at an elevation of 12 feet NAVD88 to an elevation of 14.5 feet NAVD88	▪ Remove 7,000 SF of impervious surface area and unvegetated area ▪ Plant 2,500 SF of saltmarsh vegetation and enhance an additional 22,575 SF ▪ Plant 8,925 SF of trees and shrubs	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality ▪ No mitigation needs for federal permitting, but mitigation opportunities could be used for the project as a whole
Travel Lift and C-Dock Gangway Transition Areas	▪ Build a 3-foot temporary seawall starting at an elevation of 11 feet NAVD88 to an elevation of 14 feet NAVD88	▪ None identified	▪ SLR adaptations require permits for upland work
Section 2	▪ Build a new sheetpile bulkhead starting at an elevation of 12 feet NAVD88 to an elevation of 14 feet NAVD88 ▪ Build 1,440 SF of cantilevered overwater walkway	▪ Remove 750 linear feet of creosote bulkhead ▪ Remove 28 creosote piles and bulkhead totaling ~136 tons of creosote	▪ If the Corps claims jurisdiction for building a new seawall behind the existing structure or the overwater walkway then upland and in-water permits are required; requires mitigation ▪ May need to provide information on stormwater and associated BMPs to improve water quality ▪ No mitigation needs for federal permitting if the Corps does not claim jurisdiction
Section 3	▪ Raise parking lot/roadway by ~2.5 feet starting at an elevation of 11 feet NAVD88 to an elevation of 13.5 feet NAVD88	▪ None identified	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Section 4 through Section 6, and Transition Areas	▪ Section 4: Raise concrete sidewalk/trail by ~3 feet to an elevation of 14 feet NAVD88 ▪ Section 5: Raise asphalt street by ~0.5 feet to an elevation of 14 feet NAVD88 ▪ Transition areas: Build a 3-foot temporary seawall starting at an elevation of 11 feet NAVD88 to 14 feet NAVD88 ▪ Section 6: Raise the curb by ~2 feet to an elevation of 14 feet NAVD88	▪ Remove 3 creosote piles totaling ~4 tons of creosote	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality ▪ No mitigation needs for federal permitting, but mitigation opportunities could be used for the project as a whole

Section or Transition Area	Potential SLR Adaptation(s)	Mitigation Opportunities	Permitting and Mitigation Assumptions
Motel Street End Transition Area	▪ Raise existing level of asphalt by ~1.5 feet to an elevation of 14 feet NAVD88 ▪ Build a new access ramp for pedestrians	▪ Remove 3,639 SF of impervious surface area or unvegetated area ▪ Plant 1,139 SF of saltmarsh vegetation, 1,000 SF of shrubs, and 1,500 SF of trees ▪ Enhance 1,838 SF of saltmarsh	▪ SLR adaptations require permits for upland and in-water work; requires mitigation ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Section 7	▪ Build a ~2.5-foot new seawall starting at an elevation of 12.5 feet NAVD88 ▪ Place 80 linear feet of scour protection/armoring at HTL	▪ None identified	▪ SLR adaptations require permits for upland and in-water work; requires mitigation ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Section 8	▪ Build a ~2.5-foot new seawall starting at an elevation of 12.5 feet NAVD88	▪ None identified	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Decatur Street End Transition Area	▪ Raise existing level of asphalt by ~1.5 feet to an elevation of 14 feet NAVD88 ▪ Build a new access ramp for pedestrians	▪ Remove 3,145 SF of impervious surface area or unvegetated area ▪ Plant 1,145 SF of saltmarsh vegetation, 1,500 SF of shrubs, and 1,000 SF of trees ▪ Enhance 2,500 SF of saltmarsh	▪ SLR adaptations require permits for upland and in-water work; requires mitigation ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Kearney Street End Transition Area	▪ Raise existing level of asphalt by ~1.5 feet to an elevation of 14 feet NAVD88	▪ Estimated to be similar benefits as Decatur Street End Transition Area	▪ SLR adaptations require permits for upland and in-water work; requires mitigation ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Section 9 through Section 11	▪ Section 9: Build a new seawall starting at an elevation of 12 feet NAVD88 ▪ Section 10: Build a new curb supported by a sheet pile bulkhead ▪ Section 11: Raise trail by 1-foot	▪ Remove 35 creosote piles totaling ~20 tons of creosote	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality
Section 12	▪ Option 1: Raise the rip-rap wall by 2 feet to an elevation of 15 feet NAVD88 ▪ Option 2: replace the rip-rap wall with a new bulkhead	▪ Remove 370 linear feet of rip-rap material	▪ Option 1 requires permits for upland work ▪ Option 2 requires permits for upland and in-water work; requires mitigation
Section 13, 14, and Transition Areas	▪ Building a 2-foot concrete curb starting at an elevation of 13 feet NAVD88	▪ None identified	▪ SLR adaptations require permits for upland work ▪ May need to provide information on stormwater and associated BMPs to improve water quality

BMPs = best management practices; HTL = high tide line; SF = square feet; SLR = sea level rise

6.0 COST ESTIMATE

The NMFS calculator (v1.6) was used as a tool to estimate impact debits and mitigation credits as a proxy to identify mitigation needs (i.e., number of debits) and costs. There is also a program available to applicants that use the Salish Sea Nearshore Programmatic (SSNP) consultation through the Puget Sound Partnership (PSP). This program allows an applicant to buy mitigation credits that can be used to balance mitigation needs identified through the NMFS calculator. The current rate is $1,411 per credit (PSP 2024). This program is only available for projects where the Corps is the federal lead, but the costs generated from impact debits in the NMFS calculator and associated cost per mitigation credit can provide a conservative estimate for the Port's Waterwalk project.

6.1 Environmental Costs

The costs below focus on the locations where there is a potential federal permitting requirements (Table 6). These costs only include mitigation needs and no other aspects that may be related to mitigation (e.g., monitoring, field delineations, mobilization and demobilization). These costs are also based on conceptual designs and would need to be updated as project-specific information becomes available.

Table 6. Port's Waterwalk project SLR adaptations, on-site mitigation opportunities, and assumptions.

Section or Transition Area	Potential SLR Adaptation(s)	Impact Debits	Mitigation Cost
Section 2	▪ Build a new sheetpile bulkhead starting at an elevation of 12 feet NAVD88 to 14 feet NAVD88	120	$ 169,320
	▪ Build 1,440 SF of cantilevered overwater walkway	36	$ 50,796
Motel Street End Transition Area	▪ Raise existing level of asphalt by ~1.5 feet to an elevation of 14 feet NAVD88	N/A	N/A
	▪ Build a new access ramp for pedestrians	23	$ 32,453
Section 7	▪ Add scour protection along the HTL	27	$ 38,097
Decatur Street End Transition Area	▪ Raise existing level of asphalt by ~1.5 feet to an elevation of 14 feet NAVD88	N/A	N/A
	▪ Build a new access ramp for pedestrians	25	$ 35,275
Section 12	▪ Option 1: Raise the rip-rap wall by 2 feet to an elevation of 15 feet NAVD88	N/A	N/A
	▪ Option 2: replace the rip-rap wall with a new bulkhead	54	$ 76,194
Other Lump Sum Costs	▪ Palustrine wetland enhancement ($35,000/acre) for 1.7 acres	N/A	$ 59,500
	▪ Additional pling removal	N/A	$ 150,000
	TOTAL	**285**	**$ 611,635**

6.2 Mitigation Opportunities

Based on the total estimate of impact debits calculated at this planning level, there should be enough on-site mitigation opportunities to balance the Port's Waterwalk project (Table 7). These opportunities focus on improvements to existing ESA-listed critical habitat while also addressing a public-interfacing experience to the Port's waterfront. Improvements could include removing creosote piles and bulkheads from the shoreline, adding vegetation to pocket beach habitat, shading for surf smelt spawning areas, converting impervious surface area to riparian vegetation, adding species diversity in saltmarsh habitat, and removing invasive species. These improvements could enhance the shoreline throughout the Port's Waterwalk project site.

Table 7. Port's Waterwalk project SLR adaptations, on-site mitigation opportunities, and assumptions.

Section or Transition Area	Mitigation Opportunities	Mitigation Credits
Wash Pad Transition Area	▪ Enhance existing 1.7-acre palustrine wetland	11
Wash Pad Transition Area	▪ Remove 3,585 SF of impervious surface area ▪ Plant 2,500 SF of saltmarsh vegetation ▪ Plant 3,469 SF of trees	105
Section 2	▪ Remove 750 linear feet of creosote bulkhead ▪ Remove 28 creosote piles and bulkhead totaling ~136 tons of creosote	290
Section 4 through Section 6, and Transition Areas	▪ Remove 3 creosote piles totaling ~4 tons of creosote	2
Motel Street End Transition Area	▪ Remove 3,639 SF of impervious surface area or unvegetated area ▪ Plant 1,139 SF of saltmarsh vegetation, 1,000 SF of shrubs, and 1,500 SF of trees ▪ Enhance 1,838 SF of saltmarsh	19
Decatur Street End Transition Area	▪ Remove 3,145 SF of asphalt ▪ Plant 3,145 SF of saltmarsh (grasses), 1,500 SF of shrubs, and 1,000 SF of trees	20
Kearney Street End Transition Area	▪ Estimated to be similar benefits as Decatur Street End Transition Area	20
Section 11	▪ Remove 35 creosote piles totaling ~20 tons of creosote	42
Section 12	▪ Replace 370 linear feet of rip-rap material	25
	TOTAL	**534**

Not all mitigation opportunities are required to be done, but it appears from the calculations provided in the NMFS calculator that available mitigation could balance the potential in-water or near water SLR adaptations proposed.

6.3 Stormwater Assessment

Recent studies associated with pollutants introduced from stormwater runoff have raised the level to which stormwater should be addressed in permitting and design (Ecology 2024b). Additional costs could be generated from the need to show improvements to the existing stormwater system along the Port's Waterwalk project site during local, state, and federal permitting. Changes to upland locations, such as parking lots and roadways would be evaluated in an ESA consultation based on the potential impacts to water quality. Recently, NMFS has required that applicants provide advanced treatment recommendations by Ecology (2024b) to ensure that projects filter pollutants such as 6PPDQ, oils, and PAHs that can discharge into Puget Sound from impervious surfaces (B. Shorin, pers. comm., 2024). If upland portions of the project are included in the ESA consultation, this may require additional modifications to the existing stormwater system and additional costs to the project that are difficult to estimate without further design.

Similarly, both state permitting (e.g., Ecology NPDES or Stormwater General Permit) and local permitting (e.g., clearing and grading permit) would require information on drainage and stormwater control/treatment at the site. While the project could result in an overall reduction in impervious surface area, that may not be enough to address concerns related to the potential to introduce pollutants into Puget Sound. The existing stormwater system is substantial in locations where the majority of pollutants are present (i.e., boatyard facility), but there may be a need to improve conditions within the remainder of the Port's Waterwalk project site.

Stormwater improvements should be an early engagement topic with NMFS, Ecology, and Port Townsend.

7.0 SUMMARY

The Port's Waterwalk project is located in an area that is characterized as one of the most highly modified shorelines in the City. While the majority (>95%) of existing infrastructure includes hard armoring along the shoreline, the Port's waterfront continues to be exposed to flooding risk due to low elevations and proximity to Puget Sound. Potential solutions for climate resiliency include a variety of highly engineered adaptions (e.g., sheetpile bulkhead) combined with simple approaches (e.g., raising the grade of existing trails or adding curbs to direct water flow). The SLR adaptations are also integrated with a pedestrian waterwalk that work to enhance both public experience and habitat value along the Port's shoreline.

Depending on the location of the proposed SLR adaptation, there are 7 to 12 different federal, state and local environmental permits and authorizations required. Environmental permitting needs also include a range of avoidance, minimization, and compensatory mitigation steps. The primary avoidance and minimization measure considered during conceptual design is focusing impacts on relocating existing infrastructure and designing solutions above the HTL in areas that do not require in-water work. This approach serves two purposes: (1) provides avoidance and minimization of impacts to species and habitat, and (2) reduces overall mitigation costs for the project.

The first component of the permitting strategy for the Port's Waterwalk project is to create a collaborative process that could provide certainty and reduce regulatory review timelines. Early engagement meetings to introduce the project, determine agency jurisdiction, and identify permits needed for the project would aid in the permit application and review process. These early conversations should also include a discussion of the existing stormwater treatment within the boatyard facility at the Boat Haven Marina and potential needs for improvements within other locations of the Port's Waterwalk project area that include improvements to roadways and parking lots.

An additional permitting strategy includes preparing a robust mitigation package that provides balance between mitigation needs and project costs. The NMFS calculator (v1.6) was used as a tool to estimate impact debits generated by the project as a proxy to estimate mitigation costs. This approach used the impact debits calculated for project and assigned a mitigation cost of $1,411 per credit needed to offset the impact debits and balance the project. Additional costs were included to address potential mitigation opportunities not captured in other locations (e.g., palustrine wetland enhancement, creosote piling removal). Overall, mitigation costs are estimated to be $611,635 for the Port's Waterwalk project. These mitigation actions would enhance the Port's shoreline, integrate pedestrian access, and support ESA-listed species critical habitat. Overall, on-site mitigation opportunities could account for enough mitigation credits to balance the proposed impact debits associated with the project.

The purpose of this document was to aid the Port in obtaining federal grant funding for the Waterwalk project. The information included baseline environmental conditions along the Port's shoreline, addressed potential impacts from suggested SLR adaptations, identified mitigation opportunities within the Waterwalk project site, and anticipated environmental permits needed to construct SLR adaptations and address future climate resiliency. Solutions for SLR and climate resiliency can create special challenges for regulatory compliance. However, a holistic approach to permitting can create efficiencies and collaborations throughout the process. The conceptual design for the Port's Waterwalk project has found innovative ways to approach the dual purpose of pedestrian access and mitigation opportunities. This document provides a pathway for the Port as they progress in design of the Waterwalk project.

8.0 REFERENCES

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Appendix D
Cost Estimate

Section	Element	Total	Notes
Section 1	Flood Protection	$ 311,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 311,000	
Transition Zone: Wash Pad	Flood Protection	$ 482,000	
	Landscape	$ 308,660	
	Environ		
	Subtotal	$ 790,660	
Transition Zone: 300-Ton Travel Lift Dock Area	Flood Protection	$ 850,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 850,000	
Section 2	Flood Protection	$ 9,819,000	
	Landscape	$ 203,600	
	Environ	$ 220,116	
	Subtotal	$ 10,242,716	
Transition Zone: 75-Ton Travel Lift Transition Area	Flood Protection	$ 400,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 400,000	
Transition Zone: In the Middle of Section 2 / C-Dock Gangway	Flood Protection	$ 200,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 200,000	
Section 3	Flood Protection	$ 597,729	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 597,729	
Section 4	Flood Protection	$ 106,000	
	Landscape	$ 118,000	
	Environ	$ -	
	Subtotal	$ 224,000	
Section 5	Flood Protection	$ 117,828	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 117,828	
Transition Zones (2): Commercial Dock Gangways (between section 5&6, in the middle of section 6)	Flood Protection	$ 300,000	(2) access points, self-closing flood barrier
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 300,000	
Section 6	Flood Protection	$ 85,000	
	Landscape	$ 66,000	
	Environ	$ -	
	Subtotal	$ 151,000	

Section	Element	Total	Notes
Transition Zone: Fishery Driveway Left of Fish Plant/ In Between Stations 42 & 44	Flood Protection	$ 267,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 267,000	
Section 7	Flood Protection	$ 59,000	
	Landscape	$ -	
	Environ	$ 38,097	
	Subtotal	$ 97,097	
Section 8	Flood Protection	$ 2,793,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 2,793,000	
Transition Zone: Motel Stret End	Flood Protection	$ 408,000	
	Landscape	$ 311,500	
	Environ	$ 32,453	
	Subtotal	$ 751,953	
Transition Zone: Decatur Street End Adjacent to Pour House Patio / Station 48	Flood Protection	$ 455,000	
	Landscape	$ 259,887	
	Environ	$ 35,275	
	Subtotal	$ 750,162	
Section 9	Flood Protection	$ 599,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 599,000	
Transition Zone: Kearney Street End / Station 52	Flood Protection	$ 377,000	
	Landscape	$ 261,900	
	Environ		
	Subtotal	$ 638,900	
Section 10	Flood Protection	$ 2,183,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 2,183,000	
Section 11	Flood Protection	$ 19,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 19,000	
Section 12	Flood Protection	$ 861,000	
	Landscape	$ -	
	Environ	$ 76,194	
	Subtotal	$ 937,194	
Transition Zone: Ex-Beach Stairs / Station 64	Flood Protection	$ 300,000	(2) access points, self-closing flood barrier
	Landscape	$ -	
	Environ	$ -	
	Subtotal	$ 300,000	

Section	Element	Total	Notes
Section 13	Flood Protection	$ 45,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	**$ 45,000**	
Transition Zone: Water St Trail Access / Station 68	Subtotal	$ 50,000	Low Lump Sum SWAG for this section as discussed on 3/14 between KPFF & Berger
Section 14	Flood Protection	$ 10,000	
	Landscape	$ -	
	Environ	$ -	
	Subtotal	**$ 10,000**	
Transition Zone: East End Trail Termination	Subtotal	$ 32,000	
Other Lump Sum Costs	Stormwater Mgt	$ 44,261	
	Additional Piling Removal	$ 150,000	
	Palustrine Wetland Enhancement	$ 59,500	
	Subtotal	$ 253,761	
Total Estimate of Probable Construction Cost		**$ 23,912,000**	
Cost w/Escalation (yr/yr)	5.40%	$ 31,104,194	Assuming 5 years, average excalation from ENR over previous 3 years
Cost w/Escalation and Taxes	9.40%	$ 34,027,988	WSST + Local
Cost w/Contengicy (Low Range)	-10%	**$ 30,625,189**	AACE Class 4/5 Estimate for Study/Concept Screeing
Cost w/Contengicy (High Range)	50%	**$ 51,041,982**	AACE Class 4/5 Estimate for Study/Concept Screeing
Engineering/Professional Services	15%	$ 4,665,629	Design, permitting, & engagement
Construction and Project Mgmt	8%	$ 2,488,336	
Port Management	3%	$ 777,605	
Total Soft Costs		$ 7,931,569	
Program total cost (low)		$ 38,556,759	
Program total cost (high)		$ 58,973,552	