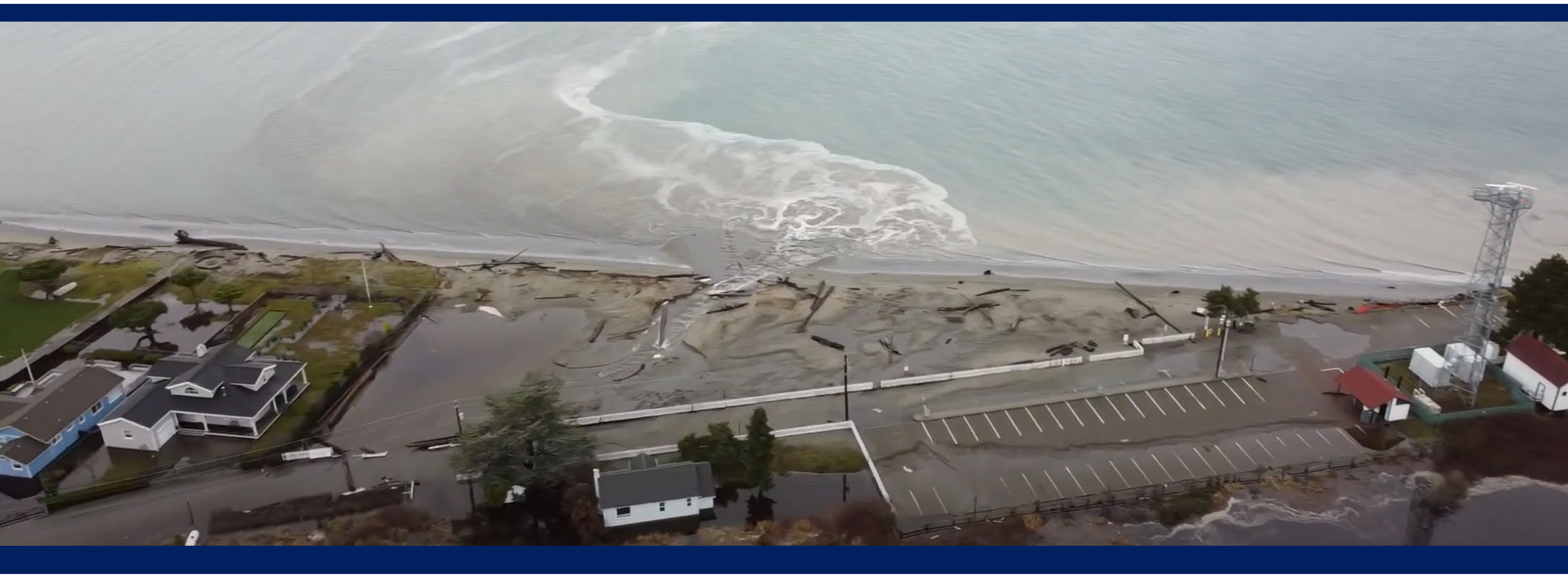

Point No Point

Flood Protection Design Alternatives and Basis of Design

Prepared for
Kitsap County Parks

Prepared by
Blue Coast Engineering LLC

May 2025

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APPENDICES

1 Introduction

At the request of Kitsap County Parks (KCP), Blue Coast Engineering LLC (Blue Coast) has completed an alternatives analysis and design for flood protection measures at Point No Point Park, which is owned in part by KCP and in part by United States Coast Guard (USCG). The land owned by USCG is leased to KCP, who operates and maintains all park infrastructure. The park is located on a low-lying sandy barrier beach at the northeastern tip of the Kitsap Peninsula and at the entrance to Puget Sound from Admiralty Inlet (Figure 1-1). The park consists of a parking lot, restrooms, picnic area, perimeter walking trail, and natural sandy shoreline. Additional facilities on the property include the USCG Light Station (Lighthouse), Keeper's Quarters leased to US Lightkeepers Society and vacation rental, Maggs House vacation rental and three smaller ancillary buildings (Shed/Oil House, Maggs Shedd, and the Barn/Shop)

Flooding on December 27 and 28, 2022, related to high water levels from coincident high tides and a low-pressure system caused substantial damage to the park and neighboring properties and resulted in KCP closing the park to the public. KCP contracted with Blue Coast to develop conceptual design alternatives, final design and specifications for flood protection at the park. KCP requested that the design alternatives meet several goals and objectives:

- Restore the north beach so that the park is usable and can be reopened.
- Limit overtopping of the northern and eastern shorelines.
- Align the project with the planned restoration being led by Mid Sound Fisheries Enhancement Group (MSFEG [Blue Coast 2021, 2023]).

The design alternatives were developed to address the flooding issues at the Park. The preferred design alternative (presented in this report) is meant to provide a longer-term mitigation against flooding during future king tides.[1] In Winter 2023/2024, an imminent danger repair was implemented (Section 4) as Phase 1 of the project to provide an intermediary beach repair to reduce the potential for flooding of the park, road, and neighborhood due to king tides in 2024.

This report summarizes the existing conditions at the site, the development of conceptual design alternatives, and the evaluation of benefits and limitations of each alternative for performance, constructability, permitting, and construction cost. The basis of design for the selected preferred alternative is provided in Section 5.

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[1] A popular, non-scientific term often used to describe exceptionally high tides

Figure 1-1. Point No Point site map.

2 Site Characterization

This section provides a description of the site including ownership and usage of the Park and the natural processes influencing the site.

2.1 Site Description and Background

Point No Point is a low-lying sandy barrier beach located at the northeastern tip of the Kitsap Peninsula at the entrance to Puget Sound from Admiralty Inlet (Figure 1-1). Freshwater wetlands at Point No Point are located to the east and south of NE Point No Point Rd; however, this was once the largest barrier embayment salt marsh complex along the northern shore of the Kitsap Peninsula (Figure 2-1). The freshwater wetlands are fed by an unnamed perennial stream and are connected to Puget Sound via a tide gate along the eastern shoreline.

The site features a historic (see section 2.6) USCG light station and guest houses that are owned and leased as vacation rentals by KCP, and which house the U.S Lighthouse Society headquarters. The site is surrounded by private landownership and residences to the south and north, and is a popular public recreation area for walking, hiking, birdwatching, and fishing.

Point No Point is owned and operated by KCP with a parking lot, restrooms, picnic area, and perimeter walking trail that leads to a set of stairs that ascend to a higher forested park area. The site and adjacent areas are protected from further development through the 2014 Kitsap County Shoreline Master Plan[2].

Kitsap County's 2014 Shoreline Master Plan designates the northern portion of the site as a Natural Shoreline, the most protective designation possible, and the southern half of the site as a Rural Conservancy, which is only slightly less protective. The Park and perimeter walking trail contain nearly 2,040 feet of shoreline, 1,580 feet of which is unarmored sandy beach and 460 feet of which is protected by an aging armor rock revetment. The 1,060-foot perimeter walking trail runs south along the eastern shoreline from the northeastern tip of the park.

Blue Coast and MSFEG completed an alternatives analysis for a shoreline and estuary restoration project (Blue Coast 2021) at Point No Point to replace the tide gate and reconnect up to 32 acres of salt marsh to Puget Sound. The reconnection would involve construction of an open tidal channel through the barrier beach along the eastern shoreline and increases the interior marsh channel complexity to increase the storage of surface water and ground water and provide habitat for fish and wildlife. As part of the restoration project, levees along NE Point No Point Rd would be constructed to contain saltwater within the restored estuary and stormwater infrastructure would be modified based on the selected restoration design.

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[2] https://www.kitsapgov.com/dcd/Pages/Shoreline_Master_Program.aspx

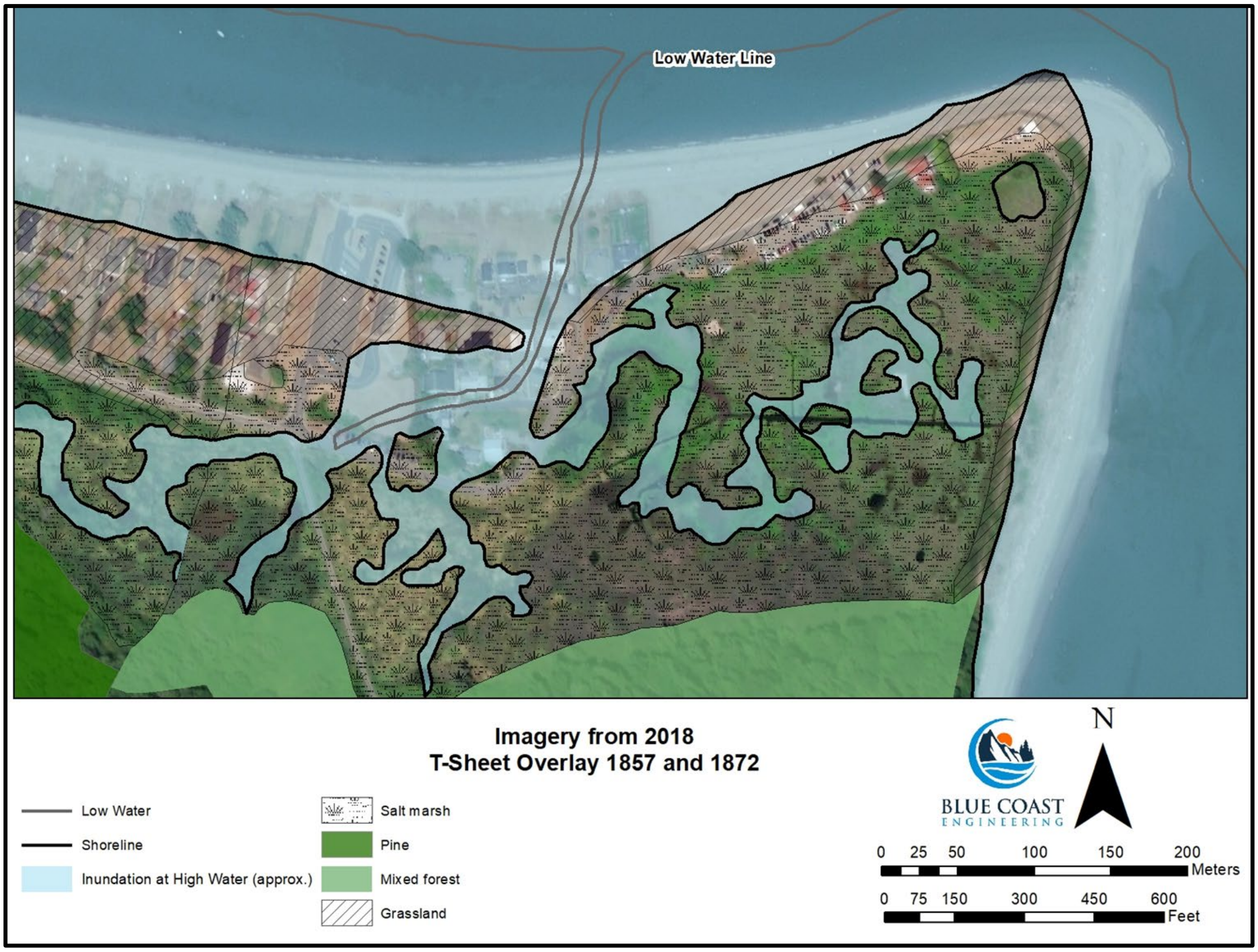

Figure 2-1. Point No Point T-sheet overlay.

2.1.1 Topography

Several topographic data sources exist for Point No Point that were used to identify relevant slopes, elevations, and structure locations for the design:

- Kitsap County completed topographic surveys in the area of the flood damage along north beach, NE Point No Point Rd, and the remainder of the northern shoreline (including the east parking area, rock revetment, and upland lawn area). Two separate topographic surveys were completed by the County, one in January 2023 and a second follow-up survey in February 2023, which included the eastern portion of the northern shoreline.
- The most recent available Light Detection and Ranging (LiDAR) topographic dataset for Kitsap County provided by the United States Geological Survey (USGS). The LiDAR dataset, flown in

December 2017, has a 3-foot resolution with an absolute accuracy of about 0.3 feet and provides coverage outside of the topographic surveys (above mid-tide levels).

- Blue Coast RTK-GPS monitoring surveys of beach profile cross-sections at low-tide were used to analyze beach slope and historical beach change since 2018 (see Section 2.3.5). Relative to the storm events, the most recent surveys were collected on May 3, 2022, September 23, 2022, May 5, 2023, and September 27, 2023.

Descriptions of the post-storm topography (January 2023) and layout of three project areas that are the focus of the flood protection design are provided in the following sub-sections:

North beach:

- 415-foot-long sand beach along the northern shoreline of the park. This shoreline and private development to the west of the park are built on reclaimed (fill) land (see T-sheet overlay, Figure 2-1).
- Vegetated back beach area 20- to 175-feet wide with NE Point No Point Rd and parking adjacent to the south.
- Scattered large wood along the top of the beach.
- This is a heavily used recreational area within the park.
- Elevations (NAVD88[3]):
  - Top of beach: 11 to 12 feet
  - Back beach area: 9 to 11 feet
  - Point No Point Rd: 10 to 11 feet

East parking area and rock revetment:

- 125-foot-long parking area (12 parking stalls) adjacent to sandy beach. The parking area is separated from the beach by a shallow poured concrete “curb.” The curb is less than 1 foot wide and 2 feet in height.
- 460-foot-long rock revetment between the east parking area and end of the point. Abuts east parking area and curb.
- Perimeter walking trail, lawn, benches, lighthouse, and other infrastructure behind the rock revetment.
- Elevations (NAVD88):
  - Top of beach (pre-flooding): 12 feet
  - Top of beach / toe of beach (post-flooding): 9 feet
  - Parking area: 11.5 feet

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[3] North American Vertical Datum of 1988 (NAVD88)

    - Top of rock: 12 to 14 feet
    - Toe of exposed rock (depth of buried rock is unknown): 8 to 9 feet
    - Lawn: 10 to 11.5 feet

Eastern shoreline:

- 1,050-foot length of shoreline extending from the end of the point near the lighthouse to the southern property boundary.
- Sand and gravel beach with scattered large wood along the top of the beach.
- The perimeter walking trail is located atop a levee separating the interior marsh from the shoreline. The tide gate is located mid-way along the length of the shoreline.
- Elevations (NAVD88):
    - Top of levee: 10 to 11.5 feet.

2.1.2 Recent Flooding and Erosion

Two significant events occurred in the winter of 2022 that resulted in erosion and flooding at Point No Point Park. A strong westerly wind event in the Strait of Juan de Fuca on November 5, 2022 resulted in northerly winds through Admiralty Inlet and across the 15-mile fetch to the north and northwest of Point No Point. Although this occurred around during a mean tide (3 to 4 feet NAVD88 water surface elevation), the waves from this event resulted in the formation of a 2- to 3-foot scarp of the upper beach at approximate elevations of 8 to 9 feet NAVD88 (Figure 2-2). The scarp was observed along the length of the north beach and the east parking area.

On December 27, high water levels occurred throughout Puget Sound because of coincident high astronomical tide and a low pressure system, which was the 7th lowest on record (978.3 mb) at Seattle-Tacoma International Airport (NOAA-NWS 2023). This resulted in the highest water level ever recorded at the NOAA Seattle tide station and many other stations throughout Puget Sound. Flood waters at Point No Point breached through both the eastern shoreline and the north beach. The breach through the north beach scoured out a 60-foot-wide channel between the existing shoreline and NE Point No Point Rd (Figure 2-3). Video of the flooding shows floodwater moving through this channel onto the road.[4]

Beach erosion caused several of the parking signs at the east parking area to fall over and resulted in exposure of the base of the curb between the shoreline and the east parking area (Figure 2-4). Erosion in front of the east parking area adjacent to the rock revetment appears exacerbated by the hardened structure (an end effect from the revetment). The rock revetment appears to be in poor condition and is lacking a proper rock gradation, a filter layer, and a geotextile fabric. Pumping of

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[4] Point No Point King tide flooding - YouTube

sediment and rock through the revetment has been observed during storm events. Based on the site review, there was an indication of coastal floodwaters overtopping and eroding portions of the eastern shoreline along the perimeter walking trail.

Following the flooding on December 27 and 28, 2022, KCP installed a temporary wall along the northern edge of NE Point No Point Rd, the parking areas, and the western property boundary. The wall was constructed using super sacks filled with road ballast and covered with plastic tarping (Figure 2-4).

Minor damage to the upland was observed behind the existing riprap near the lighthouse as a result of high tides and wave action on December 27, 2022. Figure 2-5 shows an example of the upland loss of soil and lawn area due to erosion through the excess void spaces in the existing revetement and as a result of overtopping.

Figure 2-2. Photograph of flood damage to north beach, November 2022 (source: Andrew Nelson, Kitsap County).

Figure 2-3. Photograph of flood damage to north beach, December 2022 (source: Darren Gurnee drone video).[5]

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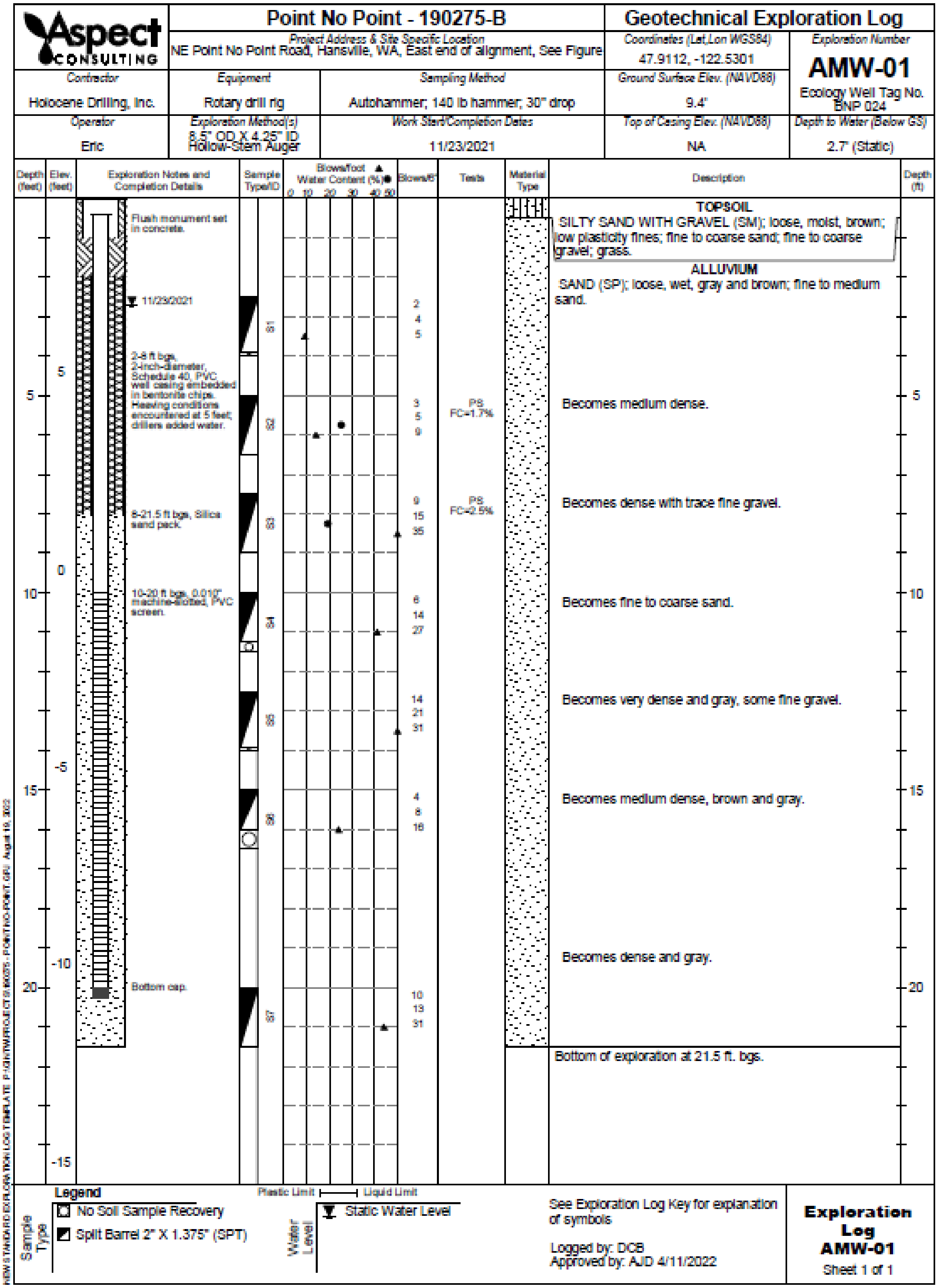
[5] https://www.youtube.com/watch?v=2mIeYsuHgSk

Figure 2-4. Photograph of flood damage to east parking area, December 2022.

Figure 2-5. Photograph of failing armor rock revetment, January 2023.

2.2 Geotechnical Evaluation

Aspect Consulting (2022) conducted an exploration program to determine the soil properties in the Point No Point Park area as part of the Point No Point estuary restoration planning project being conducted by Blue Coast for MSFEG (Blue Coast 2023). The program included five drilled borings to extract sediment cores. Based on the borings, the project site is underlain by topsoil, fill, Holocene-age alluvium, and Holocene-aged, nonglacial, salt marsh deposits, which is in general agreement with the geologic maps of the area. Topsoil was found in the top 6 inches of the ground surface. Salt marsh deposits were encountered in two of the borings from 6 inches to approximately 5 feet below ground surface (bgs). Holocene-age alluvium (generally medium to coarse sand or silty sand) was found in all five borings below the saltmarsh deposits or below the fill in areas where no saltmarsh was found and extended to the depth of each boring (20 to 50 feet bgs). The boring in Point No Point Road near the park entrance (AMW-01) had 1 to 2 feet of topsoil underlain by fine to medium sand (Figure 2-6). Based on these borings and observations of the exposed eroded surfaces after the 2022 storm events, the north beach and below grade of the park is assumed to be medium to coarse sand down to at least 20 feet bgs.



Point No Point - 190275-B

Geotechnical Exploration Log

Project Address & Site Specific Location: NE Point No Point Road, Hansville, WA, East end of alignment, See Figure

Coordinates (Lat,Lon WGS84): 47.9112, -122.5301

Exploration Number: **AMW-01**

Ecology Well Tag No. BNP 024

Contractor: Holocene Drilling, Inc.

Equipment: Rotary drill rig

Sampling Method: Autohammer; 140 lb hammer; 30" drop

Ground Surface Elev. (NAVD88): 9.4'

Operator: Eric

Exploration Method(s): 8.5" OD X 4.25" ID Hollow-Stem Auger

Work Start/Completion Dates: 11/23/2021

Top of Casing Elev. (NAVD88): NA

Depth to Water (Below GS): 2.7' (Static)

Depth (feet)	Elev. (feet)	Exploration Notes and Completion Details	Sample Type/ID	Blows/6"	Tests	Description
0		Flush monument set in concrete.				**TOPSOIL** SILTY SAND WITH GRAVEL (SM); loose, moist, brown; low plasticity fines; fine to coarse sand; fine to coarse gravel; grass.
		11/23/2021				**ALLUVIUM** SAND (SP); loose, wet, gray and brown; fine to medium sand.
			S1	2 4 5		
5	5	2-8 ft bgs, 2-inch-diameter, Schedule 40, PVC well casing embedded in bentonite chips. Heaving conditions encountered at 5 feet; drillers added water.	S2	3 5 9	PS FC=1.7%	Becomes medium dense.
		8-21.5 ft bgs, Silica sand pack.	S3	9 15 35	PS FC=2.5%	Becomes dense with trace fine gravel.
10	0	10-20 ft bgs, 0.010" machine-slotted, PVC screen.	S4	6 14 27		Becomes fine to coarse sand.
			S5	14 21 31		Becomes very dense and gray, some fine gravel.
15	-5		S6	4 8 16		Becomes medium dense, brown and gray.
	-10					Becomes dense and gray.
20		Bottom cap.	S7	10 13 31		
						Bottom of exploration at 21.5 ft. bgs.
	-15					

Legend

Sample Type
- ☐ No Soil Sample Recovery
- ◪ Split Barrel 2" X 1.375" (SPT)

Water Level
- Static Water Level

See Exploration Log Key for explanation of symbols

Logged by: DCB
Approved by: AJD 4/11/2022

Exploration Log AMW-01

Sheet 1 of 1

Figure 2-6. Exploration log for boring in Point No Point Road at park entrance (Aspect 2022).

2.3 Coastal Processes

The following sections describe the relevant coastal processes (water levels, wind and wind-waves, total water levels, and beach change) at the site. The information is derived from a site characterization completed for the restoration project (Blue Coast 2021) updated to include recent data and observations relevant to this project.

2.3.1 Water Levels

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. Reference vertical datums and projections for sea level rise are provided in this section to understand the frequency and level of inundation along the shoreline at Point No Point.

Characteristic tidal datum elevations are calculated for Point No Point using the NOAA Vdatum online tool (Table 2-1) and include the offset to North American Vertical Datum of 1988 (NAVD88) relative to Mean Lower Low Water (MLLW). A National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) analysis of the water level record provides extreme water levels at the Seattle station (#9447130, 22 miles SE of the project site) relative to the 1983 to 2001 epoch with projections to 2018 based on the linear historic trend in mean sea level. The extreme water levels (1-year, 2-year, 50-year, and 100-year return interval) based on the analysis are provided in Table 2-1 for Seattle and Point No Point (extrapolated from Seattle). The extreme water levels range from 10.1 feet NAVD88 for the 1-year return interval (roughly equivalent to a king tide) to 11.6 feet for the 100-year return interval. The extreme water levels include fluctuations due to astronomical tide, storm surge, and wind and wave setup, but do not include wave run-up. Water levels at the project site will be incorporated into the design alternatives for flood protection.

Table 2-1 also includes water levels for two extreme water level events at Point No Point:

- *January 7, 2022: 11.0 feet NAVD88 (between 2 and 10-year water level).* This event resulted in moderate flooding along the shoreline and road.
- *December 27, 2022: 11.8 feet NAVD88 (greater than 100-year water level)*. Extensive flooding and erosion, including breaching of north beach.

The Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP) have prepared Flood Insurance Rate Maps (FIRM) (2017a)[6] and a Kitsap County Flood Insurance Study (FIS) (2017b) that provide flood elevation return intervals for the eastern Kitsap Peninsula. The Base Flood Elevation (BFE) (subject to inundation by the 1% annual chance flood) along Point No Point is mapped as elevation 13 feet NAVD88 (14.8 feet MLLW) on the FIRM. The

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[6] Revision provided by FEMA on October 9, 2023, to Table 17 (personal communication, K. List)

coastal BFE is calculated as the total still water elevation for a 1% annual chance flood plus the additional flood hazard from overland wave effects (storm-induced erosion, wave run-up, and overtopping).

Table 2-1. Summary of water level elevations at Point No Point.

Datum / Elevation	Point No Point[1]	
	Elevation (ft MLLW)	Elevation (ft NAVD88)
FEMA BFE (1% AEP) includes wave effects	14.8	13.0
FEMA SWL (1%AEP), coastal transect 18	14.1	12.3
December 27, 2022	13.6[3]	11.8[3]
January 7, 2022, observed	12.8[4]	11.0[4]
100-year water level (1% AEP)[2]	13.4	11.6
10-year water level (10% AEP)[2]	13.1	11.3
2-year water level (50% AEP)[2]	12.6	10.8
1-year water level (99% AEP)[2]	11.9	10.1
High Tide Line (HTL)	12.0	10.2
Highest Astronomical Tide (HAT)[5]	12.3	10.5
Mean Higher High Water (MHHW)	10.5	8.7
Mean High Water (MHW)	9.6	7.8
Mean Tide Level (MTL)	6.2	4.4
Mean Sea Level (MSL)	6.1	4.3
Mean Low Water (MLW)	2.8	1
Mean Lower Low Water	0	-1.8

Notes: [1]Datums for project site are calculated based on NOAA Vdatum online too; [2]Extrapolated from NOAA-NOS Seattle station (#9497130) extreme water level trend analysis; [3]Estimated based on Seattle station measured tides and subordinate station temporal and height offsets provided for the Hansville, WA Station (9447130); [4]Measured by Blue Coast using offshore water level gage located at +4 feet NAVD88 at Point No Point; [5]NOAA Nearshore Conservation Calculator webmap (Cereghino et al. 2022).

High Tide Line

The location of the High Tide Line (HTL) is defined by the United States Army Corps of Engineers (USACE) in 33 C.F.R. § 328.3. The HTL for this site was determined to be 12 feet MLLW (10.2 ft NAVD88) based on the 10-year average elevation for the highest estimated tide for each year from 2021 to 2030 at the NOAA water level station in Hansville (#9445526) (see Appendix A). This methodology was based on guidance from USACE (Seattle district) on other projects; the location of this elevation in the field coincided with appropriate geomorphic and biological markers.

Ordinary High-Water Mark

The Ordinary High-Water Mark (OHWM) was delineated following Washington State Department of Ecology (Ecology) guidelines (Ecology 2016, WAC 173-22-03(5)), and is generally located above the HTL at the toe of the unarmored bank, the landward extent of large wood, or along intact shoreline armoring. The HTL and OHWM determinations are described in more detail in the technical memoranda provided in Appendix A.

Sea Level Rise

Long-term mean sea level in Puget Sound is predicted to increase versus historical rates of sea level rise (SLR) because of climate-change-related impacts. Miller et al. (2018) provides projections of local SLR at coastal locations in Puget Sound and Washington for various planning horizons. The projections incorporate the latest assessments of global sea level rise due to low (Representative Concentration Pathway [RCP] 4.5) and high (RCP 8.5) greenhouse gas scenarios and local estimates of vertical land motion. The median estimates for SLR (Table 2-2) in year 2050, 2070, and 2100 at the project site range from 0.8 to 2.4 feet. These estimates will be considered in calculations of total water level at the site which will guide the flood protection design.

Table 2-2. Projected median sea level rise for different time periods and greenhouse gas scenarios for the coastal area near Point No Point.

Year	Greenhouse Gas Scenario	Sea level rise magnitude (feet), central estimate (50% probability exceedance)
2050	Low (RCP 4.5)	0.8
2050	High (RCP 8.5)	0.8
2070	Low (RCP 4.5)	1.2
2070	High (RCP 8.5)	1.4
2100	Low (RCP 4.5)	1.9
2100	High (RCP 8.5)	2.4

Notes: Estimates from Miller et al. (2018)

2.3.2 Wind and Wind-Waves

The prevailing wind direction over the eastern Kitsap Peninsula is from the south and southwest in the winter and west and northwest during the summer (Overland and Walter 1983). The strongest winds are typically from the south during winter storm events.

Hourly wind records are available from the Point No Point USCG lighthouse station from 2005 to 2017 and for two short intervals in 2019 and 2022. The closest long-term meteorological stations are West Point (located 18 miles to the southeast of the project site in Seattle) with wind records from 1975 to 2022 and Whidbey Naval Air Station (NAS; located 31 miles to the north of the site on Whidbey Island) with wind records from 1945 to 2022.

Wind roses for the wind records at the three stations are shown in Figure 2-7 superimposed on a map of the region. The wind roses show the bimodal wind distribution at each station, aligning with the local topography along the Strait of Juan de Fuca and Admiralty Inlet at Whidbey NAS, Admiralty Inlet (northwest), and central Puget Sound basin (south) at Point No Point, and along the main axis of the central Puget Sound basin (north to south) at West Point. The strongest winds measured at these stations are between 50 and 60 miles per hour (mph).

The limited wind record at Point No Point has signficiant data gaps and the direction measurements are poor resolution (45 degree increments), as illustrated by joint frequency of occurrence of wind speed and direction compared to Whidbey NAS (Tables 2-3 and 2-4). A review of the wind records indicates that for northerly and westerly winds, the Whidbey NAS station is most representative of conditions at Point No Point, and for southerly winds, West Point is most representative of conditions at Point No Point.

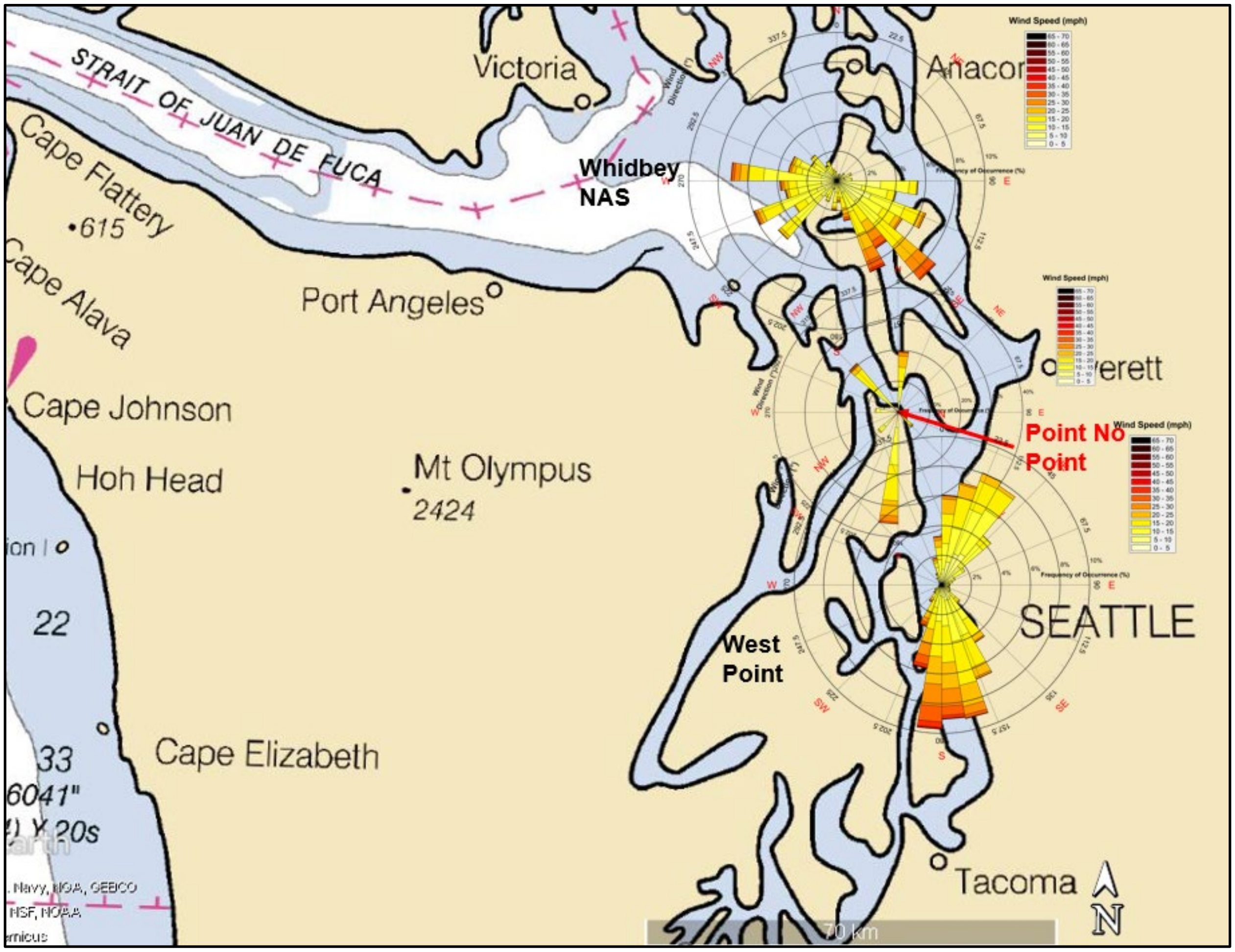


Figure 2-7. Wind rose for the Whidbey NAS, Point No Point, and West Point meteorological stations overlain on a regional map. Direction is the direction from which wind is blowing.

Table 2-3. Joint frequency of occurrence for wind speed and wind direction Whidbey NAS 1945-2023 wind record.

Speed (mph) / Dir. Bin (deg)	Frequency of Occurrence (%)													
	0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	50 to 55	55 to 60	60 to 65	65 to 70
0 to 30	0.5	0.3	0.1	<.1	<.1	<.1	<.1	0	<.1	0	0	0	0	0
30 to 60	0.8	0.4	0.1	<.1	<.1	<.1	0	0	0	0	0	0	0	0
60 to 90	1.4	1.0	0.2	<.1	<.1	<.1	<.1	0	0	0	0	0	0	0
90 to 120	7.0	6.2	2.1	0.4	0.2	<.1	<.1	<.1	<.1	0	0	0	0	0
120 to 150	4.6	4.9	4.3	2.5	1.7	1.0	0.2	<.1	<.1	<.1	<.1	0	0	0
150 to 180	1.7	2.6	2.6	1.7	1.2	0.8	0.2	0.1	<.1	<.1	<.1	0	0	<.1
180 to 210	1.6	1.6	0.6	0.2	0.1	<.1	<.1	<.1	<.1	<.1	<.1	0	0	<.1
210 to 240	2.8	4.4	2.2	0.3	0.1	<.1	<.1	<.1	<.1	<.1	0	0	0	0
240 to 270	3.5	6.1	2.5	0.7	0.4	0.2	0.1	<.1	<.1	<.1	<.1	0	0	0
270 to 300	4.2	5.7	1.8	1.0	0.6	0.3	0.1	<.1	<.1	<.1	<.1	0	0	0
300 to 330	2.4	2.4	0.5	0.1	0.1	<.1	<.1	<.1	0	0	<.1	0	0	0
330 to 360	1.1	1.2	0.6	0.1	<.1	<.1	<.1	0	0	0	0	0	0	0

Table 2-4. Joint frequency of occurrence for wind speed and wind direction Point No Point 2005-2017 wind record.

Speed (mph) / Dir. Bin (deg)	Frequency of Occurrence (%)													
	0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	50 to 55	55 to 60	60 to 65	65 to 70
0 to 30	3.4	4.8	6.3	3.7	1.1	0.3	0.1	<.1	<.1	<.1	0	0	0	0
30 to 60	<.1	<.1	<.1	<.1	0	0	0	0	0	0	0	0	0	0
60 to 90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90 to 120	0.7	0.4	0.2	<.1	<.1	<.1	<.1	0	0	0	0	0	0	0
120 to 150	1.6	2.4	1.5	0.5	0.3	0.1	<.1	<.1	0	0	0	0	0	0
150 to 180	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180 to 210	4.9	12.1	11.5	4.9	1.9	0.6	0.1	<.1	<.1	0	0	0	0	0
210 to 240	6.1	2.1	0.4	<.1	<.1	0	0	0	0	0	0	0	0	0
240 to 270	0	0	0	0	0	0	0	0	0	0	0	0	0	0
270 to 300	5.7	1.6	0.2	<.1	<.1	0	0	0	0	0	0	0	0	0
300 to 330	2.6	7.6	8.0	1.5	0.5	0.4	0.1	<.1	<.1	<.1	0	0	0	0
330 to 360	0	0	0	0	0	0	0	0	0	0	0	0	0	0

An extreme value analysis of the wind records was completed to estimate extreme wind speeds at the site. The return value wind speeds from the extreme value analysis are summarized in Table 2-5 along with the 95% confidence interval wind speeds for the northerly and southerly sectors. The results of a wind-wave hindcast following the following the USACE methodology (Leenknecht et al. 1992) are presented in Table 2-6.

Table 2-5. Extreme wind speeds at Whidbey NAS (northerly wind directions) and West Point (southerly wind directions) meteorological stations (2-minute wind speeds).

Return Period (years)	Northerly wind directions (Whidbey NAS)		Southerly wind directions (West Point)	
	Wind Speed (mph)	95% confidence interval, lower and upper (mph)	Wind Speed (mph)	95% confidence interval, lower and upper (mph)
1	34	33-35	43	42-44
2	39	38-40	46	44-47
5	43	41-44	49	47-51
10	45	43-47	51	50-53
25	48	46-50	54	52-57
50	50	47-52	56	53-59
100	51	48-54	58	55-61

A wind-wave hindcast was completed to estimate the wave conditions at Point No Point during the November 2022 storm event (Section 2.1.2), which resulted in the formation of a 2- to 3-foot scarp near the top of the beach. Wind speeds (Figure 2-8) during the event peaked around mean tide levels (3 to 4 feet NAVD88) at 47 mph at Whidbey NAS and 31 mph at Point No Point. Based on the extreme value analysis for Whidbey NAS, this was the equivalent to a 25-year or 50-year return interval event considering 95% confidence interval for northerly winds. Corresponding wind speeds at West Point were low (<10 mph), reflecting the topographic differences across Puget Sound. Wind direction at Whidbey NAS was westerly while at Point No Point it was northerly.

Wind-wave parameters were calculated using the Automated Coastal Engineering System (ACES) software (Leenknecht et al. 1992) developed by the USACE to estimate wind-wave growth over a restricted fetch in deep water. The calculated wave height (H_s) is 4.5 feet with a peak period (T_p) of 4.3 seconds for the November 2022 storm event.

Table 2-6. Design wind speeds at the Whidbey NAS and Point No Point meteorological stations for northerly wind directions and associated wind-wave hindcast estimates for Point No Point.

Return Period (years)	Northerly wind directions (300° to 40°)		
	Wind Speed (mph)	Significant wave height (ft)	Peak wave period (seconds)
Typical[1]	10	0.5	1.6
1	34	3.1	3.6
25	48	4.7	4.4
50	50	5.0	4.5
100	51	5.1	4.5

Notes: N/A: not applicable; [1]Prevailing wind speed from the northerly sector which occurs approximately 15% of the time based on analysis of the Point No Point meteorological station data record (Blue Coast 2023.

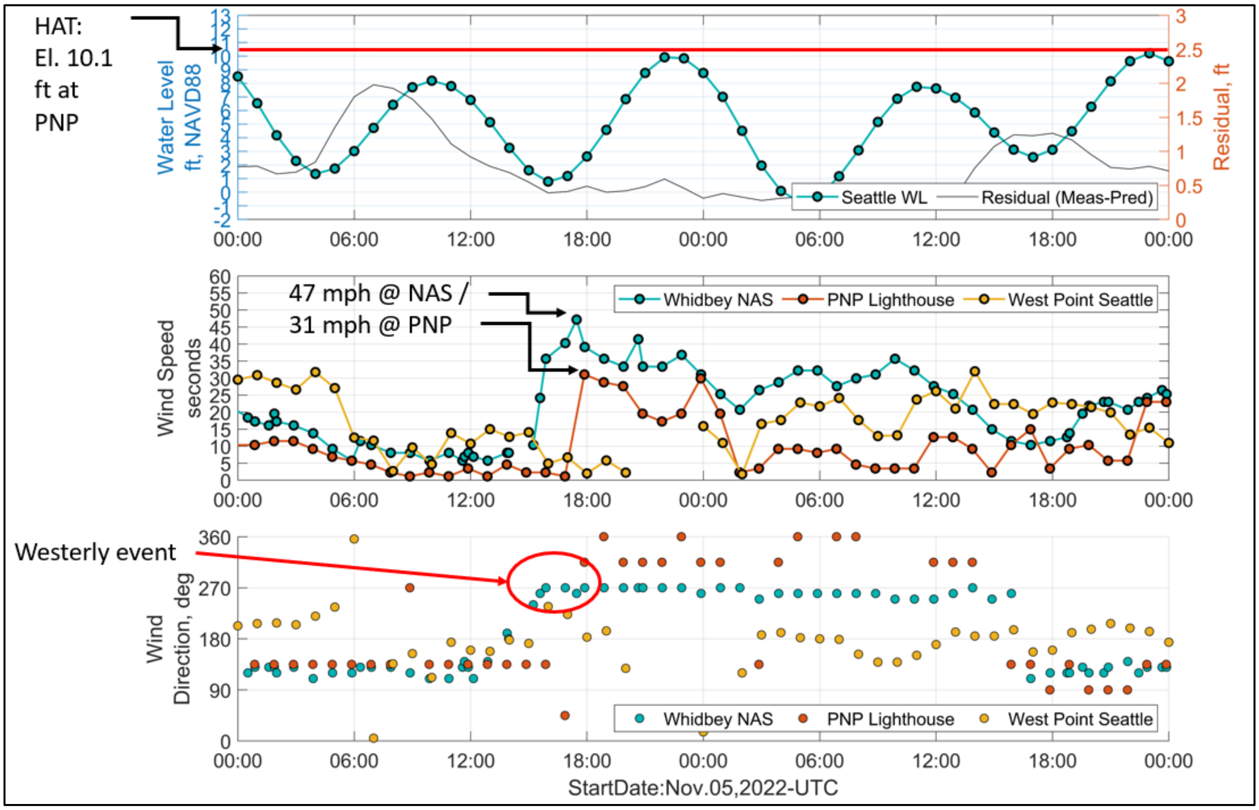


Figure 2-8. Time series of November 2022 wind event with measurements from Whidbey NAS, Point No Point Lighthouse, and West Point (Seattle). Water level record is from the Seattle station.

2.3.3 Wave Run-Up

Wave run-up is the landward extent of wave uprush measured vertically from the still water level and is an important consideration for the vertical extent of flood protection mitigation measures. Wave run-up was estimated for the November 2022 wind-wave event at three transect locations using XBeach (Figure 2-9). XBeach (non-hydrostatic) is a depth-averaged cross-shore one-dimensional model that predicts nearshore hydrodynamics and can be used to predict wave run-up under storm conditions (Roelvink et al. 2015, McCall et al. 2010). The non-hydrostatic module extends XBeach's capability to model non-linear waves and waves breaking in the surf zone. Wave run-up is highly dependent on slope of the beach or structure on which the wave runs up. The beach slopes were calculated based on the 2017 LiDAR topographic survey to be between 8:5:1 and 9.5:1 (Table 2-7) prior to the 2022 storm event. The wave parameters for the November 2022 event estimated using CEDAS (H_s = 4.5 feet, T_p = 4.3 seconds) were input into the model as the offshore boundary condition and the 2017 LiDAR was used as the input surface.

Wave run-up predictions from XBeach were consistent with those predicted using the empirical method of Stockdon et al. (2006) as reported in Melby et al. (2013). These values for $R_{2\%}$ are provided in Table 2-7.

Table 2-7. Predicted wave run-up and total water levels for Point No Point during the November 5, 2022, storm event.

Beach Profile	Slope (H:V) between MTL & HTL	Stillwater level (feet NAVD88)	Wave run-up $R_{2\%}$ (feet)	Total water level (feet NAVD88)
A	9.5:1	4.4	2.0	6.4
B	9:1	4.4	2.1	6.5
C	8.5:1	4.4	2.2	6.6

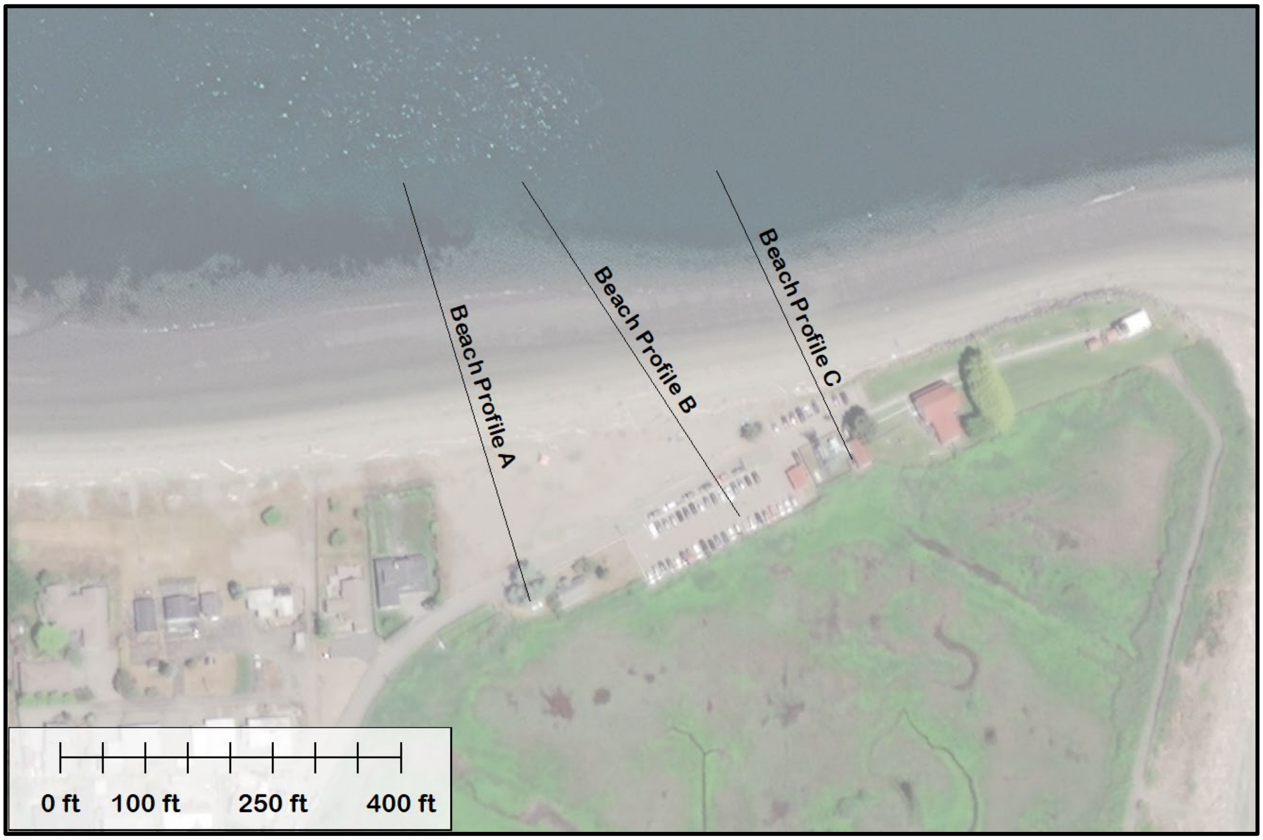


Figure 2-9. Point No Point beach profile locations used in XBeach model.

2.3.4 Total Water Levels

Total water levels (TWL) provide an understanding of the coincidence of high water levels and storm-induced wind-waves and the resulting inundation and erosion along the shoreline. The TWL at the north beach was calculated for several different scenarios (Table 2-8) by summing the stillwater elevation (tide and storm surge), wind-wave run-up, and projected sea level rise out to 50 years (2070). The scenarios present a range of possible water levels that could impact the site. In an extreme scenario, a TWL of almost 14 feet NAVD88 is possible for a coincident 1-year water level and a 25 to 50-year northerly wind-wave event (scenario 3). This would result in overtopping of the north beach and potentially the revetment in the current condition. The TWL scenario increases to 15 feet for a 100-year water level combined with a 25 to 50-year wind-wave event (scenario 4).

Table 2-8. Total water levels at the north beach.

Scenario	Stillwater level, tide and storm surge (feet NAVD88)	Wave Condition	Wind-wave run-up $R_{2\%}$ (feet)	Total water level (feet NAVD88)	Projected sea level rise in 2070, RCP8.5 (feet)	Future total water level (feet NAVD88)
1, high probability	10.1 (1-year)	H_s = 0.5 feet, T_p = 1.6 seconds[1]	0.3 (assumes 7H:1V slope[3])	10.4	1.4	11.8
2, medium probability	11.6 (100-year)	H_s = 0.5 feet, T_p = 1.6 seconds[1]	0.3 (assumes 7H:1V slope[3])	11.9	1.4	13.3
3, medium probability	10.1 (1-year)	H_s = 4.5 feet, T_p = 4.3 seconds[2]	2.0-2.2 (see Table 2-7)	12.1-12.3	1.4	13.5-13.7
4, low probability	11.6 (100-year)	H_s = 4.5 feet, T_p = 4.3 seconds[2]	2.0-2.2 (see Table 2-7)	13.6-13.8	1.4	15.0-15.2

Notes:

1. Typical conditions (see Table 2-6)
2. 25- to 50-year return interval; November 2022 observed wind-wave event
3. Conservative upper limit for beach slope (based on beach profile data) and design slope for beach nourishment placement

Wave runup and overtopping calculations were also completed for the revetment based on guidance provided in the EurOtop (2018) manual on wave overtopping of sea defenses and related structures. EurOtop equations are empirically derived for a wide range of data (university research and government agencies). The results of the wave run-up and overtopping analysis are presented in Table 2-9 and calculation sheets are provided in Attachment F. The results present wave run-up in vertical feet above SWL and overtopping discharge in liters per second per meter of shoreline (l/s/m) to be consistent with units commonly cited in design guidance as damage thresholds. The calculations predict that during typical conditions (scenarios 1 and 2) the revetment is not overtopped, however, overtopping does occur for the extreme wave and water level scenarios (3 and 4) and the TWL exceeds the crest elevation of the revetment (13 feet NAVD88).

Table 2-9. Total water levels at the revetment.

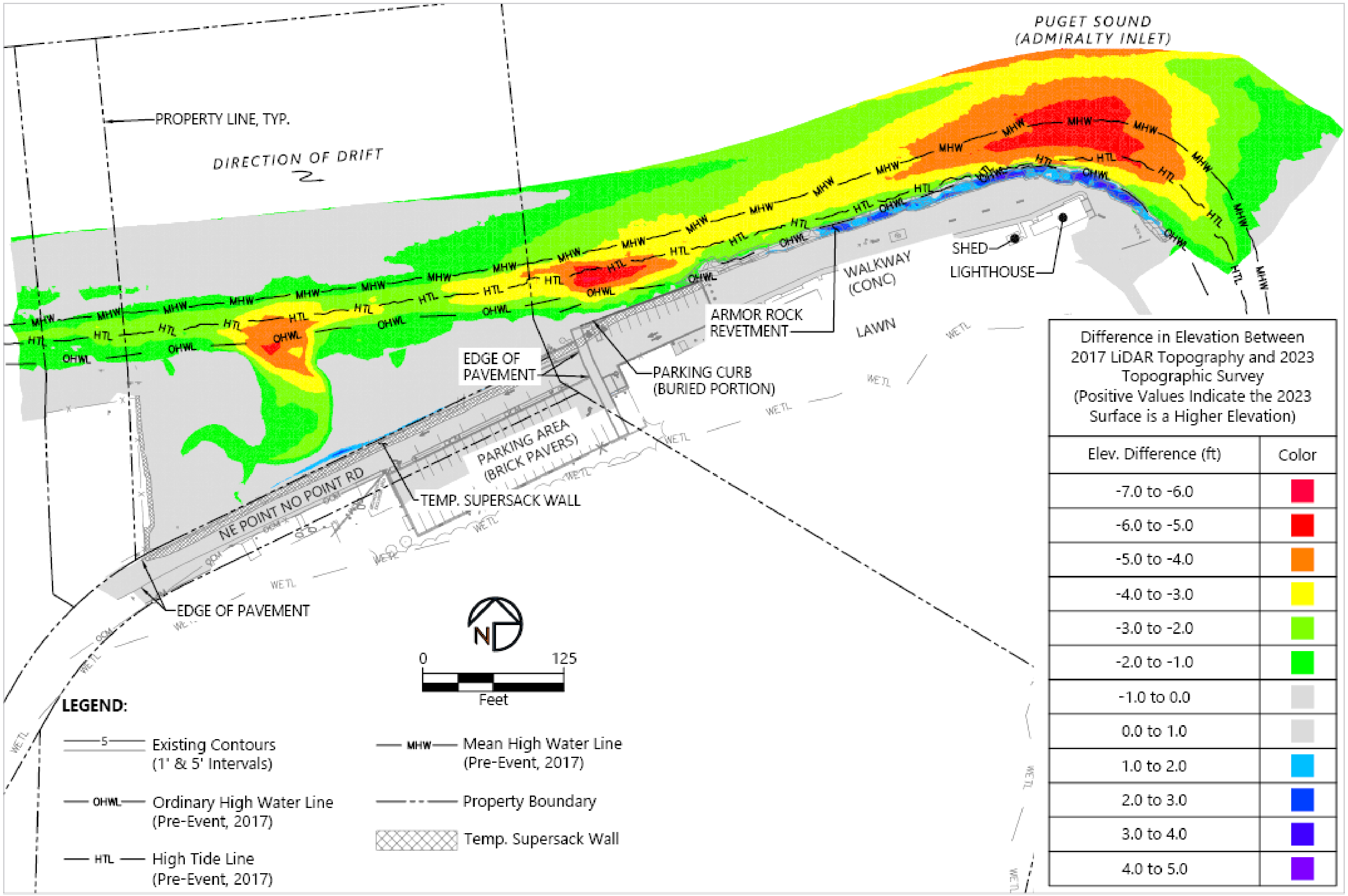
Scenario	Stillwater level, tide and storm surge (feet NAVD88)	Wave Condition	Wind-wave run-up $R_{2\%}$ (feet)[3]	Total water level (feet NAVD88)	Overtopping Discharge (liters per second per m)
1, high probability	10.1 (1-year)	H_s = 0.5 feet, T_p = 1.6 seconds[1]	1.0	11.1	0
2, medium probability	11.6 (100-year)	H_s = 0.5 feet, T_p = 1.6 seconds[1]	1.0	12.6	0
3, medium probability	10.1 (1-year)	H_s = 4.5 feet, T_p = 4.3 seconds[2]	8.2	18.3	85
4, low probability	11.6 (100-year)	H_s = 4.5 feet, T_p = 4.3 seconds[2]	8.2	19.8	214

Notes:

1. Typical conditions (see Table 2-6)
2. 25- to 50-year return interval; November 2022 observed wind-wave event
3. 1.75 H:V slope (design slope for the revetment)

2.3.5 Beach Profiles and Beach Change

An analysis of topographic changes was completed for the north beach and shoreline using a comparison of the 2017 LiDAR topographic dataset to the recent (2023) Kitsap County topographic surveys. The comparison (Figure 2-10) shows 1 to 3 feet of lowering along the top of the beach with higher amounts (4 to 5 feet) where the channel breach occurred. The most erosion occurred in front of the east parking area. Overall, the total volume change from 2017 to 2023 within the survey area was 13,000 cubic yards (CY) of material. This is equivalent to 2,600 CY per year, or approximately 2.3 CY per foot per year of shoreline (averaged over 1,150 linear feet)



Difference in Elevation Between 2017 LiDAR Topography and 2023 Topographic Survey (Positive Values Indicate the 2023 Surface is a Higher Elevation)

Elev. Difference (ft)	Color
-7.0 to -6.0	🟥
-6.0 to -5.0	🟥
-5.0 to -4.0	🟧
-4.0 to -3.0	🟨
-3.0 to -2.0	🟩
-2.0 to -1.0	🟩
-1.0 to 0.0	⬜
0.0 to 1.0	⬜
1.0 to 2.0	🟦
2.0 to 3.0	🟦
3.0 to 4.0	🟪
4.0 to 5.0	🟪

Figure 2-10. Elevation difference map (2017 LiDAR vs 2023 topographic surveys).

To better understand the morphologic response of shoreline, Blue Coast evaluated beach profile monitoring data collected as part of the restoration project since 2018. Topographic elevation data have been obtained at up to 12 shore-perpendicular survey transects (profiles), including four along the northern shoreline (highlighted in red on Figure 2-11). Data were collected using a Trimble R-10 Global Positioning System (GPS) receiver corrected in real time to a high-precision position using the Washington State Reference Network (WSRN) Continuous Operating Reference Station (CORS) accessed through cellular service. Survey points were collected every 5 to 10 feet along the transects and at breaks in grade and changes in substrate or feature type.

Results from the available monitoring data for transects 1 to 4 (located along the northern shoreline) are provided in Figure 2-12 and compared to the recent 2023 topographic survey completed by Kitsap County. -Surveys collected on the following dates were used in this analysis:

- May 3, 2022 (pre-storm)
- September 23, 2022 (pre-storm)
- May 5, 2023 (spring post-storm)
- and September 27, 2023 (fall post-storm)

Observations from the beach monitoring profiles are provided below:

Pre-storm (September 2022 and others):

- Top of beach berm elevation ranged from 11 to 12 feet NAVD88 (transects 1-3)
- Elevation of the beach at the toe of the rock revetment (transect 4) was approximately 9 feet NAVD88 in May 2022

Post-storm (January 2023 and May 2023):

- Top of beach berm elevation ranged from 10 to 11 feet NAVD88
- At the channel breach, the beach elevation was 8.3 feet NAVD88 in December 2022 and recovered to 10 feet NAVD88
- Beach profiles were generally 1 to 2 feet lower than pre-storm profiles except on the lower beach (below 2 to 4 feet NAVD88) where the profiles converge
- Elevation of the beach at the toe of the rock revetment (transect 4) as approximately 7 feet NAVD88
- Horizontal change varied from between 10 to 30 feet between pre- and post-storm profiles

The May 2023 post-storm beach profiles show a partial recovery of the beach to the pre-storm condition with additional recovery occurring between the May and September 2023 time periods; however, the beach had not recovered completely to the pre-storm profile as of September 2023. During the winter storm events of 2022, some of the beach sediment was deposited lower on the beach in a cross-shore bar. That sediment has been mobilized and re-deposited on the upper beach, resulting in the partial recovery of the upper beach. The May 2023 and September 2023 beach profiles do not show the existence of any cross-shore bars on the lower beach, suggesting that any sediment that was transported offshore has already been remobilized. Therefore, any additional recovery to the shoreline will occur through longshore transport of sediment within the littoral cell which is driven by wind-waves arriving obliquely along the shoreline (littoral drift). The rate at which this will occur is unclear and may leave the beach vulnerable to flooding in the interim.

The beach in front of the revetment experienced a drop in elevation of approximately 2 feet between May 2022 and January 2023 as a result of the storm events. There is evidence of a cross-shore bar in the January 2023 survey at the revetment, which does not appear in the May 2023 and the upper beach between January and May 2023 increased in elevation to almost the pre-storm profile in front of the revetment. However, the September 2023 profile indicates erosion of profile in front of the revetment.

Because of the significant changes in the beach to the west of the revetment, the sediment dynamics at the site are complicated during recovery and vary from location to location. Prior to the breach in the north beach, sediment transported alongshore from the west to the east could reach the point and be deposited in front of the revetment. After the 2022 storm events, alongshore sediment will be deposited in the low area where the channel formed first and fill the lowered beach profile in front of the curb to the west of the revetment secondly. The accretion of the beach profile in front of the revetment between January and May are likely the result of cross shore transport of the sediment stored in the bar moving onshore, but by September the sediment in the bar had been redistributed, and sediment being transported alongshore could not make it to the revetment resulting in erosion of the profile between May and September 2023.

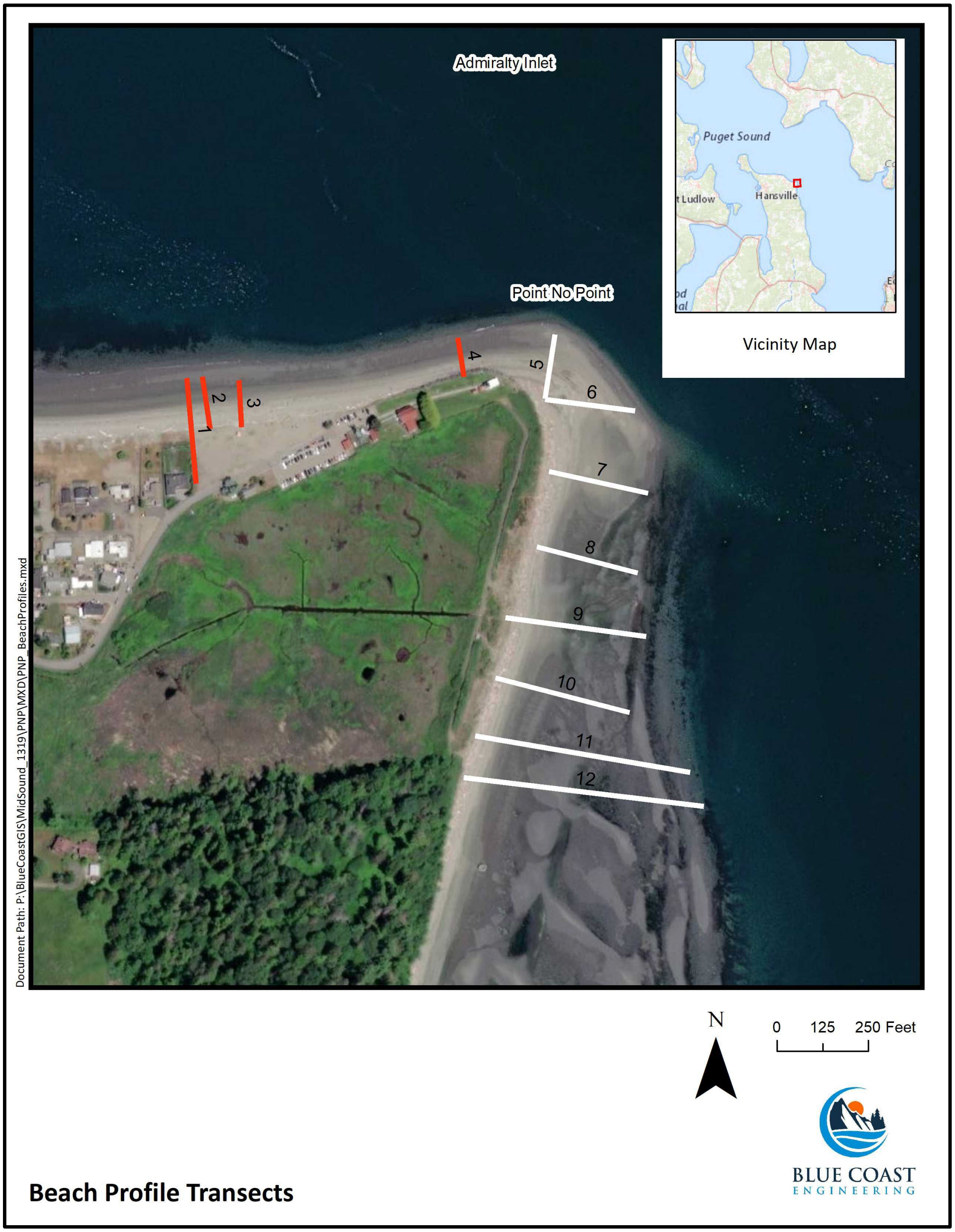


Figure 2-11. Point No Point beach profile monitoring locations. Northern shoreline profiles highlighted in red.

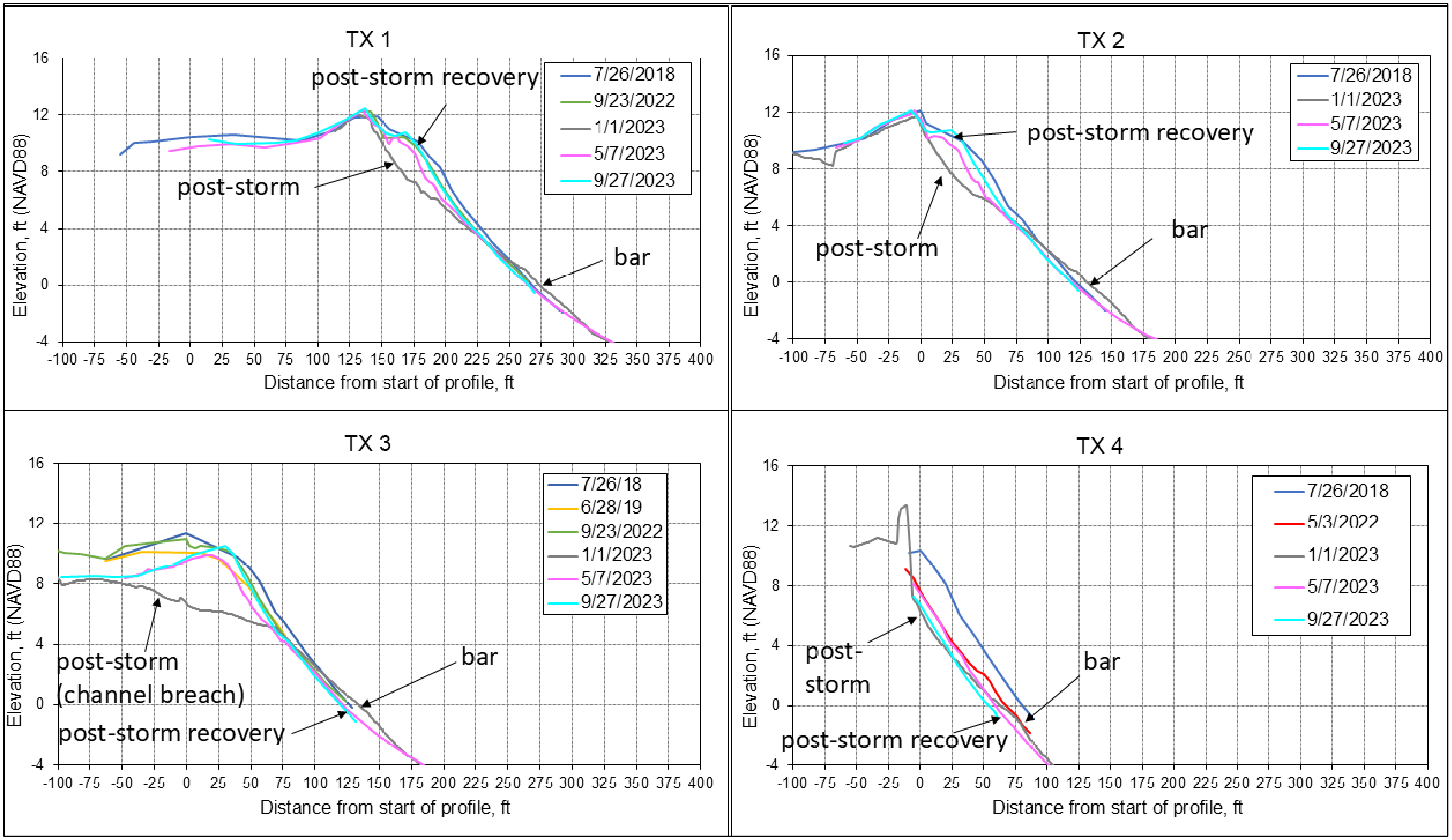


Figure 2-12. Beach monitoring profile plots. Note

2.4 Water level Mapping and Modeling

As part of the restoration project design at Point No Point Park being led by MSFEG, Blue Coast developed a design-level hydraulic model to characterize existing and proposed restoration conditions in the wetland and surrounding shoreline (Blue Coast 2023). This model was revised to include the January and February 2023 topographic surveys of the damaged north beach. This topography includes the breached inlet/channel that formed during the coastal overtopping of the northern shoreline. Although the tidal water levels during the December 27, 2022, event at Point No Point were not directly measured, peak tidal levels were estimated based on measured peak water levels at NOAA stations in Puget Sound (see Section 2.3.1). The estimated peak high tide was 11.8 ft NAVD88 at Point No Point.

The December 27, 2022, event was simulated in the model using the estimated water surface elevation (11.8 ft NAVD88) for the site. The model predicted significant overtopping of the north beach (as was observed on December 27) as well as significant overtopping of the barrier beach on the eastern shoreline of the park. The model was then used to understand the sources of the flooding in the park and quantify contributions from various sources (surface water flow, stormwater direct runoff, groundwater inflow, precipitation and indirect stormwater inflow, and overtopping during wind-wave events).

Output from the hydraulic model shows extensive flooding and very high predicted flow velocities along the northern and eastern shoreline of the park (Figures 2-13 and 2-14). There was also extensive overtopping across the eastern shoreline, but the velocities were lower because the flow was spread out across the shoreline and not focused in a small area. The northern and eastern shorelines each contributed approximately 1/3 of the flood volume observed on the road with the remainder being the result of precipitation and surface water inflow from the unnamed creek that feeds into the southwest boundary of the park. The goals of this project will not address flooding related to precipitation and surface water inflow from the creek.

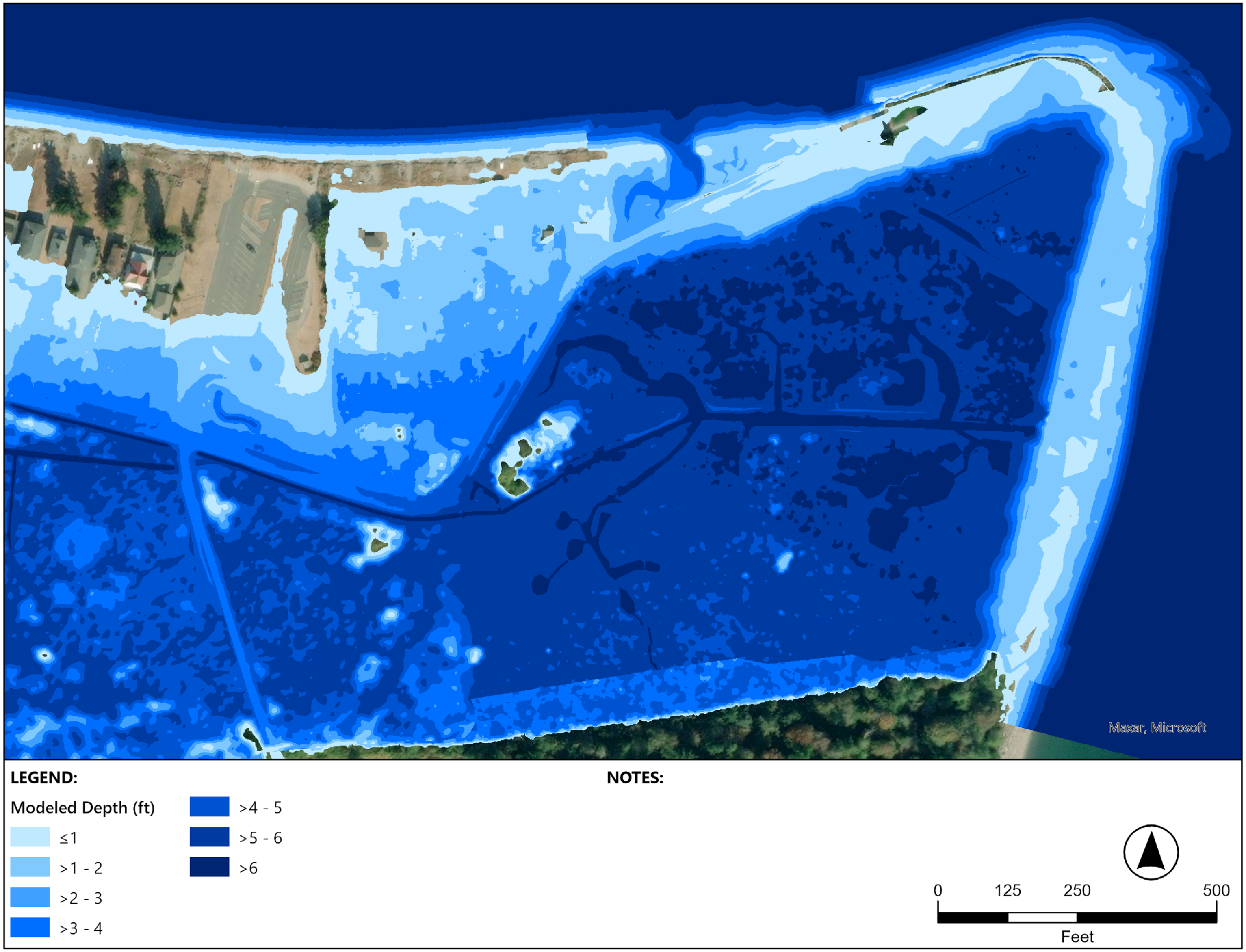


Figure 2-13. Predicted maximum water depth and flooding during the extreme water level event on December 27, 2022. Dark-blue shading indicates areas of maximum inundation.

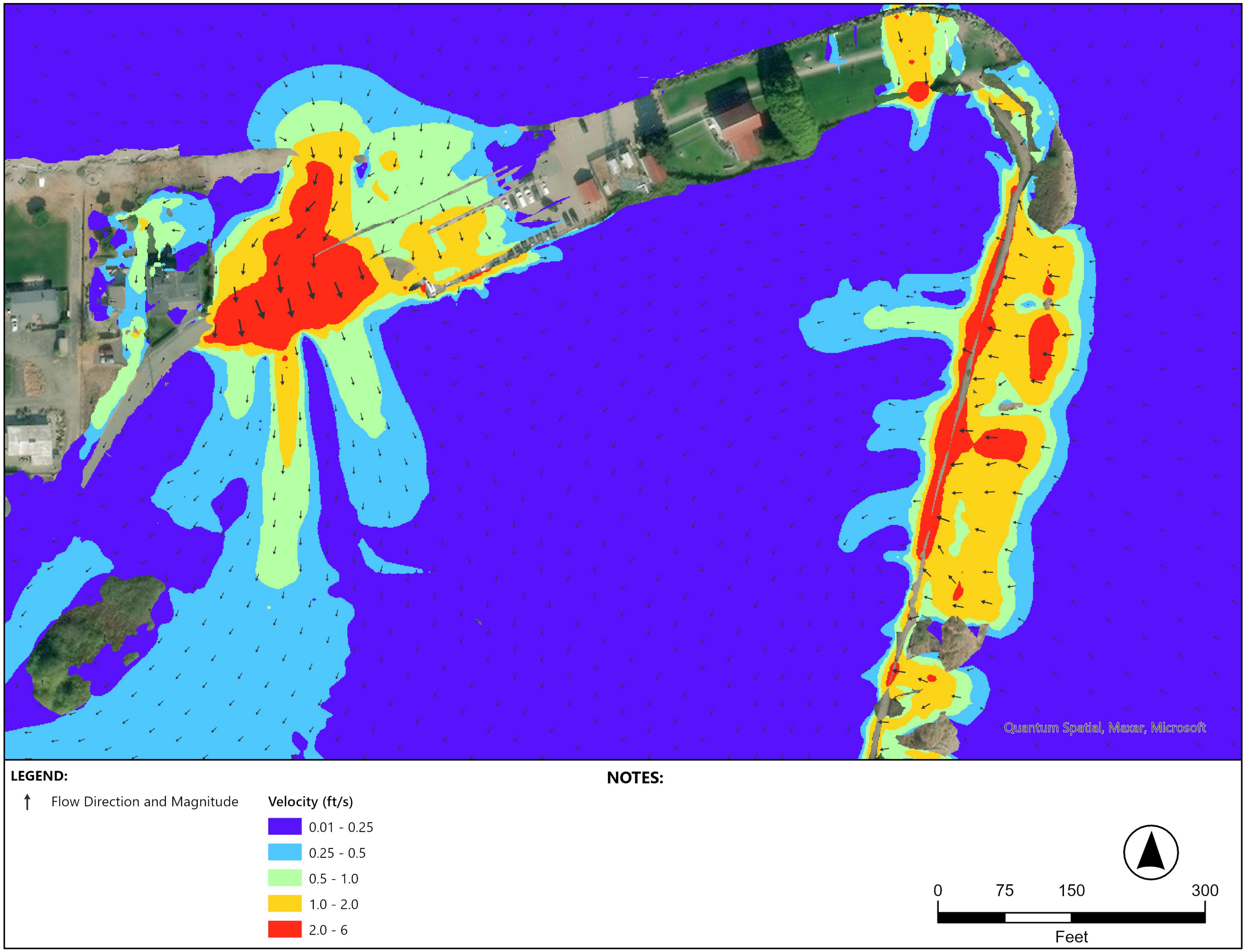


Figure 2-14. Predicted maximum overtopping velocities during the extreme water level event on December 27, 2022. Red shading indicates areas of highest velocities.

2.5 Habitat & Vegetation

The project site is bounded to the north and east by nearshore habitat adjacent to the open waters of Admiralty Inlet and Puget Sound. Nearshore marine vegetation mapping by the Washington State Department of Natural Resources (DNR) shows native and non-native eelgrass along both shorelines of the project area; this was confirmed by observations during site visits as patchy eelgrass (Blue Coast 2023, DNR 2023). No floating or understory kelp is mapped at the site, which is expected given the finer sediment composition. Site observations and DNR mapping also indicate the presence of other understory algal species such as sea lettuce (*Ulva* spp.).

The upper beach along the shoreline (other than near the lighthouse or other built infrastructure) is typical of Puget Sound shorelines, with large wood and salt-tolerant vegetation, including dune grass.

Forage fish (sand lance and surf smelt) are an important prey species for salmon and other fish and bird species in Puget Sound. Sand lance and surf smelt spawn on upper intertidal beaches in areas of mixed sand. The Washington State Department of Fish and Wildlife has documented sand lance spawning on the northern shoreline of the project site (WDFW 2023); spawning habitat in this area appears excellent. Around the point, near the lighthouse, suitable spawning habitat is restricted by armor rock extending into the upper intertidal area. On the east side of the project area, potential spawning habitat for both sand lance and surf smelt is unimpeded by armoring, although no spawning has been documented by known surveys. The site is also used by a variety of other animals, including otters, seals, sea lions, and many species of birds.

2.6 Cultural Resources

Blue Coast subcontracted Environmental Science Associates (ESA) to conduct a cultural resource assessment for the project. This assessment was developed to document any archaeological or historic sites in the project location and to evaluate the potential for the project to affect cultural resources. ESA conducted a desktop analysis, field investigation, archeological monitoring, and historic property inventories. Several areas of cultural resource assessments and historic properties were identified within 2 miles of the project site. Historic resource review of the design indicates there will not be impacts to any of the resources' integrity or ability to convey their significance. ESA does recommend monitoring to avoid the potential of effects on the resources. In addition, ESA recommends all ground-disturbing actions for Phase 2 be subject to active on-site archaeological monitoring because of the cultural importance and historical significance of the site.

3 Conceptual Design Alternatives

This section summarizes goals established for the project, describes the conceptual design alternatives developed for the project site, summarizes the alternatives evaluation, and identifies the preferred alternative for the project site.

3.1 Project Goals

During the project kick-off meeting, KCP identified the following goals and objectives of the project:

- Restore the north beach so that the park is usable and can be reopened.
- Limit overtopping of the northern and eastern shorelines.
- Align the project with the planned restoration being led by MSFEG (Blue Coast 2021).

The design alternatives address repairs in three areas:

- North beach
- East parking area and rock revetment
- Eastern shoreline

The conceptual design alternatives are described in further detail in each of the following sub-sections. Drawings for alternatives 2 and 3 are provided in Appendix B and Appendix C, respectively.

3.2 Design Objectives

Design criteria are provided below for the different repair elements.

North beach:

- Rebuild the beach berm to the pre-storm (2022) condition (elevation of 12 feet NAVD88).
- Limit overtopping, erosion, and breaching of the beach berm, add stabilization, and reduce the maintenance cycle.
- Maintain access to the beach.
- Establish vegetation similar to vegetation along the existing eastern shoreline to help reduce erosion.

East parking area and rock revetment:

- Address end effects of the rock revetment.
- Address scour and undermining of the parking curb.
- Repair the existing revetment to limit piping of sediment and rock through the revetment.
- Provide a consistent crest height and reduce void space in the revetment to reduce upland damage during overtopping events

3.3 Description of Alternatives

Three design alternatives were considered to address flooding and erosion at Point No Point Park:

- Alternative 1: Do nothing.
- Alternative 2: Repair the north beach and foredune area to the pre-event (2022) condition.
- Alternative 3: Over nourish the north beach area and build up the foredune area to a greater elevation than the pre-event (2022) condition to increase resilience against future storm events.

Additional elements included in both alternatives 2 and 3 include:

- Repair beach overwash areas along the eastern shoreline by placing imported beach gravel.
- Replace the parking curb with a wall embedded to a suitable depth and with a suitable footing.
- Reduce end-effect erosion by setting back (realigning) the rock revetment near the parking curb and placing a gravel/cobble toe.
- Rebuild the remainder of the rock revetment.

Specific project elements included in the design concepts are summarized in Table 3-1 and described below.

3.3.1 Alternative 1: Do Nothing

Doing nothing would rely on natural coastal processes to replenish sediment in the north beach area. This has happened already to a limited extent (see beach profiles, Section 2.3.5) through cross-shore and longshore transport of sand. It is believed that during the winter storm events of 2022 some of the sediment was deposited on the lower beach. That sediment, based on the May 2023 beach profiles, was mobilized and re-deposited on the upper beach, resulting in a partial recovery of the upper beach. However, the beach profiles indicate that the sediment has been exhausted, and any additional recovery will only occur through longshore transport. The rate at which this will occur is unclear and may leave the beach vulnerable to flooding in the interim.

If the “do nothing” option is chosen, and no repairs are completed on the beach, there are several risks to the existing infrastructure:

- The parking curb could continue to be undermined, and the curb could topple over onto the beach. Parking area pavers could become displaced, requiring more extensive future repairs (likely). If the parking lot has major failure, the radio tower could be flooded (less likely).
- Because the channel in the back beach area has not filled in, water levels during king tide events could reach the road and erosion could start to undermine the road (low to moderate likelihood).

- The revetment—particularly near the parking area—will continue to unravel and could fail, which may increase flooding near the historic lighthouse (less likely).

3.3.2 Alternative 2: Repair to Pre-Event Condition

This option consists of placing material from the super sacks (or gravel from an alternative source) to fill the channel area and placing beach nourishment material (medium sand) to restore the north beach area to its pre-storm condition. The nourishment would be placed to a similar elevation and slope as the pre-storm condition. Large wood would be stockpiled during construction and replaced following placement of material. Sand fencing would be installed around the perimeter (1,500 feet) of the beach nourishment area, including along the edge of the park's drive aisle (NE Point No Point Rd) to limit wind-blown erosion of the nourishment material.

This alternative would serve as a temporary protection for the next winter storm season but would not provide full reconstruction of the shoreline and protection of the upland infrastructure.

3.3.3 Alternative 3: Enhanced Nourishment and Foredune Construction

This option consists of placing beach nourishment material (medium sand) to construct a beach berm with a larger footprint and higher elevation than the pre-storm condition to account for losses during initial beach stabilization. The beach berm fill would be constructed to a minimum crest elevation of 12.5 feet NAVD88 (1 to 1.5 feet above the pre-storm elevation), a crest width of 20 feet, and a slope of 7H:1V (steeper than the pre-storm condition). Vegetation and large wood would be incorporated into the design in the appropriate locations. Several options were considered for increasing the stability of the beach berm fill, including a biodegradable core or a harder rock or geotube core.

Material from the super sacks (or gravel from an alternative source) could be used to infill the channel area and additional beach nourishment material (medium sand) would be used to raise the elevation of the back beach and foredune area to a top elevation of 14 feet NAVD88 while maintaining sand lance habitat. Coir matting will be placed in 1-foot lifts during the fill placement and will provide an added measure of stability against erosion and channel breaching. The foredune area would be planted with vegetation (grasses, shrubs, and trees) to add surface roughness for mitigation against flooding and overtopping.

Other design alternatives were explored for repair of the parking curb and rock revetment, including:

- Construction of an Ecology-block wall in front of the curb and beach nourishment.
- Placement of rock armor in front of the curb and beach nourishment.
- Construction of a sheetpile wall behind the revetment.
- Repair of the low spots in the revetment.

A summary of the elements for each design alternative is included in Table 3-1. Additional elements included for both alternatives 2 and 3 are specified in the last entry of the table.

Table 3-1. Summary of conceptual design alternatives for Point No Point.

Alternative	Description of elements
1: Do nothing	• No action taken
2: Repair to pre-event condition	• Approximately 410 cubic yards (CY) of imported coarse sand will be placed to infill the post-storm beach channel landward of the high tide line (HTL). • Place approximately 2,200 CY of imported beach nourishment material (medium sand) in the beach nourishment area above and below the HTL. • Install 600 feet of sand fencing on the perimeter of the beach nourishment area including along the edge of the park's drive aisle (NE Point No Point Rd).
3: Enhanced nourishment and foredune construction	• Approximately 410 CY of imported coarse sand will be placed to infill the post-storm beach channel landward of the HTL. • Place approximately 6,800 CY of imported beach nourishment material (medium sand) in the beach nourishment and foredune area above and below the HTL. • Place biodegradable coir matting in 1-foot lifts (up to 5 layers) in the foredune area to provide stabilization to the sand material. • Place salvaged large wood stockpiled during site preparation in the beach nourishment area above HTL. • Plant 18,500 SF of native dune grasses in upper elevations of the beach nourishment area (Planting Zone A). • Plant 33,000 SF of native dune grasses, shrubs, and trees in the foredune area. • Install 1,000 feet of sand fencing on the perimeter of the beach nourishment area including along the edge of the park's drive aisle (NE Point No Point Rd).
East beach repairs (alternatives 2 and 3)	• Place 200 CY of imported beach gravel on the observed beach overwash locations on the east beach, above the OHWM.
Rock Revetment Setback and Parking Curb (alternatives 2 and 3)	• Remove and dispose of 2 CY of concrete rubble and other shoreline debris from the armor rock revetment repair areas. • Excavate and dispose of up to 330 CY of upland soil material from the setback area. • Salvage and stockpile approximately 25 CY of existing shoreline armor rock from the armor rock revetment repair areas. Furnish and place 75 CY of armor rock, 55 CY of filter rock, and 10 CY of chinking rock. • Construct a concrete curb wall at the toe of the east parking area (Appendix D). Backfill the parking lot area (waterward of the concrete curb) with approximately 130 CY of structural fill. • Place 235 CY of additional imported beach cobble between the beach nourishment and armor rock revetment repair areas. to transition from hard armor to soft shoreline.
Rock Revetment Repair (alternatives 2 and 3)	• Excavate and dispose of up to 190 CY of upland soil material from the setback area. • Salvage and stockpile approximately 400 CY of existing shoreline armor rock from the armor rock revetment repair areas. Furnish and place 100 CY of armor rock, 235 CY of filter rock, and 45 CY of chinking rock.

3.4 Evaluation of Alternatives and Preferred Alternative

The conceptual design alternatives were evaluated using evaluation metrics developed using criteria developed based on the project's goal and objectives. The three criteria are listed below:

1. Performance
2. Recreation use, access, aesthetics
3. Implementation feasibility
    a. Overall capital costs
    b. Maintenance and lifecycle costs
    c. Complexity to permit

Scores were assigned to each alternative (Table 3-2). A scoring system of 1 to 3 was used for each metric, with 1 assigned to the alternative(s) best fulfilling the metric. Alternative 3 received the lowest (best) score of 8 and was selected as the preferred alternative.

Table 3-2. Evaluation criteria scoring summary.

Option	Anticipated Performance	Recreation use, access, aesthetics	Overall capital costs	Maintenance and Lifecycle Costs	Complexity to Permit	Total
1: Do nothing	3	3	1	3	1	11
2: Repair to pre-event condition	2	1	2	2	2	9
3: Enhanced nourishment and foredune construction	1	1	3	1	2	8

Notes: 1 = highest benefit / lowest maintenance/lowest capital cost, 3 = lowest benefit /highest maintenance/ highest capital cost

4 Imminent Danger Repair

In December 2023, due to the nature and extent of the storm damage, an imminent danger situation was declared requiring immediate action to avoid threats to the public, private property, and NE Point No Point Road, which provides regular and emergency access. As a result, an interim phase of work (similar to Alternative 2 to repair to pre-storm conditions) was permitted independently of the preferred alternative (Alternative 3). The Point No Point Flood Phase 1 Restoration and Repair was completed in December 2023 and January 2024 with imported beach nourishment and imported beach gravel materials placed in the north beach area to bring the elevation of the eroded beach areas back up to pre-storm conditions (Appendix B). This was intended to provide temporary protection during the storm season while permits are acquired for a full reconstruction project. Specific project elements completed in Winter 2023/2024 are described below:

- Placed approximately 410 CY (or 585 tons) of imported coarse sand and gravel to infill the post-storm beach channel landward of the HTL.
- Placed approximately 2,200 CY (or 3,000 tons) of imported beach nourishment material (medium sand) in the beach nourishment area above and below the HTL.
- Installed 500 linear feet of sand fencing on the perimeter of the beach nourishment area, including along the edge of the park's drive aisle (NE Point No Point Rd).
- Re-placed existing large wood in the shoreline area.

5 Final (100%) Basis of Design

Blue Coast developed the 100% design for flood protection measures at Point No Point Park for the Phase 2 design which would augment the imminent danger repair and provide longer term protective measures against coastal overtopping of the north beach. This section provides the basis of design for a modified version of the alternative 3 based on the implementation of phase 1.

5.1 Design Criteria

The following design criteria have been used as the basis of the design unless these criteria conflict with previously stated design objectives (section 3.2). The primary limitation on using these design criteria is the need to preserve cultural and historic resources by limiting excavation whenever possible.

- Still water Level elevation of 11.6 feet NAVD88, 100-year return period event
- 25- to 50-year wind wave event resulting in 4.5 to 5 foot deep water wave height
- Sea level rise scenario for RCP 8.5 in 2070 equal to 1.4 feet

5.2 Project Elements

Specific project elements included in the preferred alternative are summarized in Table 5-1 and a detailed description of the elements is provided in Sections 5.1.1 to 5.1.4. Drawings for 100% design are provided in Appendix G.

Table 5-1. Final (100%) design of preferred alternative project elements.

Project element	Description of elements
Clearing & Site Preparation	• Relocate and/or protect in-place utilities • Removal of vegetation as needed to access the site
Placement of Beach Nourishment Material	• Place approximately 4,600 CY of additional imported beach nourishment material (medium sand) in the beach nourishment and foredune area above and below the HTL. • Place biodegradable coir matting in 1-foot lifts (up to 2 layers) in the foredune area to provide stabilization to the sand material while plantings get established. • Place 200 CY of imported beach gravel on the observed beach overwash locations on the east beach, above the OHWM.

Project element	Description of elements
Plantings and Restoration	*Plantings may require a separate mobilization depending on the timing of the work.* • Place salvaged large wood stockpiled during site preparation in the beach nourishment area. • Plant 18,500 SF of native dune grasses in upper elevations of the beach nourishment area. • Plant 33,000 SF of native dune grasses, shrubs, and trees in the foredune area. • Install 600 feet of sand fencing on the perimeter and interior of the beach nourishment area including along the edge of the park's drive aisle (NE Point No Point Rd). • Place 20 CY of crushed limestone surfacing and 40 CY of crushed surfacing top course landward of the beach nourishment area as part of the pedestrian trail.
Rock Revetment Setback and Parking Curb	• Remove and dispose of 2 CY of concrete rubble and other shoreline debris from the armor rock revetment repair areas. • Excavate and dispose of up to 230 CY of upland soil material from the setback area. • Salvage and stockpile approximately 25 CY of existing shoreline armor rock from the armor rock revetment repair areas. Furnish and place 75 CY of armor rock, 55 CY of filter rock, and 10 CY of chinking rock. • Construct a concrete curb wall at the toe of the east parking area (Appendix D). Backfill the parking lot area (waterward of the concrete curb) with approximately 130 CY of structural fill. • Place 235 CY of additional imported beach cobble between the beach nourishment and armor rock revetment repair areas.
Revetment Repair	• Excavate and dispose of up to 190 CY of upland soil material from the setback area. • Place 235 CY imported filter rock as the base layer in the armor rock revetment repair areas. • Place 70 CY imported armor rock and 380 CY of salvaged armor rock in revetment repair areas. • Furnish and place 45 CY of chinking rock.

5.2.1 Clearing and Site Preparation

Clearing and site preparation will consist of relocating and/or protecting in-place utilities. Known utilities within the work area limits include (but are not limited to) buried telecommunications line and vault/riser and overhead power lines.

Temporary removal and stockpiling of large wood debris, removal of vegetation, and relocation of the sand-filled supersacks along NE Point No Point Rd will be completed as needed to access the site and Work Area. At construction completion, the supersack bags shall be removed from the site and disposed of.

5.2.2 Beach Nourishment

Beach nourishment material will be placed over the 630-linear-foot length of the nourishment area according to the design parameters described below:

- Berm crest elevation of 12.5 feet NAVD88 and berm crest width of 20 feet

- Berm placed slope: 7:1 (horizontal to vertical) at and below elevation 12.5 feet NAVD88
- Beach nourishment material gradually slopes up to 14 feet NAVD88 at the back beach
- Back beach placed slope: 5:1 (horizontal to vertical)
- Beach nourishment minimum placement thickness: 0.5 feet

The beach nourishment material will be a medium to coarse sand (Section 5.3.1). The backshore elevation was verified using the total water level evaluation (Section 2.3.4) and provides coastal flood protection against approximately a combined 100-year still water level and 25- to 50-year wind-wave event under current conditions or a 1-year still water level and 50-year wind wave event under future water level conditions at this elevation. The grading of the beach nourishment will be tapered on the ends to meet existing grades.

The total volume of nourishment (including rounded cobble at the toe of the curb wall) is 4,740 CY. This is equivalent to approximately 7 CY per foot. This is three times the annualized erosion rate across the beach of 2.3 CY per foot (Section 2.3.5). It is important to note that erosion is episodic with larger rates in some years and lower rates in other years. Therefore, the beach nourishment fill is anticipated to reduce the potential for coastal induced flooding through overtopping of the berm crest for five to ten years and potentially longer if vegetation can get established. However, future erosion rates will vary per year depending on the storm conditions, which are difficult to predict with the changing climate.

A two layer (single wrap) of coir matting 20 feet wide by 250 feet long will be placed in the foredune portion of the nourishment area to help stabilize the lower layer of the placed material if another extreme water level occurs. Large wood material will be replaced on top of the nourishment material between MHHW and the HTL. Large wood provides habitat benefits and helps to dissipate wave energy during high tide conditions.

5.2.3 Shoreline Armor Revetment Repair

The existing 450-foot-long rock armor rock revetment is in poor condition with large voids in the rock and little evidence of an underlayer. There are no as built drawings of the revetment and therefore the condition below grade is unknown. The voids and lack of placement of the rock has resulted in continued deterioration of the underlying sediments and damage to the revetment. This damage and permeability will continue and result in loss of upland park and risk to the historic structures over time if not repaired.

The revetment will not be completely removed and reconstructed but rather repaired in place down from the crest down to an elevation of approximately 7 feet NAVD88, which was the lowest elevation of exposed rock after the storm events in 2022. The armor rock revetment must first be demolished down to the grades shown on the drawings to allow for the reconstruction of the crest and repair of the rock revetment. Any debris, such as concrete rubble, shall be removed and disposed of. Any armor rock meeting design specifications that are removed from the slope will be salvaged and stockpiled for reuse in the revetment (assumed to be approximately 80%). Debris or large armor rock that is embedded or buried into the beach or deeply buried into the upland sediments will remain in place and will not be excavated in order to maintain the stability of the upland sediments and beach. Buried rock or debris will remain in place and will be covered with filter rock (quarry spalls) and armor rock as shown on the drawings.

As a repair project, the footprints, elevations, and slopes of the armor rock revetment will not be significantly altered from existing conditions. The primary change to the footprint of the revetment will be at the western terminus of the revetment where it ties into the proposed curb wall. This section of revetment will be set back from the existing location (i.e., moved landward) to reduce end-effect erosion by smoothly tapering to the parking curb wall. In addition, the crest of the revetment will be a continuous 4 feet without voids or low spots after the repair.

The repaired armor rock revetment will consist of a two-layer revetment where 2 man stone is used and a 1 layer revetment where existing 3 to 4 man stone is used. The revetment will consist of a 1-foot thick filter layer overlain with a 4-foot layer of armor rock. The primary function of the filter layer is to provide an intermediate-sized material that supports the overlying armor rock while also preventing piping of underlying beach sand and upland soils through the armor rock. The filter layer material will consist of quarry spall rock, which is highly angular 3- to 8-inch clean rock (Unified Soil Classification System [USCS] cobble-size). This filter layer will be placed from the toe of the revetment upward to the top of slope and will tie into the grade of the park uplands (i.e., the park lawn). This filter layer will provide a smooth and continuous underlayer for armor rock placement.

On top of the filter layer will be a salvaged three- to four-man rock in the lower layers followed by two-man armor rock material in the upper layer, with an individual rock diameter ranging between 1.5 to 3 feet, and a layer thickness of 4.0 feet. Existing armor rock meeting revetment specifications, stockpiled as part of demolition, will be reused to the extent possible. The size of the armor rock size was verified using the 50-year wave condition identified in Section 2.3.2 based on methods outlined in the USACE Coastal Engineering Manual (USACE 2008).

The existing and proposed crest elevation of the rock revetment is 13 feet NAVD88. Wave run-up calculations suggest that the revetment geometry will not be overtopping during a during a 1- or 100-year return period water level combined with an annual wind-wave event, However, overtopping of the structure could occur during a 1- or 100-year return period water level combined with a 25- to 50-year wind-wave event depending on the angle of the wind at the existing and proposed crest elevation of 13 feet NAVD88. The predicted overtopping for both of these events exceeds the threshold for damage stated in the CEM (2008) of 50 liters per second (see Table 2-9) for a revetment. Raising the crest of the structure to address overtopping of the structure would encroach on upland property and resources. The revetment repair was designed to minimize disturbance to the upland sediments because of concerns about cultural resources and proximity to upland infrastructure; therefore, the footprint of the existing revetment has not been expanded. However, the crest elevation could be increased in the future by adding a cap of armor stone across the crest and landward.

The toe of the exposed revetment has been observed to be as low as 6.8 feet NAVD88 and rock buried beneath that elevation was evident based on field inspection. The beach in front of the revetment is highly dynamic and has varied from an elevation of 6.8 to 10 feet NAVD88. The revetment will be repaired down to an elevation of approximately 7 feet NAVD88 or to the elevation of exposed rock, whichever is lower at the time of construction. The repair has been designed with the assumption that there is at least one layer of three- to four-man stone below 7 feet NAVD88 and the repair is being built on top of buried rock. Placed armor rock will be keyed into partially buried rock, where visible.

The repaired revetment will provide a consistent crest height and reduce void space compared to the existing damaged revetment which will help to reduce erosion behind the revetment by reducing the transmission of sediment through the revetment by waves and water levels. The repaired revetment with the filter layer material(s) will also provide some reduction in upland erosion as the result of overtopping during high wave events by holding upland sediments while the water drains into Puget Sound.

The front slope of the revetment will be 1.75:1 (horizontal to vertical) to match the slopes and footprint of the existing revetment. Appendix F provides calculation sheets for the armor rock and filter rock sizing and dimensions. Deliberate placement of the armor rock is critical to overall revetment stability. Armor rocks must be individually placed and adjusted in place so that the angularity of each rock interlinks with the adjacent rocks and the overall void space in the slope is minimized. Dumped rock, or armor rock that is placed haphazardly, will be significantly less stable than rocks placed deliberately to minimize void space. Armor rock will be placed from the exposed toe of the revetment (without excavating the beach) upward to the crest, such that the weight of each armor rock is resting on the rock below it. The armor rock will be placed such that the transitions between the armor rock slope and the toe beach sediments and the upland lawn will be as seamless as possible. These placement requirements for contractors are included in the specifications.

After placement of the armor rock slope, any remaining voids larger than 6 inches will be filled by hand-placed chinking rock to further reduce void space in the revetment and to prevent rocking of individual armor stones during wave run-up, which over time can lead to damage to the slope. The chinking rock material consists of angular cobble-sized rock. Hand placement of the chinking rock will be required.

5.2.4 *Parking Curb Wall*

Design of the replacement parking curb wall is described in a technical memorandum provided by Art Anderson (Appendix D). The proposed curb wall is 123 feet long with 12-foot wing walls on either side (146 feet total length) and will be built in the location of the existing curb wall with beach nourishment covering the toe; the heel will be under the parking lot. The wall is designed as a retaining wall and was evaluated for a range of soil and wave loading cases. The design assumes a worst-case loading scenario where the beach nourishment is eroded to the toe and waves are directly impacting the face of the wall. The toe of the wall is at 6 feet NAVD88 which is 2 to 3 feet lower than the beach elevation after erosion and scour caused by the storms in 2022 (approximately a 25-year return interval event for northerly winds and greater than 100-year return interval flood event).The crest elevation was designed to have the same elevation (13 feet NAVD88) as the adjacent revetment. This will prevent overtopping of a coincident 1-year water level and 25- to 50-year wave event (without sea level rise).

The design calls for a total base length of 6 feet, total overall height of 7 feet, toe length of 2 feet, heel length of 3 feet, and a thickness of 1 foot. Rebar is #5 at 12-inch spacing with 3 inches of cover. New wheel stops will be added to the parking lot to replace the existing curb wall, which is currently used as a wheel stop.

5.2.5 *Plantings*

Plantings will consist of a total of 18,500 SF of native dune grasses in upper elevations of the beach nourishment area and 33,000 SF of native dune grasses, shrubs, and trees in the foredune area. Plantings of native dune grasses and plants along the upland of the revetment will consist of a total of 1,350 SF. The performance of the beach nourishment and foredune area will be extended if the plantings can be well established prior to a future wind-wave or extreme water level event.

5.2.6 *Gravel Pedestrian Trail*

A gravel pedestrian trail will be installed between the backshore dune and Point No Point Road NE. The 6 foot wide trail is based on the United States Department of Agriculture’s Forest Service (USFS) Standard Trail Plan, as adopted by Kitsap County Parks. This project modified USFS Standard Trail Plan Drawing Number STD-9131-01, Section B to include 3 inches of surface coarse rock and 6 inches base course rock. Geotextile will not be installed within the trail alignment.

5.2.7 *Material Volume Estimates*

Material quantity estimates were calculated using the 2023 topographic survey and typical sections and are provided in Table 5-2.

Table 5-2. Material volume estimates for beach nourishment and revetment repair.

Description	Unit	Estimated quantity
Beach berm and foredune		
Beach Nourishment (sand)	CY	4,600
Beach Cobble	CY	235
Beach Gravel (east beach)	CY	200
Dune Grass Plantings	SF	18,500
Foredune Plantings	SF	33,000
Dune Fencing	LF	500
Crushed surfacing limestone	CY	20
Crushed surfacing top course	CY	40
Rock Revetment Setback and Parking Curb		
Demolition of Concrete Rubble & Shoreline Debris	CY	2
Upland Soil Excavation	CY	330
Furnish and Place Filter Rock	CY	55
Re-place Existing Armor Rock	CY	25
Furnish and Place Armor Rock	CY	75
Furnish and Place Chinking Rock	CY	10
Parking curb wall	LF	135
Revetment Repair		
Demolition and Re-place Existing Armor Rock	CY	375
Upland Soil Excavation	CY	190
Furnish and Place Filter Rock	CY	235
Furnish and Place Armor Rock	CY	70
Furnish and Place Chinking Rock	CY	45

5.3 Engineer’s Opinion of Construction Cost

An engineer’s opinion of construction cost (EOC) for the proposed design was developed by Blue Coast. A summary is provided in Table 5-3 and detailed cost estimate, and quantities spreadsheets are provided in Appendix E. A 20% contingency on the construction costs is included for the design. Other assumptions include the following:

- The placement of beach nourishment material and plantings were considered separate work elements that may each require their own mobilization and demobilization depending on the timing.
- The plantings need to be completed during the fall or winter months.
- Shoreline armor and debris removal and shoreline armor placement is a separate phase of work with its own mobilization fee.

Table 5-3. Summary of EOC cost estimate for the preferred alternative.

Item	Cost
Site Preparation	$142,919
Beach Nourishment and Plantings	$720,087
Revetment Setback and Parking Curb Beach	$170,885
Revetment Repair	$109,220
Contingency (20%)	*$228,622*
Sales Tax (9.2%)	*$126,199*
Total Cost	$1,498,000

5.4 Materials

The following section describes materials to be used as part of the beach and revetment repair.

5.4.1 Beach Nourishment (Sand)

Beach nourishment sand material used for the north beach and foredune areas will be a medium to coarse sand. This material was selected based on nearby geotechnical borings collected by Aspect Consulting in November 2021 (Aspect 2022) for the proposed estuary restoration project at Point No Point being sponsored by MSFEG.

At boring AMW-01, the location closest to the Point No Point Park site, subsurface materials are identified as “SAND (SP); loose, wet, gray and brown; fine to medium sand.” Per the WSDOT Geotechnical Design Manual (M 46-03.08), SP is described as poorly graded SAND or poorly graded SAND with gravel. The USCS defines SAND (SP) as "50% or more of the coarse fraction smaller the No. 4 sieve size." The gradation specification (Table 5-4) for the beach nourishment material calls for 75% to 100% of the material to be smaller than the No. 4 sieve size.

Beach Nourishment shall be tough, durable, clean particles, adequately free from thin, flat, and elongated pieces, vegetation, or other debris.

Table 5-4. Beach nourishment material (medium to coarse sand) gradation.

Approximate Sieve Size (approximate size in mm)	Percent Passing (%)
#4 (4.75)	75-100
#100 (0.15)	0-10
#200 (0.075)	0-5

5.4.2 Rounded Cobble

Rounded cobble material to be placed in front of the parking curb wall will be a well-graded rounded cobble stone that meets WSDOT 2022 standard specifications for 12” Streambed Cobbles

Section 9-03.11(2) (WSDOT, 2021). This material is a naturally rounded cobble material that is less erosive than the fine-grained beach nourishment material. The design rounded cobble material has a maximum particle size of 12″ inches and a median grain size (D_{50}) between 3.5 and 7 inches. The gradation is presented below.

Rounded Cobble Material Specification – 12″ Streambed Cobbles[1]

Approximate Size	Percent Passing (%)
12-inch	99-100
10-inch	70-90
5-inch	30-60
¾-in	10 max.

Notes: [1]WSDOT 2022 Standard Specifications for Road, Bridge, and Municipal Construction Division 9.

5.4.3 Large Wood

Due to the large quantity of naturally accumulated large wood within the project area extents, large wood will not be imported as part of this project. Instead, large wood shall consist of salvaged driftwood stockpiled during site preparation. Salvaged fallen trees (various species) from the site may be permitted for reuse as driftwood, nurse logs, or wood debris.

Large wood should be placed irregularly (not anchored) above the HTL, approximately four pieces per 25 feet.

5.4.4 Imported Beach Gravel Material

Imported beach gravel will be used to fill in the beach overwash locations on the east beach, above the OHWM. The beach gravel material will consist of a 2.5″ minus sand and gravel material. Beach gravel material shall be clean, naturally occurring, rounded granular material (river run or processed glacial outwash deposits) free from wood waste and other extraneous objectionable materials and shall have such characteristics of size and shape that it will meet the requirements for gradation presented in Table 5-6.

Table 5-6. Imported channel fill material gradation (2.5″ minus sand and gravel)

Approximate Sieve Size (approximate size in mm)	Percent Passing (%)
2.5″ (75)	97-100
2″ (50)	55-97
1″ (25)	25-35
0.5″(13)	15-25
#4 (4.75)	10-20
#200 (0.075)	0-5

5.4.5 *Coir Mats*

Coir matting will be 100% coir fiber woven fabric rolls for use in stabilization applications. The matting roll strips shall be 14 feet wide and shall be furnished in approximately 50-yard roll lengths. The material shall conform to the properties listed below in Table 5-7.

Table 5-7. Coir fabric

Property	Detail
Weight (grams)	900
Thickness (mm)	338.30
Open Area (%)	38
Dry Ultimate Strength (lbs/inch)	164 in roll machine direction; 66.3 in cross machine direction
Wet Ultimate Strength (lbs/inch)	124.4 in roll machine direction; 60.3 in cross machine direction

5.4.6 *Filter Rock*

Filter rock will consist of a well graded 4- to 8-inch angular quarry spall rock that is clean and free of debris. The material should not contain significant quantities of elongated or flat rocks. The gradation shall conform to WSDOT Specification 9-13.1(5) Quarry Spalls material as shown below in Table 5-8.

Table 5-8. Filter rock gradation.

Approximate Sieve Size (inches)	Percent Passing (%)
8″	100
3″	40 max.
¾″	10 max.

5.4.7 *Filter Fabric*

Filter fabric material will be a tough and durable material capable of supporting the weight of the filter rock and armor rock layers above and will also be capable of preventing piping of the subgrade up into the layers of the revetment. The filter fabric will be composed of a non-woven, needle-punched, continuous-filament fabric material with sufficient tearing and tensile strengths. Additional requirements for this material will be included in the specifications.

5.4.8 *Armor Rock*

Armor rock will conform to WSDOT requirements for Section 9-13.7(1) Rock Walls and Chinking Material. This is a "two-man" armor rock with each stone weighing between 200 and 700 lbs. with an average size between 18 and 28 inches in diameter. Armor Rock must be durable and angular stone.

5.4.9 *Chinking Rock*

Chinking rock is 4- to 8-inch angular rock used to fill the interstitial voids within the placed armor rock. Chinking rock should be tough, durable, clean, and free of vegetation and other debris. Chinking rock should also be free of elongated or flat stone. Large quarry spalls greater than 4 inches that meet the other requirements for filter rock material may be used as chinking rock.

5.4.10 *Pedestrian Trail Surface Course*

Pedestrian trail surface course will consist of 5/8″ minus clean, crushed limestone surfacing free from organic matter and conforming to the following gradation when tested in accordance with ASTM D422: U.S. Standard Sieve Size Percent Passing, by Weight:

Screen Size	Percent Passing
5/8″	100
1/2″	70-100
No.4	45-75
No. 8	30-54
No. 30	12-34
No.200	5-20 Max.

Crushed limestone surfacing shall be "dense grade" limestone. The material shall be uniform in quality and free from extraneous material, except that it shall have minimal clay content of 5-9% by dry weight.

5.4.11 Pedestrian Trail Base Course

Pedestrian trail base course gradation shall conform to WSDOT requirements for Section 9-03.9(3) Crushed Surfacing Top Course, 3/4" minus Top Course and Keystone.

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7 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 Point No Point Flood Protection Project. 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 Kitsap County Parks. The information in this document is to be used for planning purposes and is not intended for design or construction.

Appendix A

HTL & OHWM Technical Memorandums

MEMORANDUM

Date: April 8, 2024
To: Kitsap County Parks Department
From: Traci Sanderson and Jessica M. Côté, PE, Greg Curtiss, PE Blue Coast Engineering
Project: Point No Point Park Rehabilitation Project
Subject: Point No Point High Tide Line Calculation

INTRODUCTION

Point No Point Park is located on a low-lying sandy barrier beach at the northeastern tip of the Kitsap Peninsula and at the entrance to Puget Sound from Admiralty Inlet. During a large storm and king tide event in December 2022, tidal waters overtopped the Point No Point beach and armored shoreline to flood NE Point No Point Road and nearby properties. Flood protection, including beach nourishment, is proposed along the northern shoreline to mitigate against further flood damage.

To support the project design a High Tide Line (HTL) delineation was completed by Traci Sanderson of Blue Coast Engineering based on desktop analysis and multiple visits to the site. The results of this delineation are documented in this memo. The location of the High Tide Line (HTL) is defined by the United States Army Corps of Engineers (USACE) in 33 C.F.R. § 328.3 and provided below. The High Tide Line for this site was determined primarily by calculating the 10-year average elevation based on the highest predicted tide for each year from 2023 to 2032 at the Hansville (#9445526) National Oceanic and Atmospheric Associations (NOAA) station and verifying this elevations applicability as HTL during site visits. The Hansville tide station is approximately 1 mile west of the project site.

Definition of High Tide Line, 33 C.F.R. § 328.3

“The term high tide line means the line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds, such as those accompanying a hurricane or other intense storm.”

SUMMARY OF OFFICE ASSESSMENT

The highest predicted tide for each year from 2023 to 2032 at the Hansville (#9445526) National Oceanic and Atmospheric Associations (NOAA) station is presented in Table 1. The calculated value for the HTL is 12.0 feet MLLW (average of the highest tides for each year from 2023 to 2032). For comparison purposes, tidal datums from the NOAA Tides and Currents website for the station in Hansville (#9445526) and relevant elevations are presented in Table 2. Conversion of Mean Lower Low Water (MLLW) to the North American Vertical Datum of 1988 (NAVD88) was completed using VDatum (Xu 2010). The Highest Astronomical Tide (HAT) at the site is 12.3 feet MLLW, 0.3 feet greater than the HTL.

Table 1. The highest predicted tide for each year from 2023 to 2032 at the Hansville NOAA station (#9445526).

Year	Highest Predicted Tide	
	Elevation NAVD88 feet	Elevation MLLW feet
2023	10.2	12.0
2024	10.2	12.0
2025	10.1	11.9
2026	10.1	11.9
2027	10.3	12.1
2028	10.4	12.2
2029	10.2	12.0
2030	10.2	12.0
2031	10.2	12.0

Table 2. HTL and tidal datums at the Hansville (NOAA station (#9445526).

Water Level/Tidal Datum	Elevation NAVD88 feet	Elevation MLLW feet
HAT	10.5	12.3
HTL	10.2	12.0
MHHW	8.7	10.5
NAVD88	0.0	1.8
MLLW	-1.8	0.0

Notes:
HAT= Highest Astronomical Tide, based on NOAA Nearshore Conservation Calculator webmap (Cereghino et al. 2022)
HTL – High Tide Line, calculated elevation at project site
MHHW – Mean Higher High Water
NAVD88 – North American Vertical Datum 1988
Mean Lower Low Water – MLLW

SUMMARY OF SITE VISIT

Multiple site visits have been completed at the site during all times of year. The calculated HTL for the project site corresponds approximately to the line of large woody debris and perennial vegetation growth at the site prior to the storm in December 2022.

CLOSURE

This document has been prepared by Blue Coast Engineering LLC in accordance with generally accepted scientific practices and is intended for the exclusive use and benefit of Kitsap County Parks Department and their authorized representatives for specific application to Point No Point Project in Hansville, Washington. 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 Kitsap County Parks Department.

REFERENCES

Cereghino, P., J. Ory, P. Pope, S. Ehinger, M. Bhuthimethee, K. Wykoff. 2022. Estimation of typical high intertidal beach face slope in Puget Sound. Draft manuscript. Prepared by the National Marine Fisheries Service, Lacey, WA. Website accessed at https://noaa.maps.arcgis.com/home/item.html?id=69c1c16ba7c8473d890e9eaed9fc6d4f#overview

National Oceanic and Atmospheric Administration (NOAA). 2021. Tides and Currents. https://tidesandcurrents.noaa.gov/

Washington State Department of Natural Resources (DNR). 2022. https://lidarportal.dnr.wa.gov/. Accessed June 15, 2022

Xu, J., E. Myers, S. White (2010). VDatum for the Coastal Waters of North/Central California, Oregon and Western Washington: Tidal Datums and Sea Surface Topography. NOAA Technical Memorandum NOS CS 22.

FIGURES

Figure 1. Project site overview showing calculated High Tide Line, imagery from August 2022.

BLUE COAST
ENGINEERING

MEMORANDUM

Date: March 27, 2024
To: Kitsap County Parks Department
From: Traci Sanderson and Greg Curtiss, PE, Blue Coast Engineering
Project: Point No Point Park Rehabilitation Project
Subject: Ordinary High Water Mark (OHWM) Delineation

INTRODUTION

Point No Point Park is located on a low-lying sandy barrier beach at the northeastern tip of the Kitsap Peninsula and at the entrance to Puget Sound from Admiralty Inlet. The park shoreline environment is considered high energy marine, which, for the purpose of delineating Ordinary High-Water Mark, is defined as an, "environment where the action of waves or currents is sufficient to prevent vegetation establishment below mean higher high water (MHHW), the OHWM is coincident with the line of vegetation" (WAC 173-22-030 (11)(a)(i)). Point No Point is the location of a proposed shoreline project to restore a beach that was eroded during a significant storm and high water event in late December 2022. Due to the dramatic changes to the beach during this event standard OHWM delineation methods were not used and the OHWM was delineated by using aerial imagery from prior to the storm event (August 2022) and marking OHWM at the landward extent of visible large wood. This method was discussed with regulatory agencies (United Stated Army Corps of Engineers, Washington Department of Fish & Wildlife) during a pre-application meeting on 3/29/2023.

Definition of Ordinary High-Water Mark, WAC 173-22-030(5).

"The Ordinary High-Water Mark on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland. In high energy environments where the action of waves or currents is sufficient to prevent vegetation establishment below mean higher high tide, the ordinary high-water mark is coincident with the line of vegetation. Where there is no vegetative cover for less than one hundred feet parallel to the shoreline, the ordinary high-water mark is the average tidal elevation of the adjacent lines of vegetation. Where the ordinary high-water mark cannot be found, it is the elevation of mean higher high tide."

SUMMARY OF OFFICE ASSESSMENT

Figure 1 shows the OHWM delineated by using aerial imagery from August 2022. The average elevation of the OHWM delineated using aerial imagery along the north beach and revetment is 12.7

ft MLLW. For comparison purposes, tidal datums from the NOAA Tides and Currents website for the station in Hansville (#9445526), approximately 1 mile west from the project site and relevant elevations are presented in Table 1. Conversion of Mean Lower Low Water (MLLW) to the North American Vertical Datum of 1988 (NAVD88) was completed using VDatum (Xu 2010). The average elevation of the OHWM is approximately 2 feet higher than MHHW tidal datum.

Table 1. Tidal datums at the Hansville (NOAA station (#9445526).

Water Level/Tidal Datum	Elevation NAVD88 feet	Elevation MLLW feet
OHWM (north beach and revetment average elevation)	10.9	12.7
MHHW	8.7	10.5
NAVD88	0.0	1.8
MLLW	-1.8	0.0

Notes:
OHWM – Ordinary High Water Mark
MHHW – Mean Higher High Water
NAVD88 – North American Vertical Datum 1988
Mean Lower Low Water – MLLW

CLOSURE

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REFERENCES

Washington State Department of Ecology (Ecology). 2016. Determining the Ordinary High-Water Mark for Shoreline Management Act Compliance in Washington State, Publication 16-06-029. https://fortress.wa.gov/ecy/publications/documents/1606029.pdf

National Oceanic and Atmospheric Administration (NOAA). 2021. Extreme Water Levels at Seattle. https://tidesandcurrents.noaa.gov/est/est_station.shtml?stnid=9447130#:~:text=The%20monthly%20extreme%20water%20levels,0.68%20feet%20in%20100%20years.

Xu, J., E. Myers, S. White (2010). VDatum for the Coastal Waters of North/Central California, Oregon and Western Washington: Tidal Datums and Sea Surface Topography. NOAA Technical Memorandum NOS CS 22.

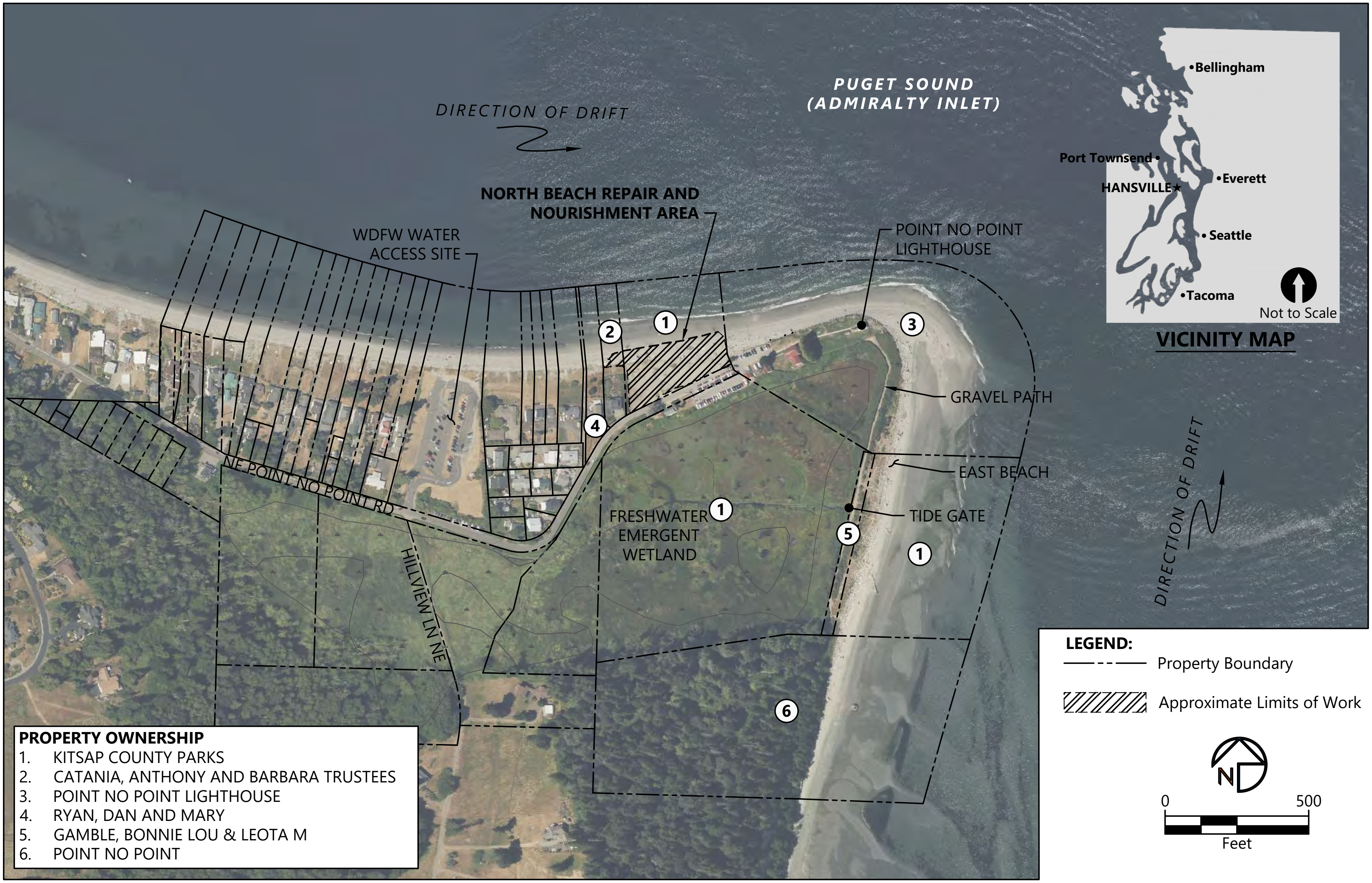
FIGURES

Figure 1. Project site overview showing OHWM contour, imagery from August 2022.

Appendix B

Design Alternative 2 Drawings

P:\CO_Kitsap_1103\2301_Point no Point\10_Design\CAD\Dwg\JARPA\PNP-JA-01-Site Vicinity.dwg 1 SITE & VICINITY MAP



LEGEND:

- Property Boundary
- ▨ Approximate Limits of Work

PROPERTY OWNERSHIP

1. KITSAP COUNTY PARKS
2. CATANIA, ANTHONY AND BARBARA TRUSTEES
3. POINT NO POINT LIGHTHOUSE
4. RYAN, DAN AND MARY
5. GAMBLE, BONNIE LOU & LEOTA M
6. POINT NO POINT

Aug 31, 2023 9:09am bluecoast

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1 BEACH REPAIR

PURPOSE: BEACH REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: AUGUST 2023

SITE & VICINITY MAP

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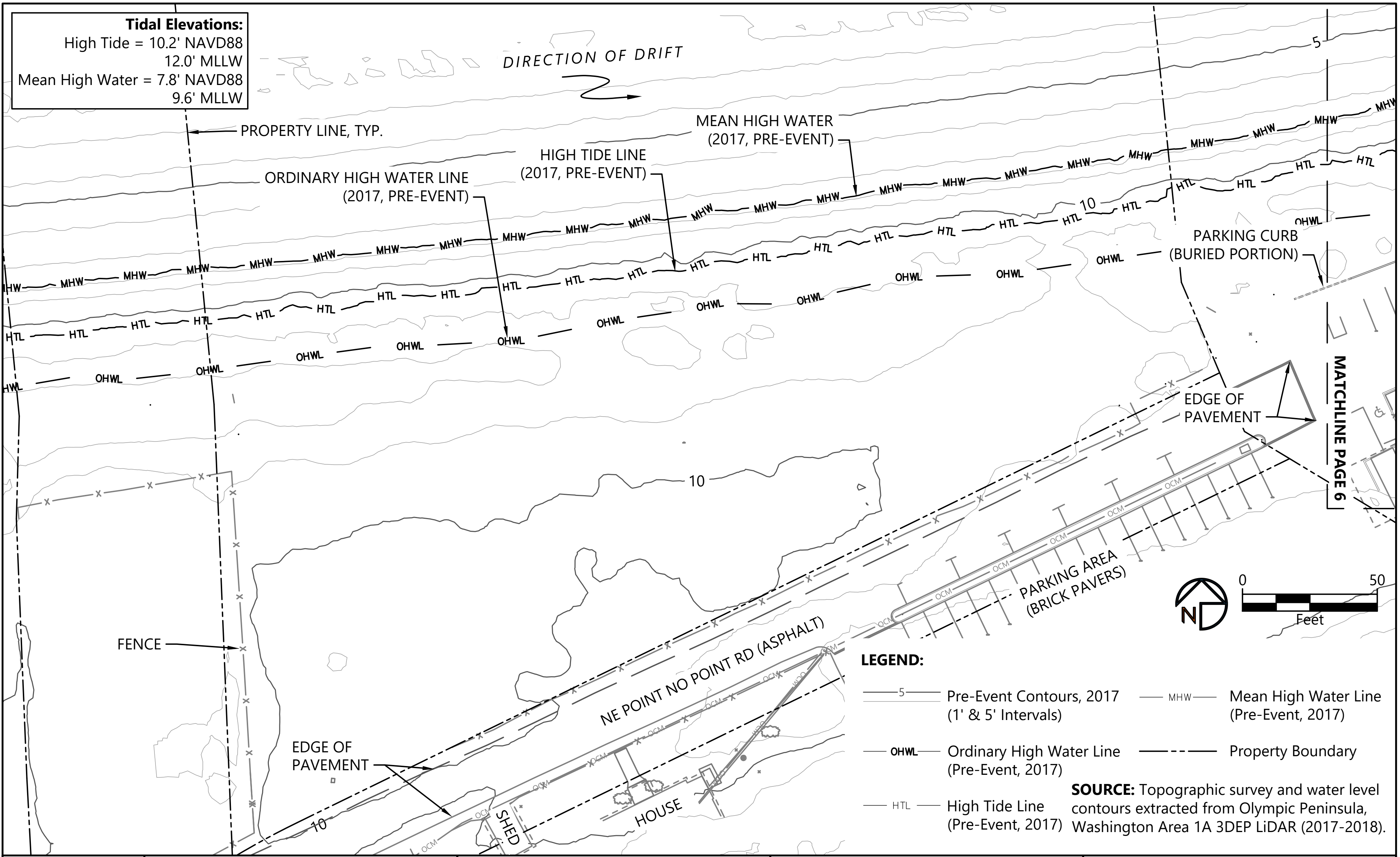
Aug 31, 2023 9:10am bluecoast


Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

LEGEND:

5	Pre-Event Contours, 2017 (1' & 5' Intervals)	MHW	Mean High Water Line (Pre-Event, 2017)
OHWL	Ordinary High Water Line (Pre-Event, 2017)	— - - —	Property Boundary
HTL	High Tide Line (Pre-Event, 2017)		

SOURCE: Topographic survey and water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

BLUE COAST ENGINEERING

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STATE: WASHINGTON
DATE: AUGUST 2023

PRE-EVENT CONDITIONS (1 OF 3)

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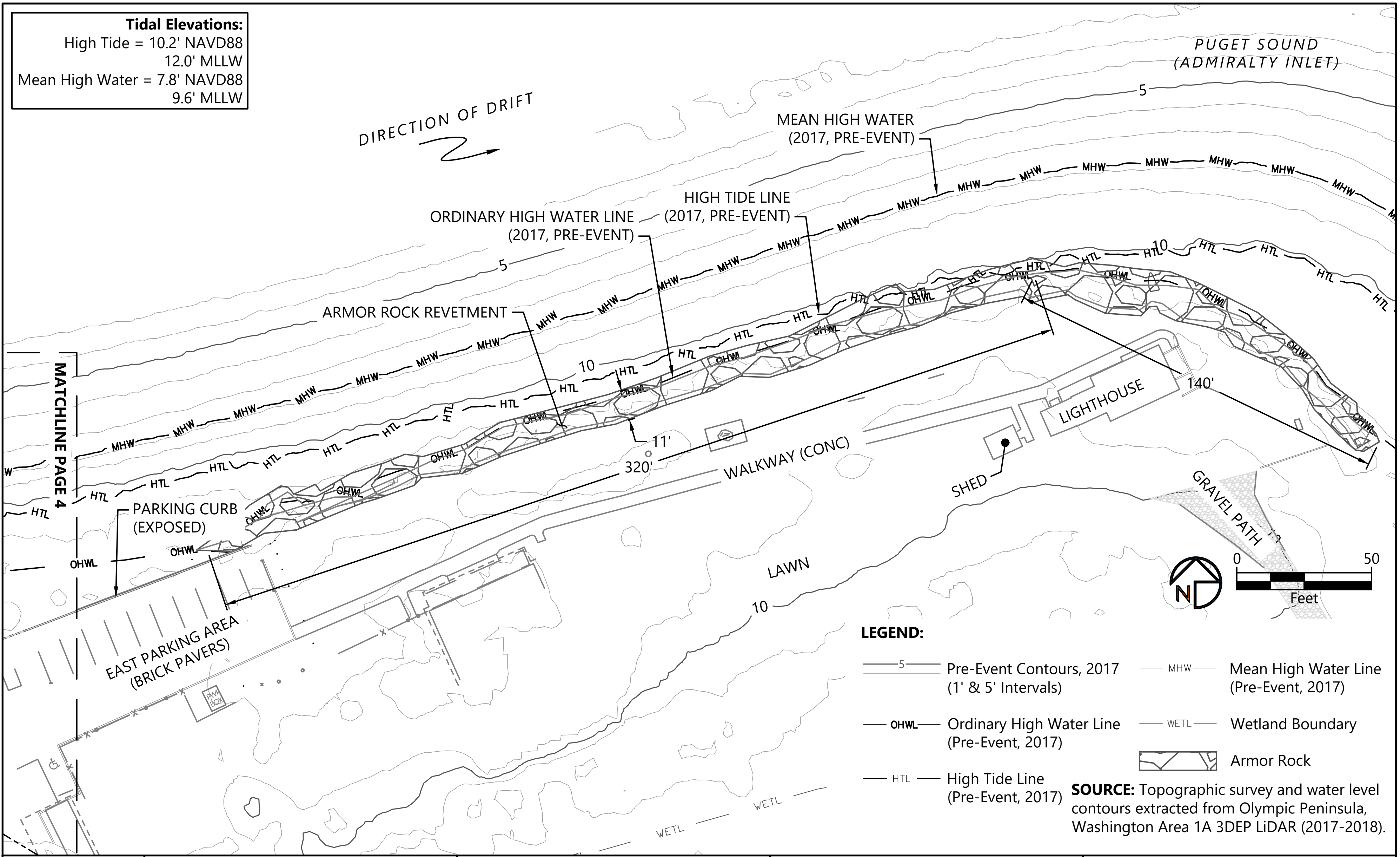

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

LEGEND:

5	Pre-Event Contours, 2017 (1' & 5' Intervals)
MHW	Mean High Water Line (Pre-Event, 2017)
OHWL	Ordinary High Water Line (Pre-Event, 2017)
WETL	Wetland Boundary
▨	Armor Rock
HTL	High Tide Line (Pre-Event, 2017)

SOURCE: Topographic survey and water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

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PRE-EVENT CONDITIONS (2 OF 3)

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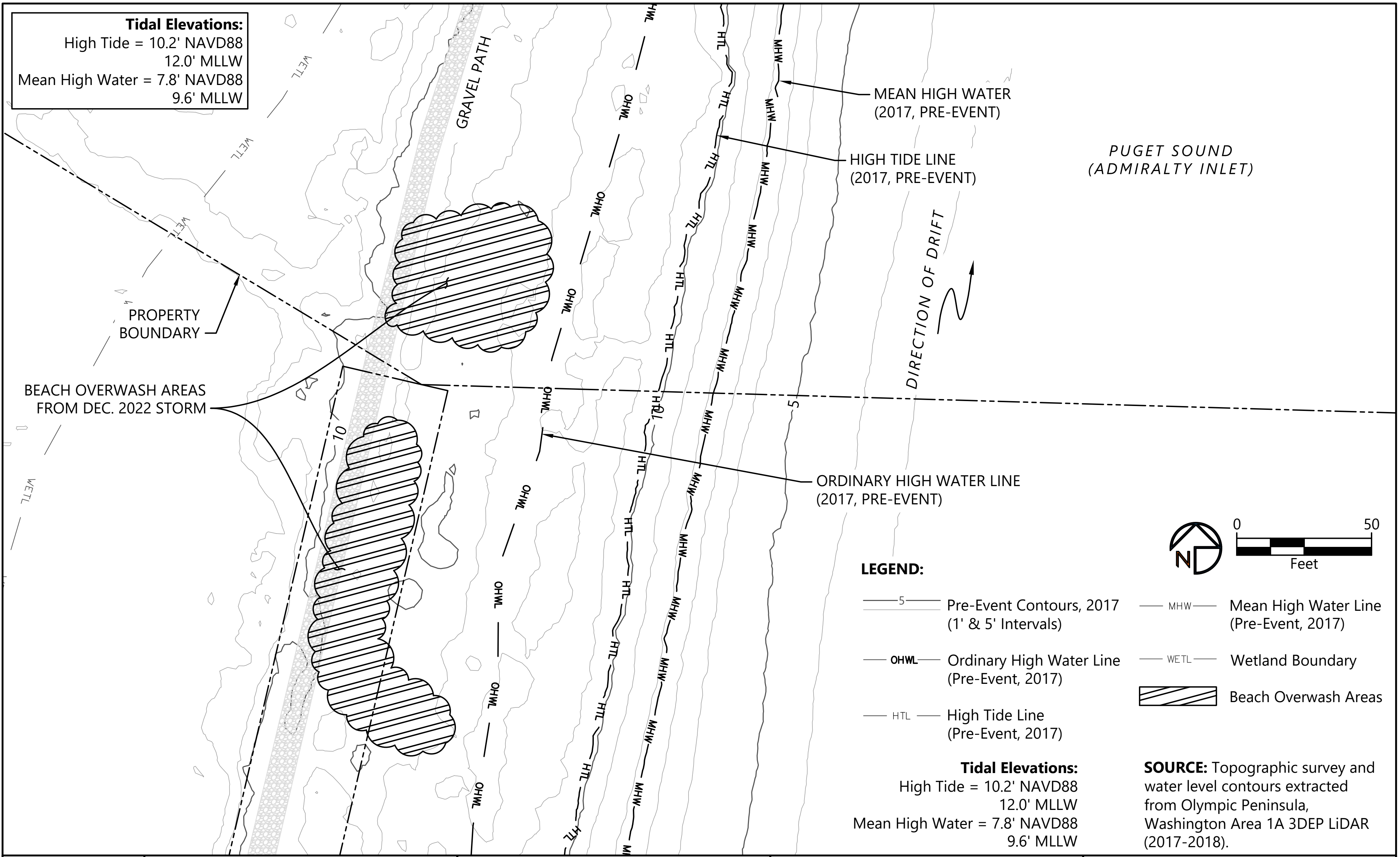
Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW



LEGEND:

5	Pre-Event Contours, 2017 (1' & 5' Intervals)
OHWL	Ordinary High Water Line (Pre-Event, 2017)
HTL	High Tide Line (Pre-Event, 2017)
MHW	Mean High Water Line (Pre-Event, 2017)
WETL	Wetland Boundary
▨	Beach Overwash Areas

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic survey and water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

Aug 31, 2023 9:10am bluecoast

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PRE-EVENT CONDITIONS (3 OF 3)

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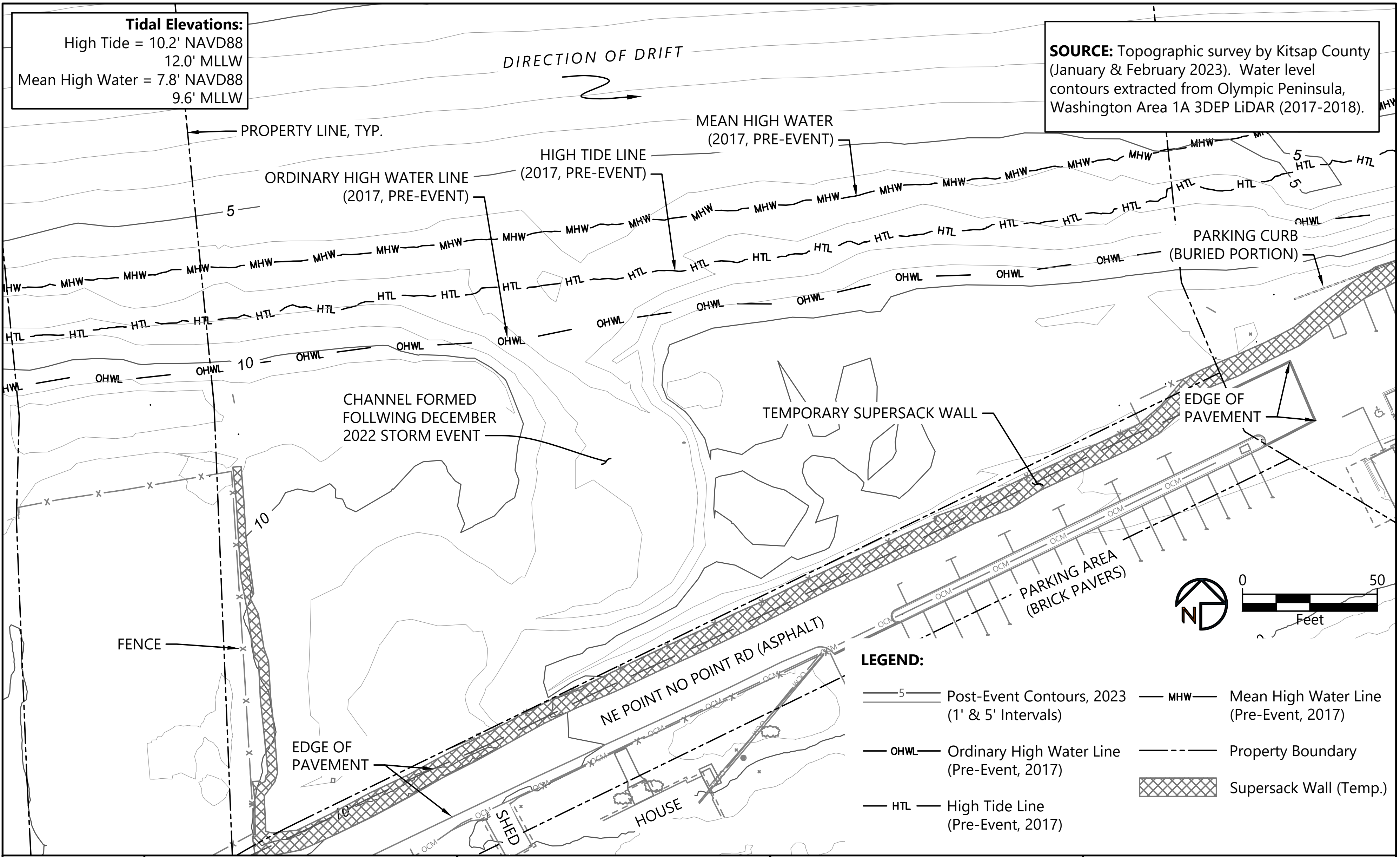

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9.6' MLLW

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Post-Event Contours, 2023 (1' & 5' Intervals)	—MHW—	Mean High Water Line (Pre-Event, 2017)
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)	— - —	Property Boundary
—HTL—	High Tide Line (Pre-Event, 2017)	▨	Supersack Wall (Temp.)

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BLUE COAST
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POST- EVENT CONDITIONS

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Tidal Elevations:
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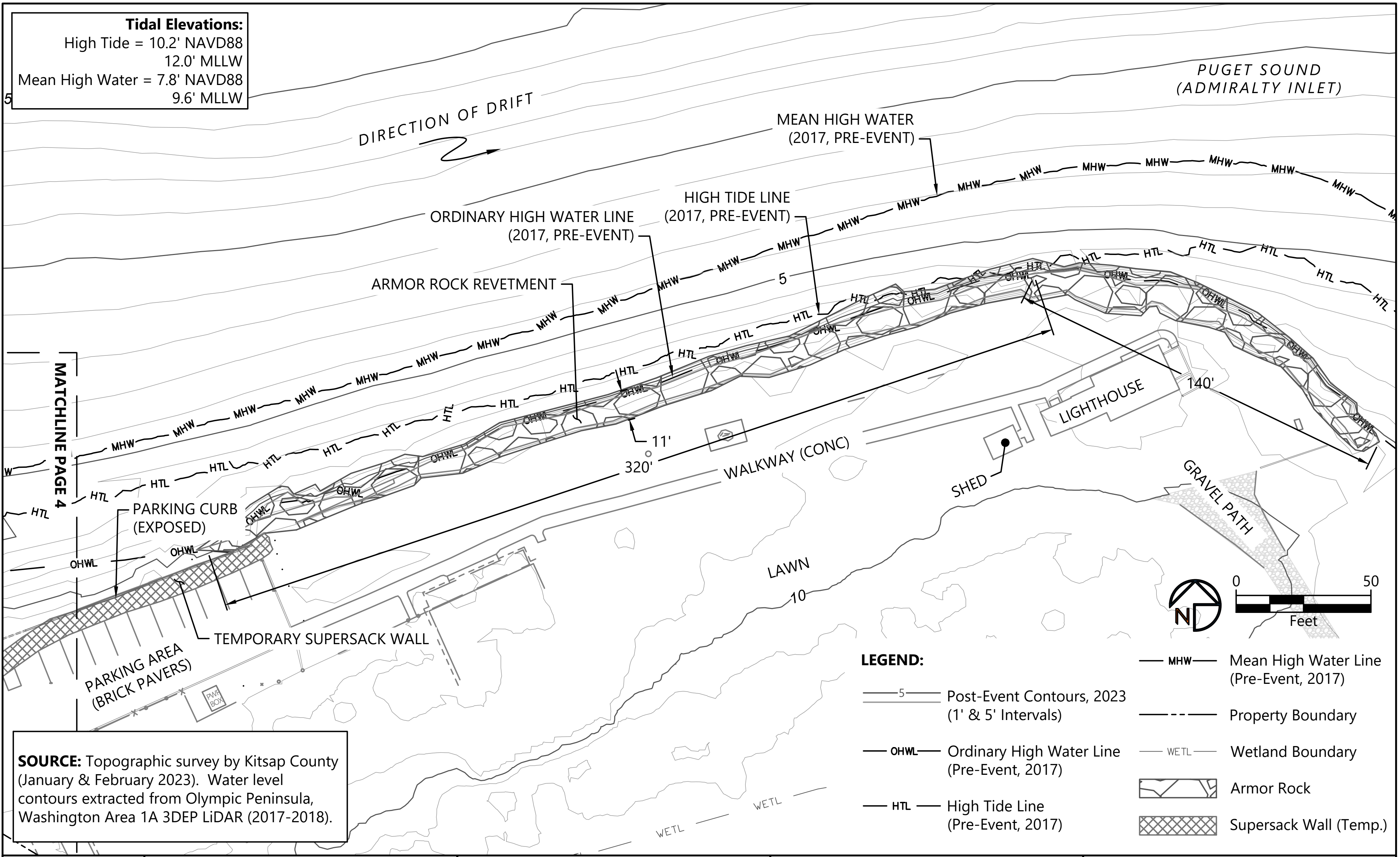

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Post-Event Contours, 2023 (1' & 5' Intervals)
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)
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▨	Supersack Wall (Temp.)

BLUE COAST ENGINEERING

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POST-EVENT CONDITIONS (2 OF 3)

PAGE: 6 OF 6

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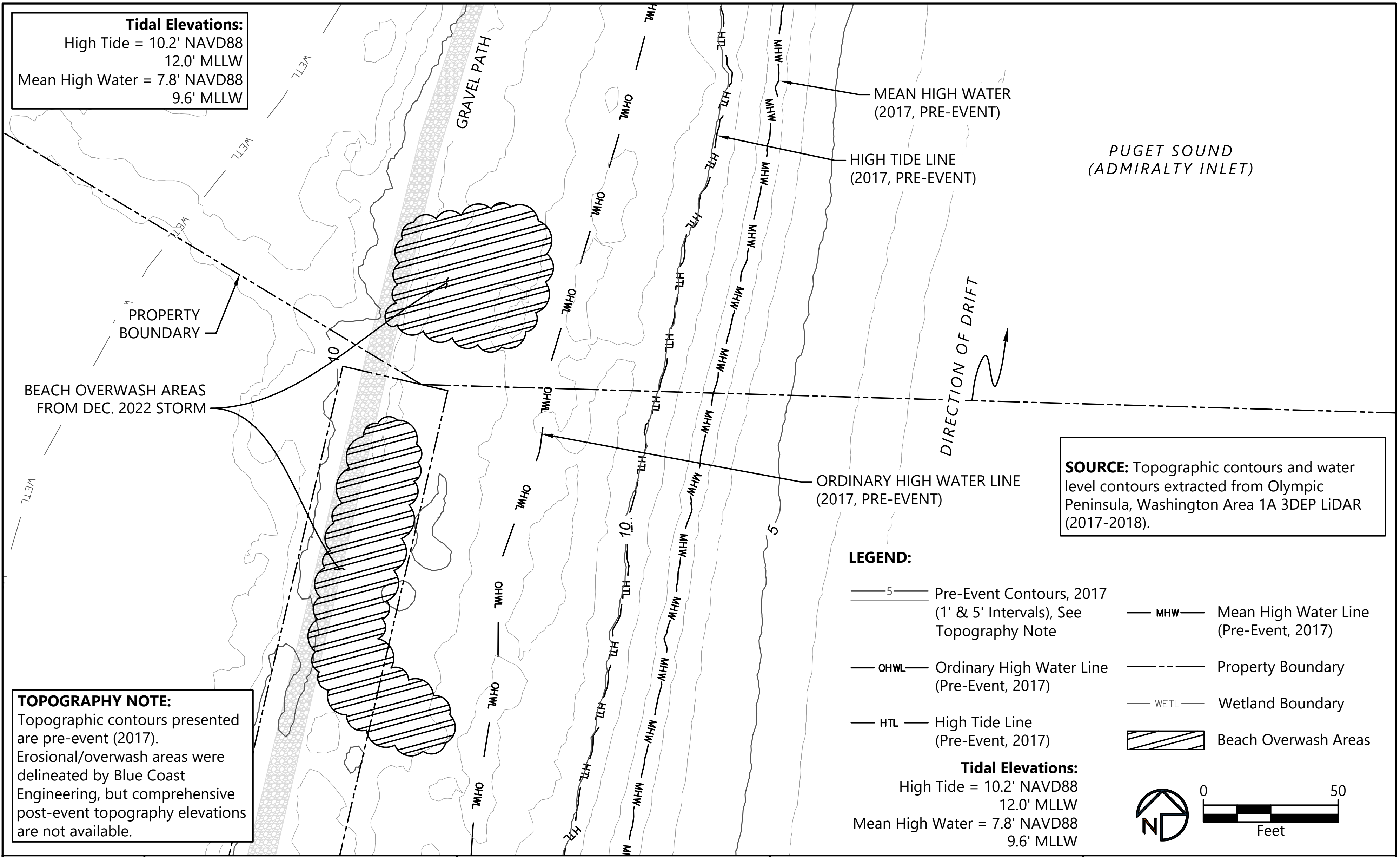

Tidal Elevations:
High Tide = 10.2' NAVD88
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SOURCE: Topographic contours and water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

TOPOGRAPHY NOTE:
Topographic contours presented are pre-event (2017). Erosional/overwash areas were delineated by Blue Coast Engineering, but comprehensive post-event topography elevations are not available.

LEGEND:

——5——	Pre-Event Contours, 2017 (1' & 5' Intervals), See Topography Note
—— OHWL ——	Ordinary High Water Line (Pre-Event, 2017)
—— HTL ——	High Tide Line (Pre-Event, 2017)
—— MHW ——	Mean High Water Line (Pre-Event, 2017)
—— - - ——	Property Boundary
—— WETL ——	Wetland Boundary
▨	Beach Overwash Areas

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BLUE COAST
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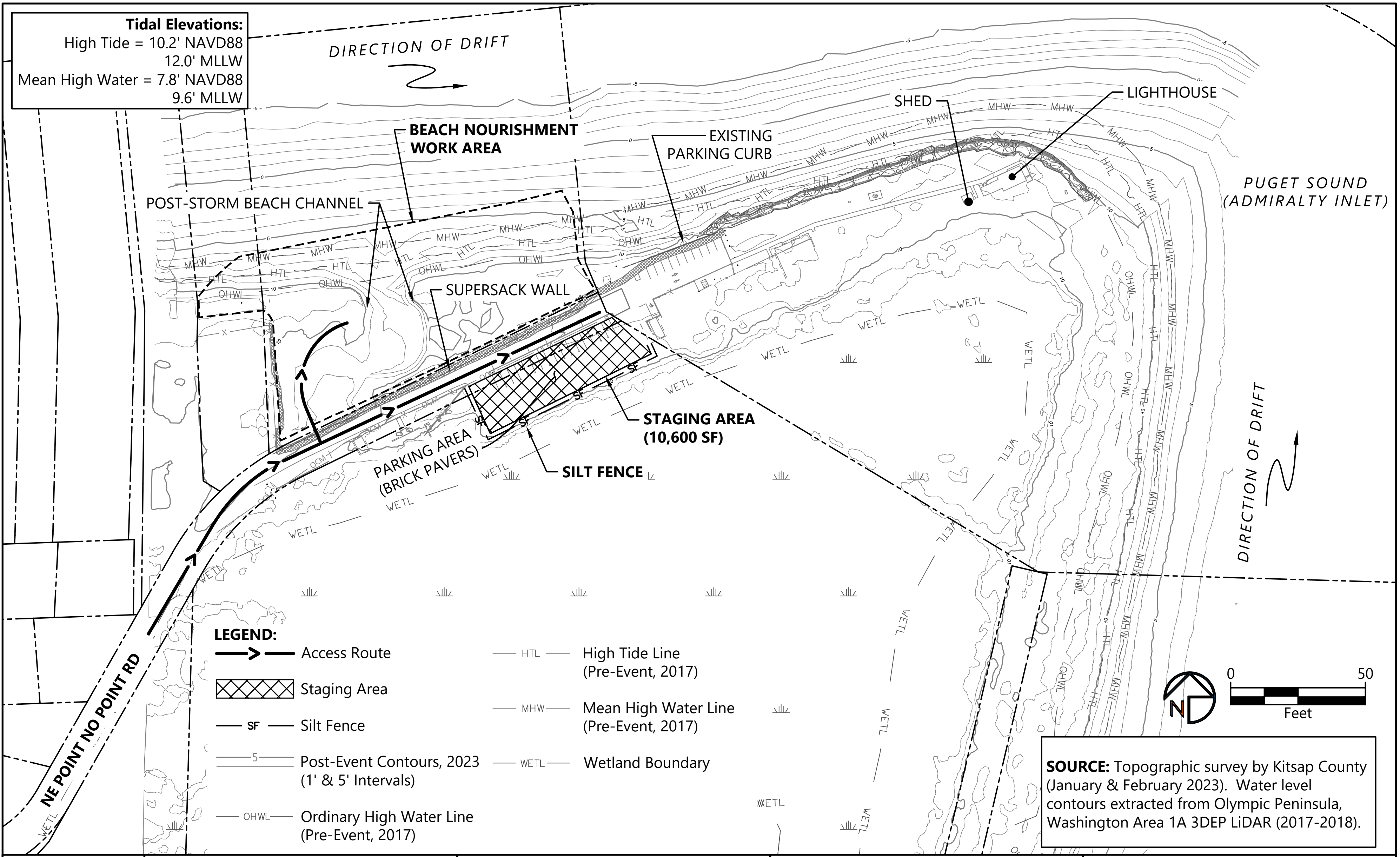
POST-EVENT CONDITIONS (3 OF 3)



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SOURCE: Topographic survey by Kitsap County (January & February 2023). Water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

P:\CO_Kitsap_1103\2301_Point no Point\10_Design\CAD\Dwg\JARPA\PNP-JA-03-Access Staging TESC.dwg 8 ACCESS STAGING AND TESC

Aug 31, 2023 9:10am bluecoast

BLUE COAST
ENGINEERING

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ACCESS, STAGING, AND TESC

PAGE: 4 OF 6

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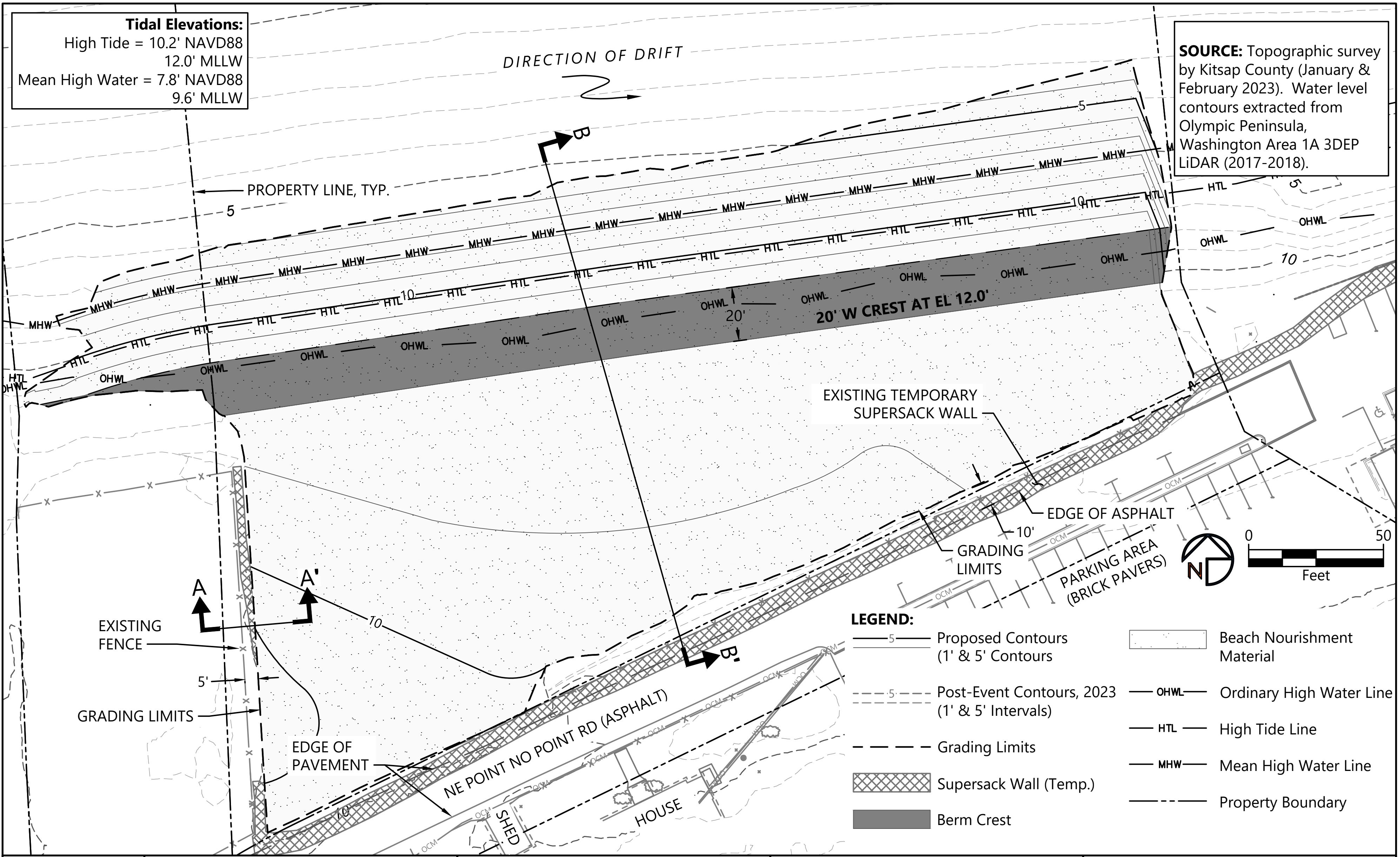
Aug 31, 2023 9:11am bluecoast



Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

- —5— Proposed Contours (1' & 5' Contours)
- - -5- - - Post-Event Contours, 2023 (1' & 5' Intervals)
- — — Grading Limits
- ▨ Supersack Wall (Temp.)
- ■ Berm Crest
- ☐ Beach Nourishment Material
- —OHWL— Ordinary High Water Line
- —HTL— High Tide Line
- —MHW— Mean High Water Line
- —·—·— Property Boundary

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1 BEACH REPAIR

PURPOSE: BEACH REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: AUGUST 2023

PROPOSED CONDITIONS

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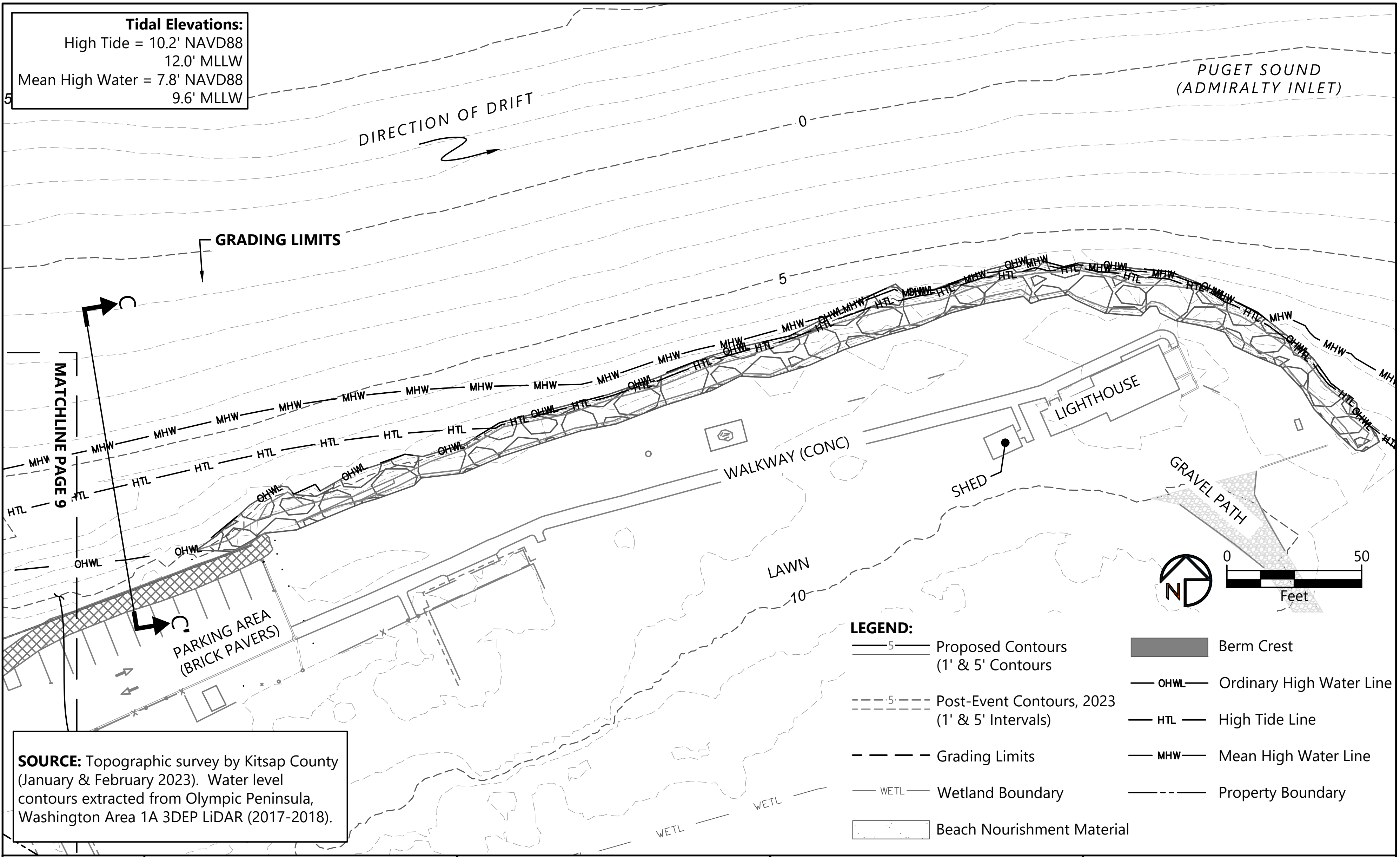
Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW



LEGEND:
- Proposed Contours (1' & 5' Contours)
- Post-Event Contours, 2023 (1' & 5' Intervals)
- Grading Limits
- Wetland Boundary
- Beach Nourishment Material
- Berm Crest
- Ordinary High Water Line
- High Tide Line
- Mean High Water Line
- Property Boundary

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

Aug 31, 2023 9:11am bluecoast

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1 BEACH REPAIR

PURPOSE: BEACH REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
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COUNTY: KITSAP
STATE: WASHINGTON
DATE: AUGUST 2023

PROPOSED CONDITIONS
(2 OF 3)

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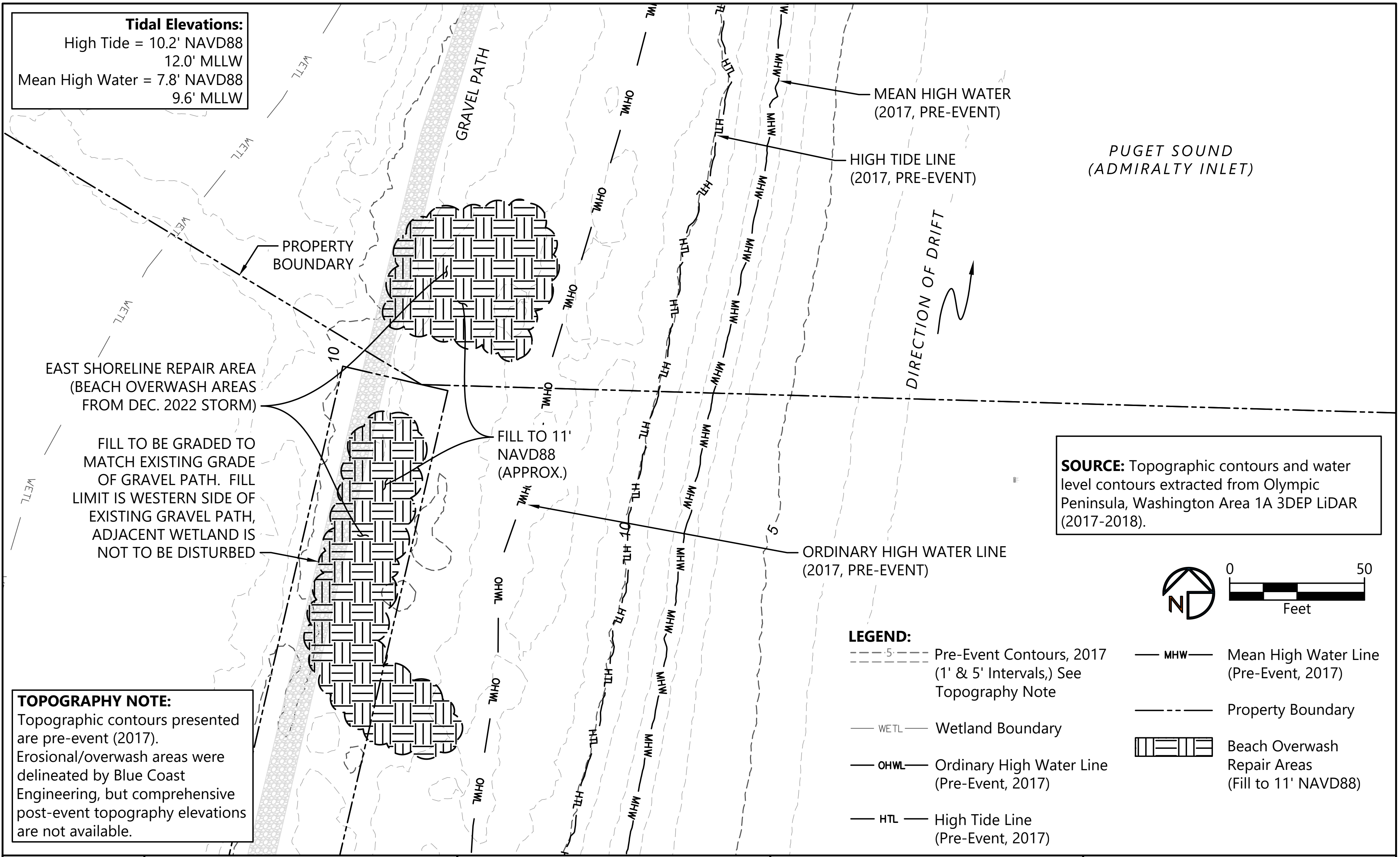
Aug 31, 2023 9:11am bluecoast



Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic contours and water level contours extracted from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

TOPOGRAPHY NOTE:
Topographic contours presented are pre-event (2017). Erosional/overwash areas were delineated by Blue Coast Engineering, but comprehensive post-event topography elevations are not available.

LEGEND:

- - 5 - -	Pre-Event Contours, 2017 (1' & 5' Intervals,) See Topography Note
— WETL —	Wetland Boundary
— OHWL —	Ordinary High Water Line (Pre-Event, 2017)
— HTL —	High Tide Line (Pre-Event, 2017)
— MHW —	Mean High Water Line (Pre-Event, 2017)
— - —	Property Boundary
▨	Beach Overwash Repair Areas (Fill to 11' NAVD88)

BLUE COAST ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

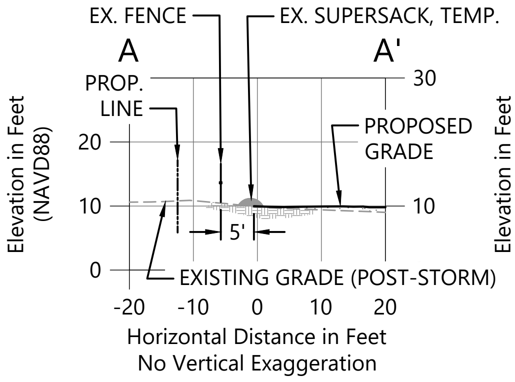
PROPOSED: PHASE 1 BEACH REPAIR

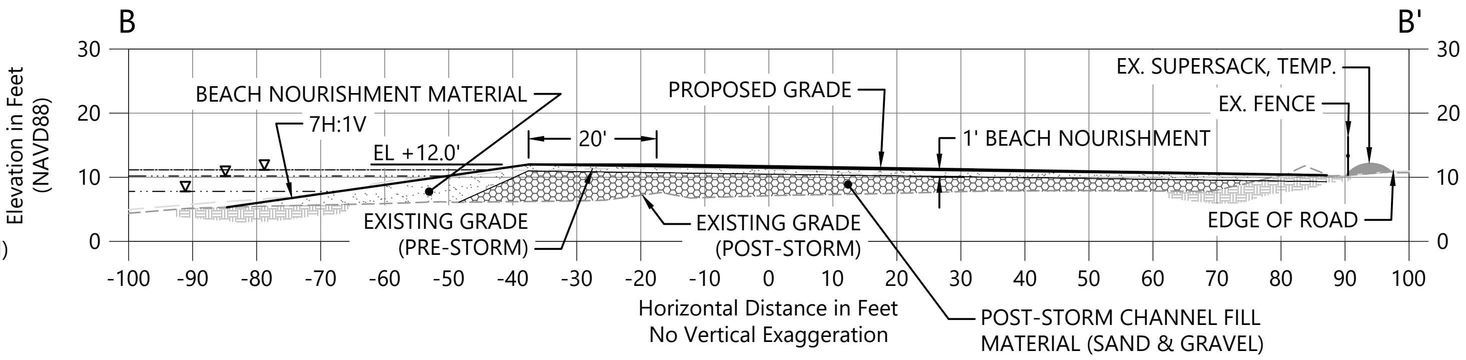
PURPOSE: BEACH REPAIR

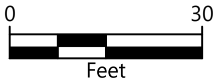
HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: AUGUST 2023

PROPOSED CONDITIONS (3 OF 3)

PAGE: 11 OF 6







LEGEND:

- — — — Existing Grade (Post-Event, 2023)
- — — — Existing Grade (Pre-Event, 2017)
- ——— Proposed Grade
- —∇— Ordinary High Water Line
- —··—∇—··— High Tide Line
- —·—∇—·— Mean High Water Line
- ▭ Beach Nourishment Material
- ▩ Post-Storm Channel Fill Material (Sand and Gravel)

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
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NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1 BEACH REPAIR

PURPOSE: BEACH REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: AUGUST 2023

PROPOSED CONDITIONS CROSS-SECTIONS

PAGE: 6 OF 6

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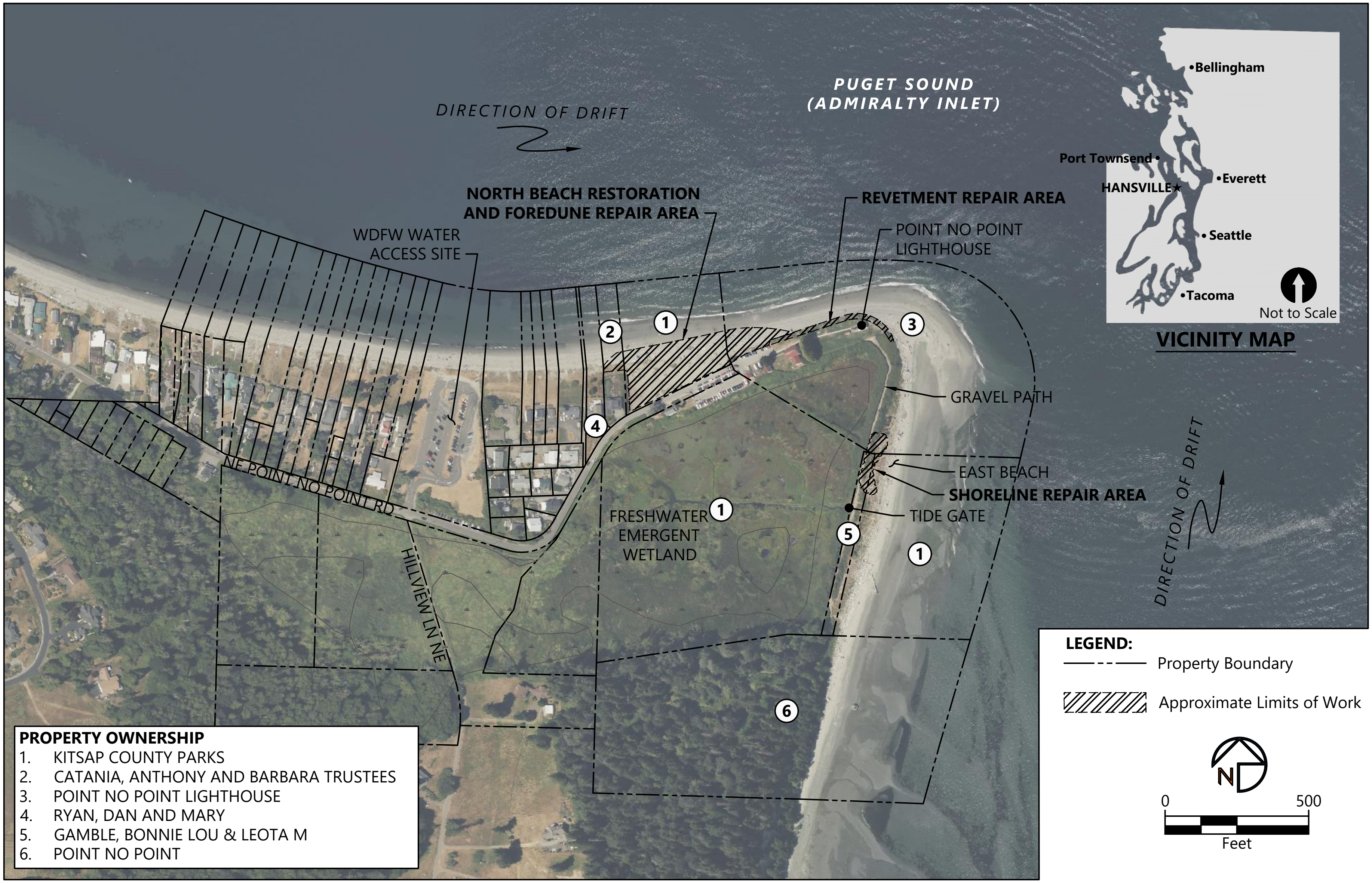
Aug 31, 2023 9:11am bluecoast

Appendix C

Preferred Alternative Final Design Drawings



PROPERTY OWNERSHIP

1. KITSAP COUNTY PARKS
2. CATANIA, ANTHONY AND BARBARA TRUSTEES
3. POINT NO POINT LIGHTHOUSE
4. RYAN, DAN AND MARY
5. GAMBLE, BONNIE LOU & LEOTA M
6. POINT NO POINT

LEGEND:

— - —	Property Boundary
▨	Approximate Limits of Work

BLUE COAST ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

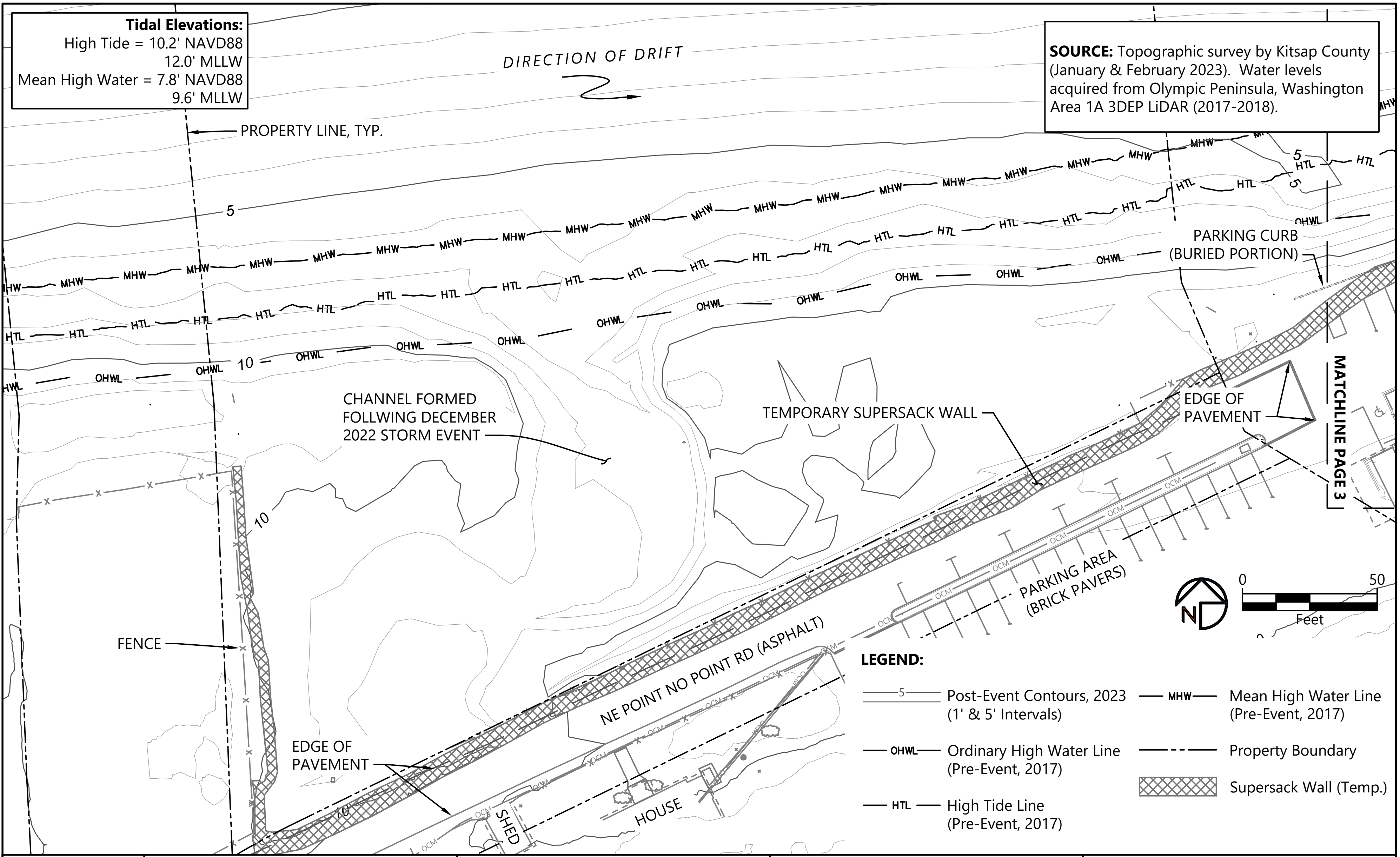
PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

SITE & VICINITY MAP

P:\CO_Kitsap_1103\2301_Point no Point\10_Design\CAD\Dwg\JARPA\PNP-JA-01-Existing.dwg 2 POST-EVENT CONDITIONS (1 OF 3)

May 17, 2023 3:50pm bluecoast



Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Post-Event Contours, 2023 (1' & 5' Intervals)	— MHW —	Mean High Water Line (Pre-Event, 2017)
— OHWL —	Ordinary High Water Line (Pre-Event, 2017)	— · —	Property Boundary
— HTL —	High Tide Line (Pre-Event, 2017)	▨	Supersack Wall (Temp.)

BLUE COAST ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

POST-EVENT CONDITIONS (1 OF 3)

PAGE: 2 OF 14

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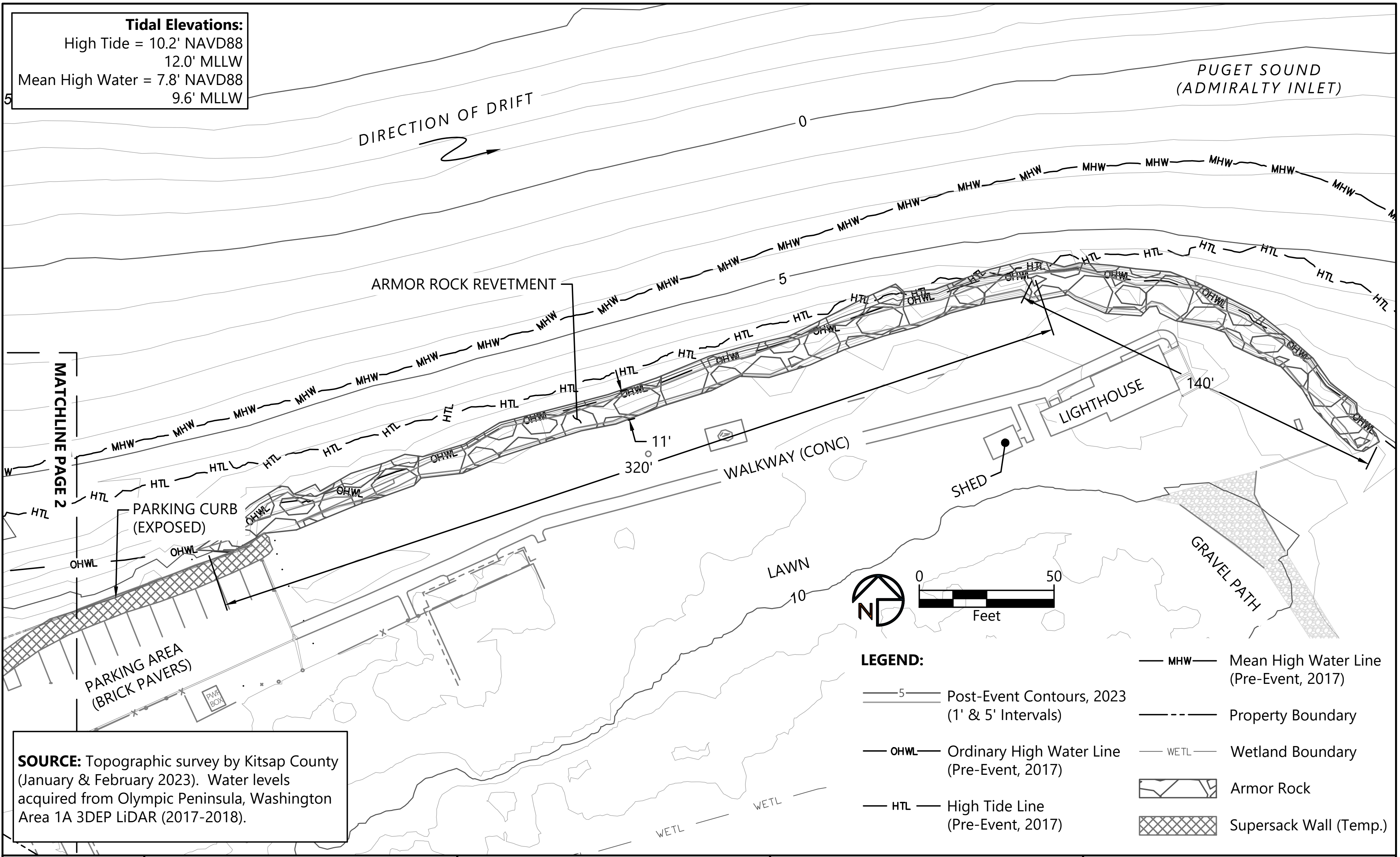
May 17, 2023 3:50pm bluecoast



Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Post-Event Contours, 2023 (1' & 5' Intervals)
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)
—HTL—	High Tide Line (Pre-Event, 2017)
—MHW—	Mean High Water Line (Pre-Event, 2017)
— - - —	Property Boundary
—WETL—	Wetland Boundary
▨	Armor Rock
▩	Supersack Wall (Temp.)

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
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LATITUDE: N47.911961°
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S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

POST-EVENT CONDITIONS (2 OF 3)

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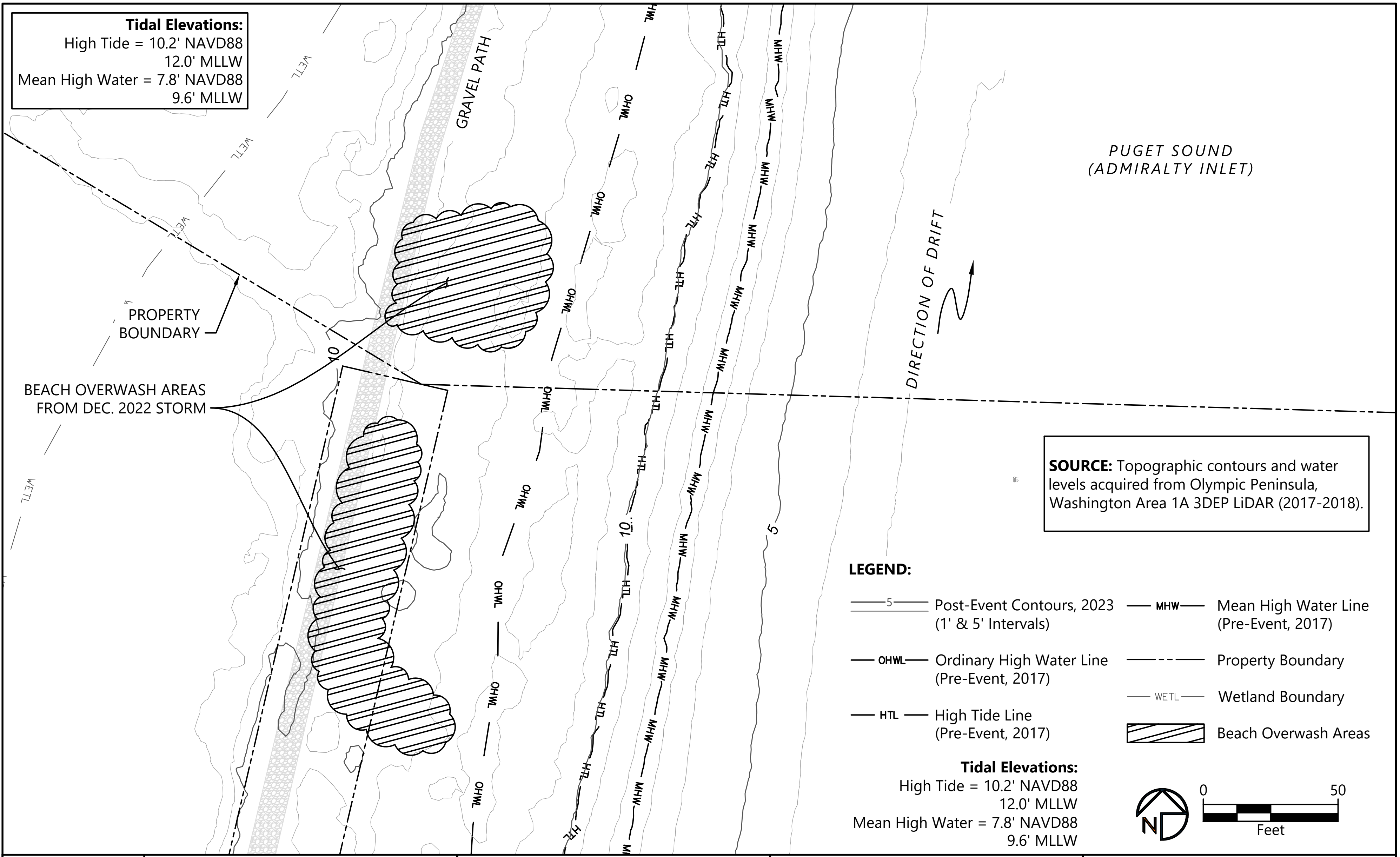
May 17, 2023 3:50pm bluecoast

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW



SOURCE: Topographic contours and water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Post-Event Contours, 2023 (1' & 5' Intervals)
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)
—HTL—	High Tide Line (Pre-Event, 2017)
—MHW—	Mean High Water Line (Pre-Event, 2017)
—·—·—	Property Boundary
—WETL—	Wetland Boundary
▨	Beach Overwash Areas

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
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LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

POST-EVENT CONDITIONS (3 OF 3)

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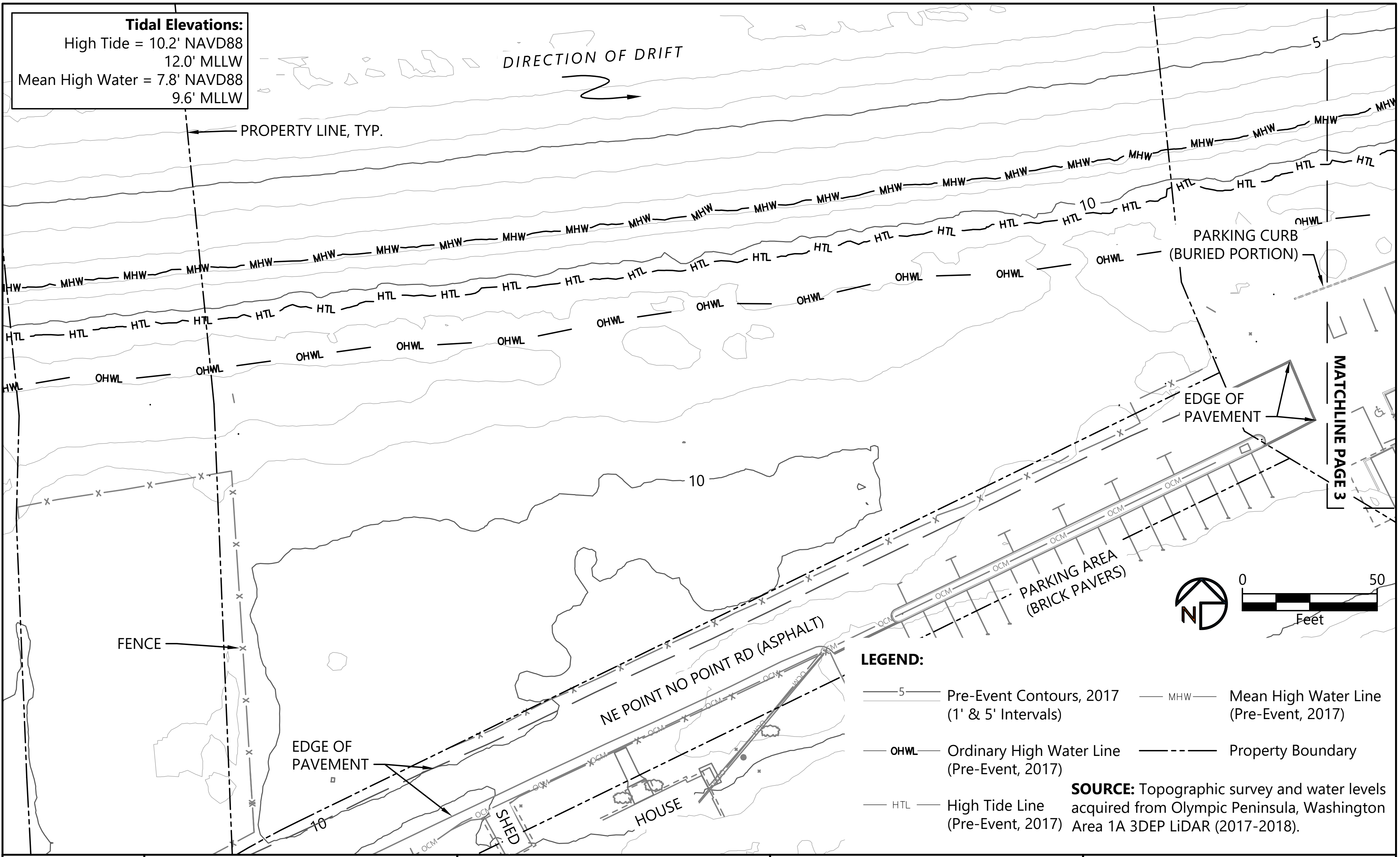
May 17, 2023 3:50pm bluecoast



SOURCE: Topographic survey and water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
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S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

PRE-EVENT CONDITIONS (1 OF 3)

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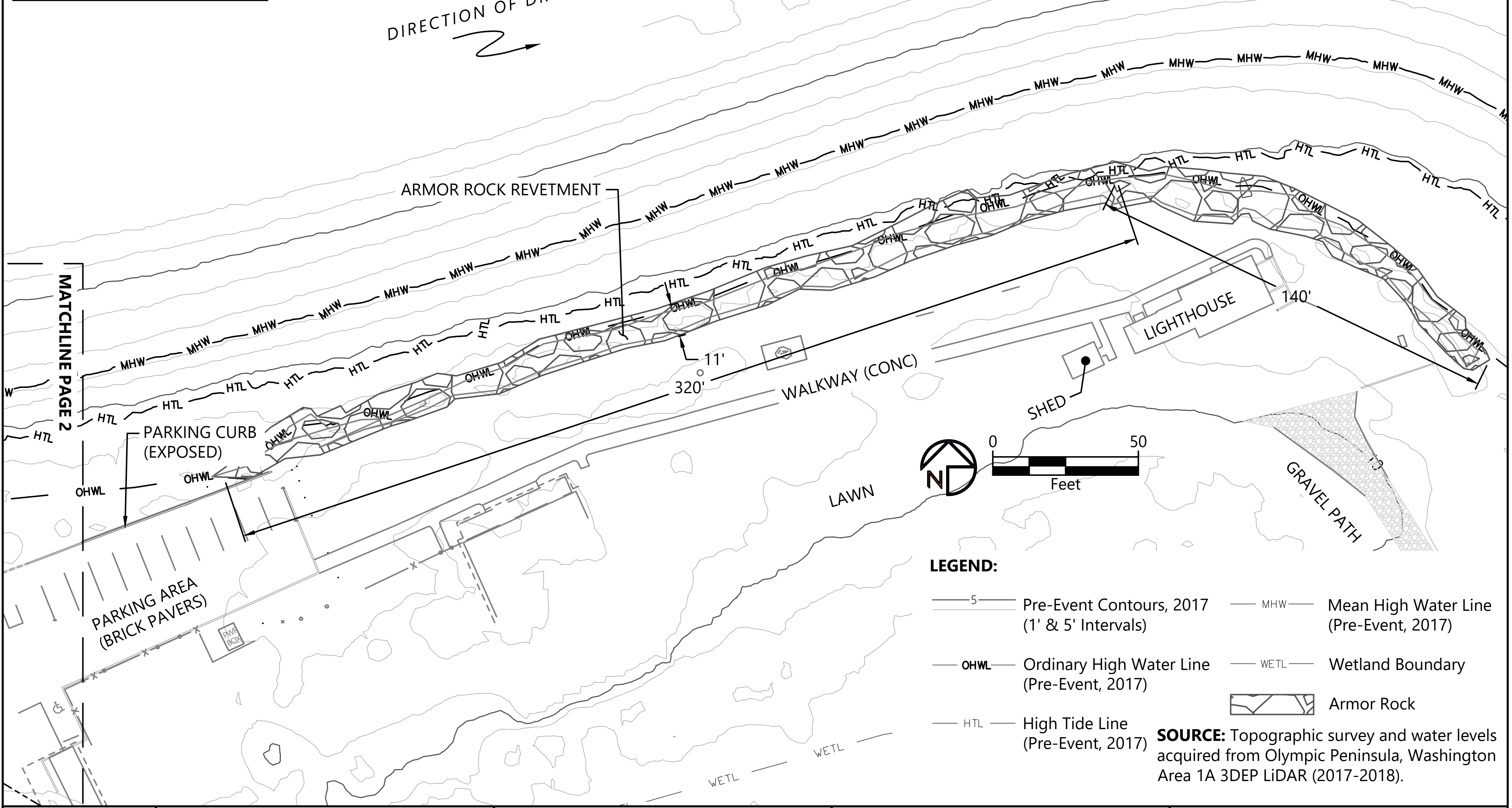
May 17, 2023 3:50pm bluecoast

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW



SOURCE: Topographic survey and water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
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S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

PRE-EVENT CONDITIONS (2 OF 3)

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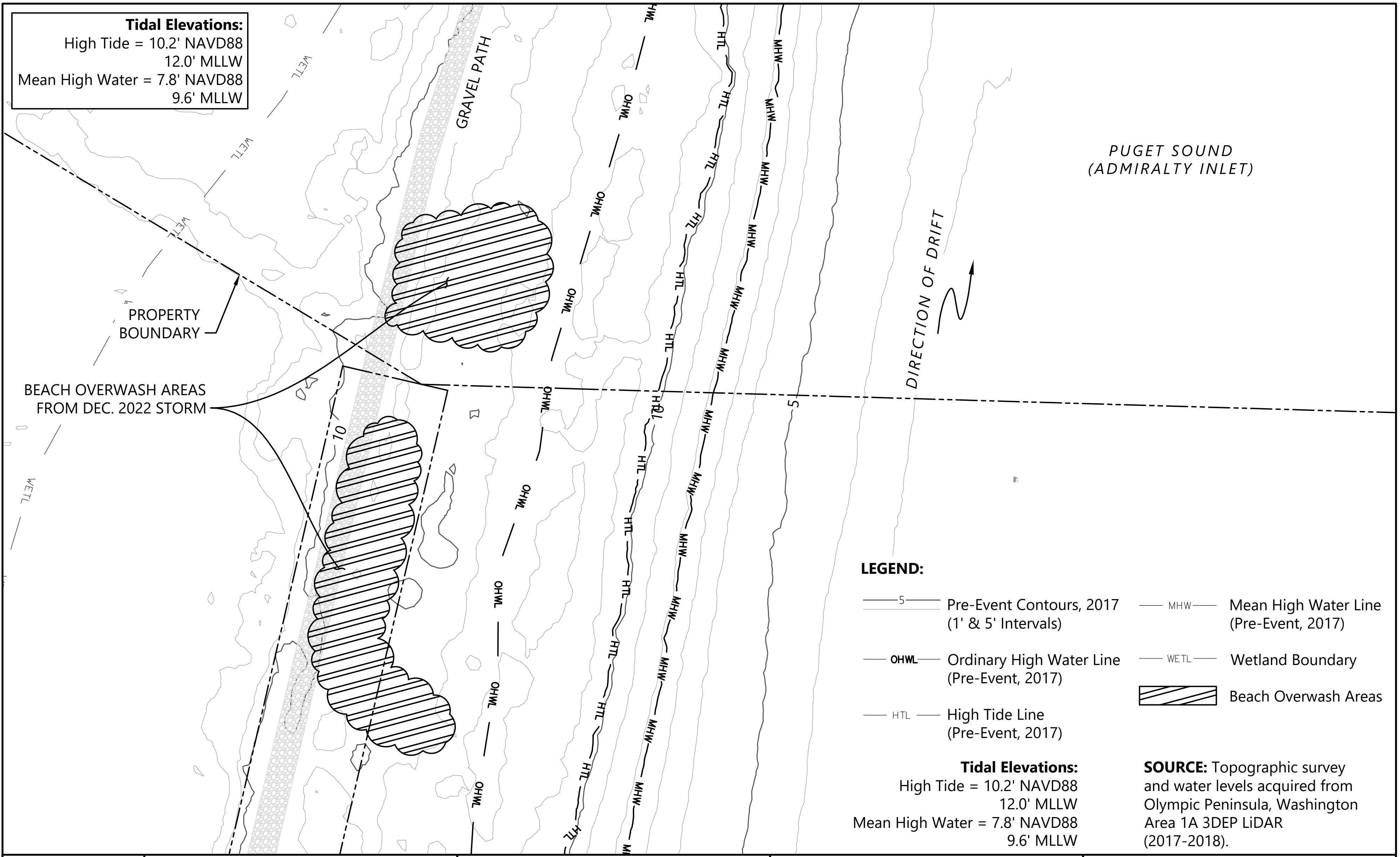
May 17, 2023 3:50pm bluecoast



Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

LEGEND:

5	Pre-Event Contours, 2017 (1' & 5' Intervals)
OHWL	Ordinary High Water Line (Pre-Event, 2017)
HTL	High Tide Line (Pre-Event, 2017)
MHW	Mean High Water Line (Pre-Event, 2017)
WETL	Wetland Boundary
▨	Beach Overwash Areas

SOURCE: Topographic survey and water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
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COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

PRE-EVENT CONDITIONS (3 OF 3)

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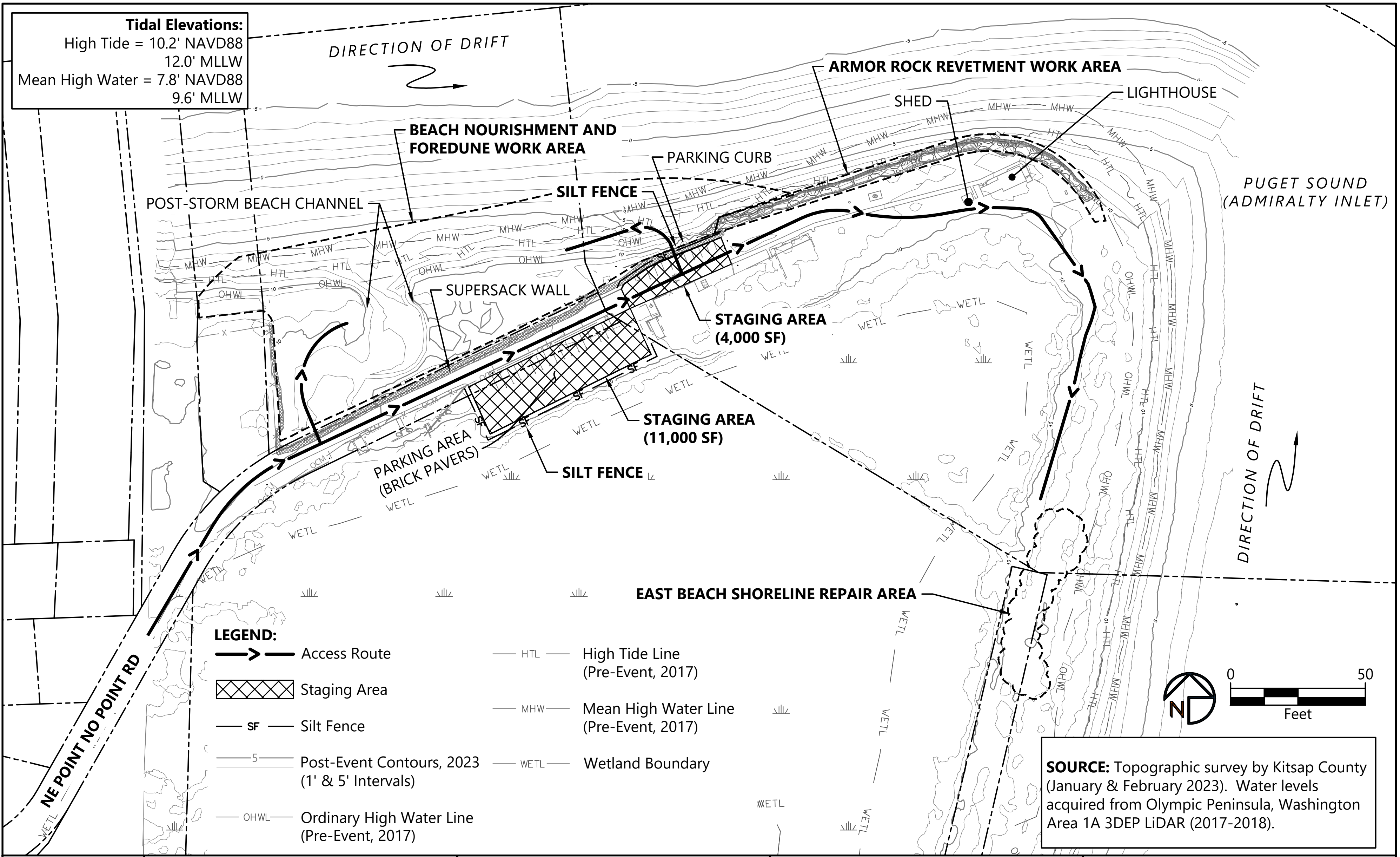
May 17, 2023 3:50pm bluecoast

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW



SOURCE: Topographic survey by Kitsap County (January & February 2023). Water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
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ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

PURPOSE: BEACH AND FOREDUNE RESTORATION AND REVETMENT REPAIR

HORIZONTAL DATUM: WSP NORTH, NAD83, US SURVEY FEET
VERTICAL DATUM: NAVD88, FEET
LATITUDE: N47.911961°
LONGITUDE: W122.528366°
S-T-R: S15-T28N-R02E
IN: HANSVILLE
NEAR/AT: ADMIRALTY INLET, PUGET SOUND
COUNTY: KITSAP
STATE: WASHINGTON
DATE: MAY 2023

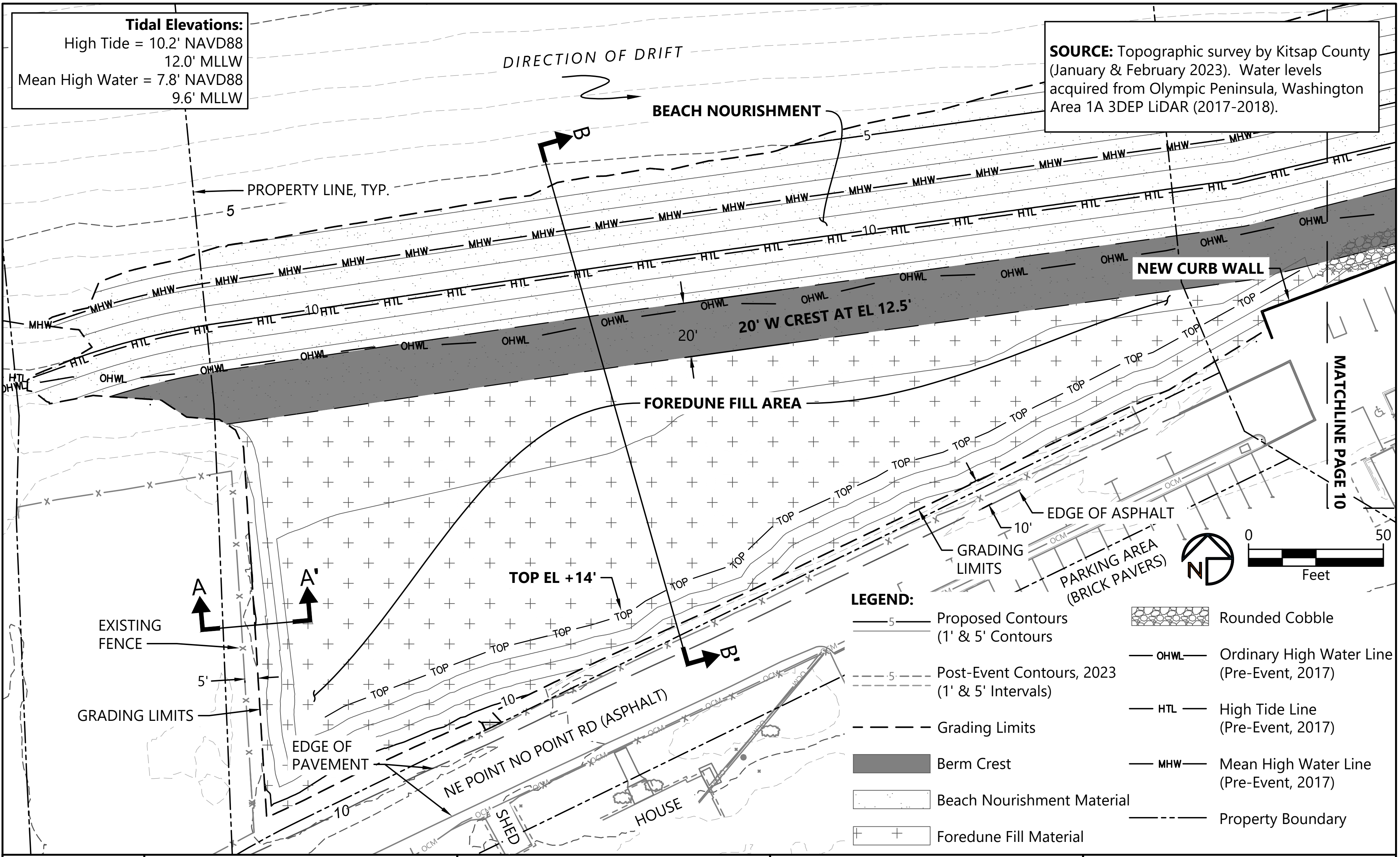
ACCESS, STAGING, AND TESC

P:\CO_Kitsap_1103\2301_Point no Point\10_Design\CAD\Dwg\JARPA\PNP-JA-01-Proposed.dwg 9 PROPOSED CONDITIONS (1 OF 3)

May 17, 2023 3:50pm bluecoast

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).



LEGEND:

—5—	Proposed Contours (1' & 5' Contours)
- -5- -	Post-Event Contours, 2023 (1' & 5' Intervals)
— — —	Grading Limits
▆	Berm Crest
░	Beach Nourishment Material
+ +	Foredune Fill Material
▨	Rounded Cobble
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)
—HTL—	High Tide Line (Pre-Event, 2017)
—MHW—	Mean High Water Line (Pre-Event, 2017)
—·—·—	Property Boundary

BLUE COAST
ENGINEERING

REFERENCE #:

APPLICANT: KITSAP COUNTY

LOCATION: 8997 NE POINT RD
HANSVILLE, WA 98340

ADJACENT PROPERTY OWNERS:
CATANIA ANTHONY AND BARBARA, GAMBLE BONNIE LOU & LEOTA M, RYAN DAN AND MARY, POINT NO POINT

NAME: POINT NO POINT PARK REHABILITATION PROJECT

PROPOSED: PHASE 1A-BEACH RESTORATION
PHASE 1B – FOREDUNE RESTORATION
PHASE 2 – REVETMENT SETBACK AND PARKING CURB
PHASE 3 – REVETMENT REPAIR

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PROPOSED CONDITIONS
(1 OF 3)

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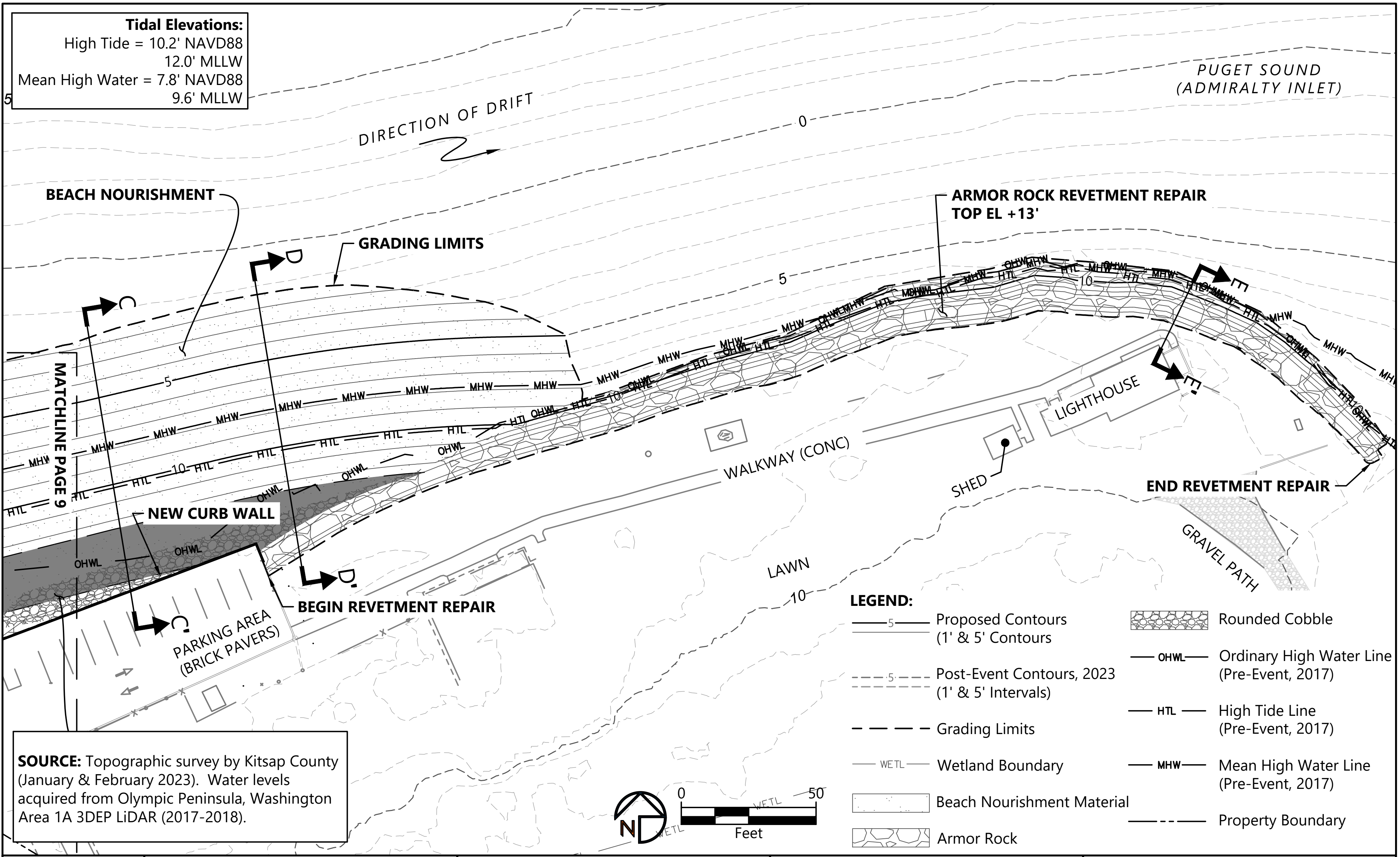
May 17, 2023 3:50pm bluecoast



Tidal Elevations:
High Tide = 10.2' NAVD88
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Mean High Water = 7.8' NAVD88
9.6' MLLW

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Proposed Contours (1' & 5' Contours)
- -5- -	Post-Event Contours, 2023 (1' & 5' Intervals)
— — —	Grading Limits
—WETL—	Wetland Boundary
▭	Beach Nourishment Material
▨	Armor Rock
▨	Rounded Cobble
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)
—HTL—	High Tide Line (Pre-Event, 2017)
—MHW—	Mean High Water Line (Pre-Event, 2017)
—·—·—	Property Boundary

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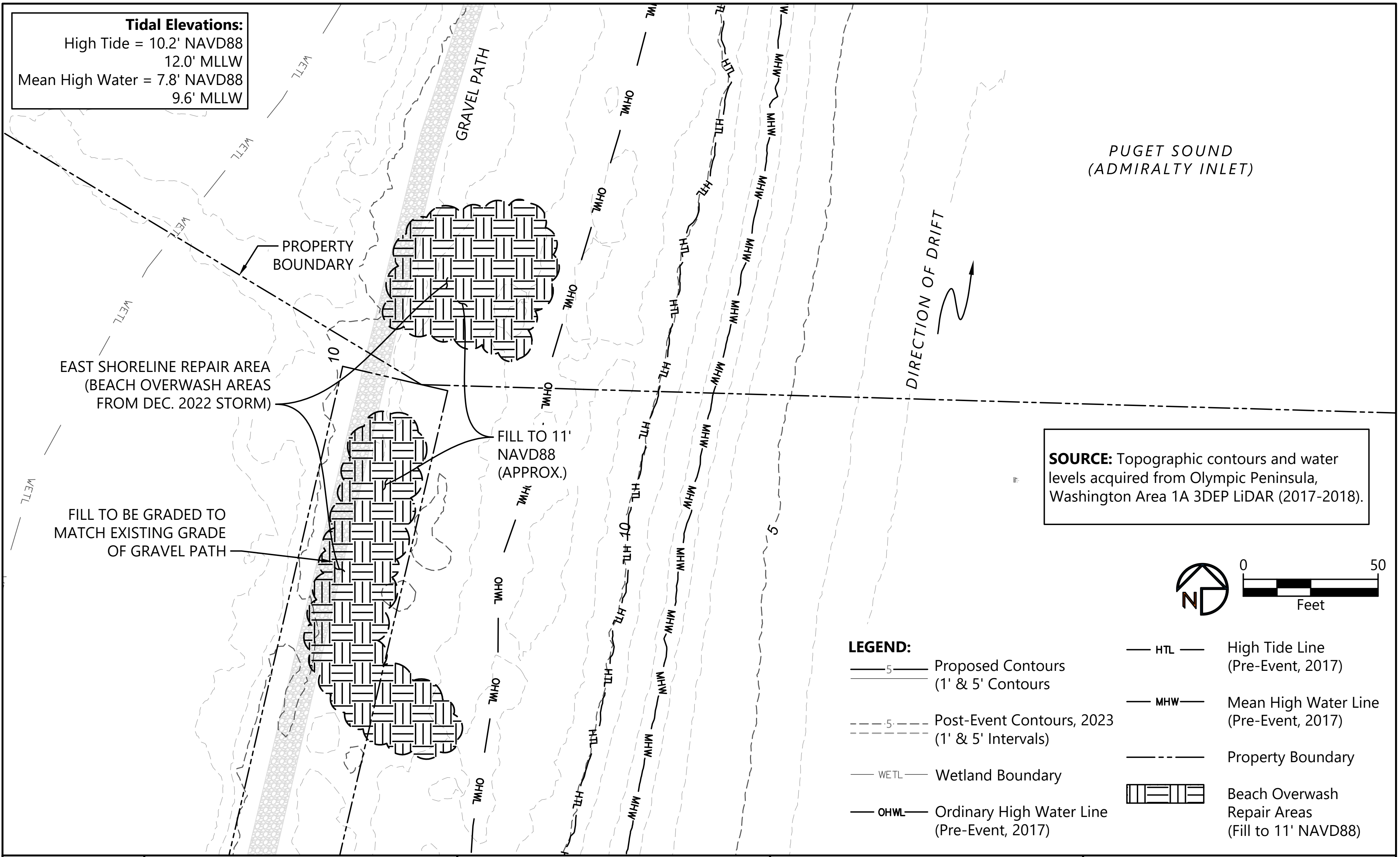
PROPOSED CONDITIONS
(2 OF 3)

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW



SOURCE: Topographic contours and water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

LEGEND:

—5—	Proposed Contours (1' & 5' Contours)
- - 5 - -	Post-Event Contours, 2023 (1' & 5' Intervals)
— WETL —	Wetland Boundary
— OHWL —	Ordinary High Water Line (Pre-Event, 2017)
— HTL —	High Tide Line (Pre-Event, 2017)
— MHW —	Mean High Water Line (Pre-Event, 2017)
— - —	Property Boundary
▥	Beach Overwash Repair Areas (Fill to 11' NAVD88)

BLUE COAST
ENGINEERING

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PROPOSED CONDITIONS (3 OF 3)

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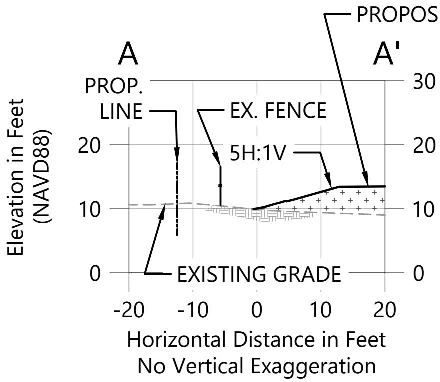

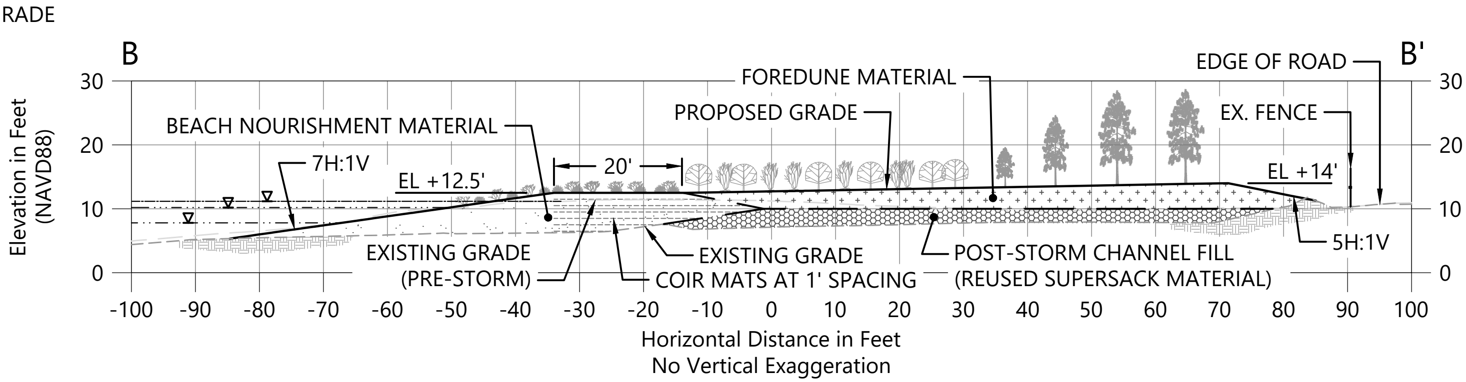

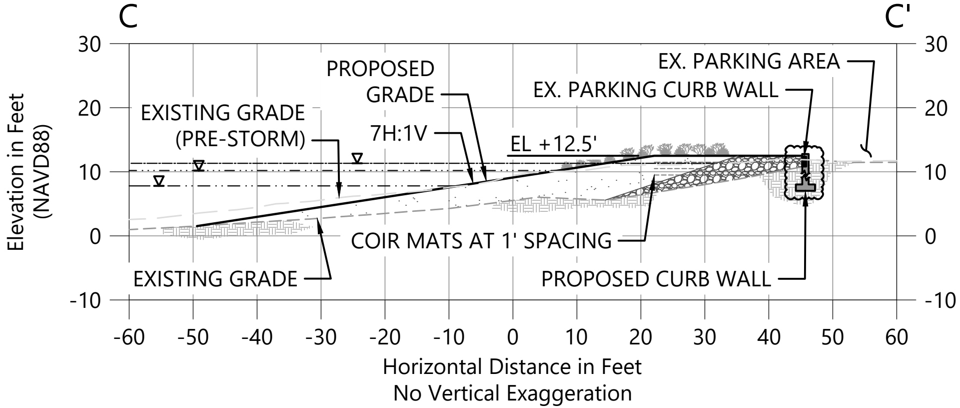

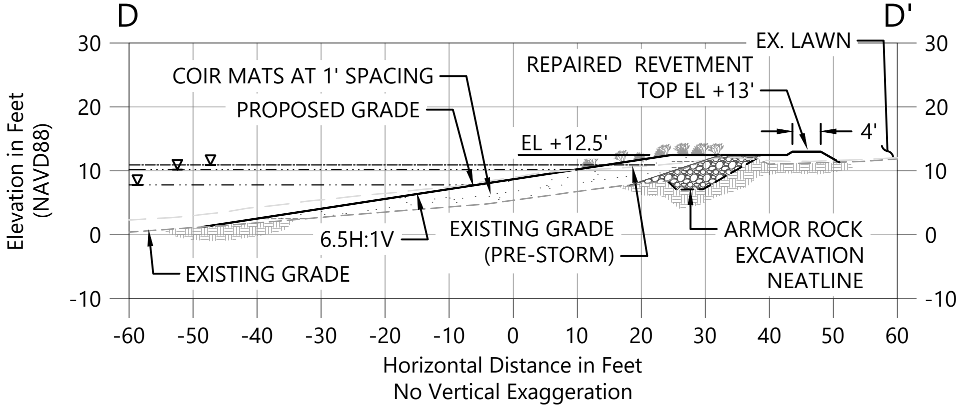

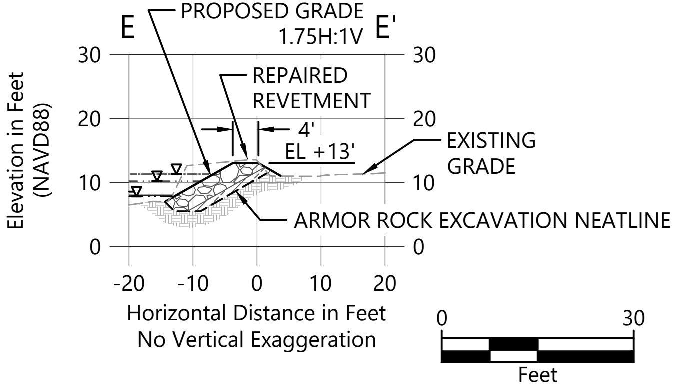

LEGEND:

— — —	Existing Grade (Post-Event, 2023)
— — —	Existing Grade (Pre-Event, 2017)
———	Proposed Grade
– – – – –	Excavation Neatline
—·—▽—·—	Ordinary High Water Line
—··—▽—··—	High Tide Line
—·—▽—·—	Mean High Water Line
⬚	Beach Nourishment Material
▨	Foredune Material
▨	Rounded Cobble
▨	Armor Rock
▨	Filter Material
▨	Post-Storm Channel Fill Material

Tidal Elevations:
High Tide = 10.2' NAVD88
12.0' MLLW
Mean High Water = 7.8' NAVD88
9.6' MLLW

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PROPOSED CONDITIONS CROSS-SECTIONS

PAGE: 12 OF 14

P:\CO_Kitsap_1103\2301_Point no Point\10_Design\CAD\Dwg\JARPA\PNP-JA-04-Planting.dwg 13 PLANTING PLAN

May 17, 2023 3:50pm bluecoast

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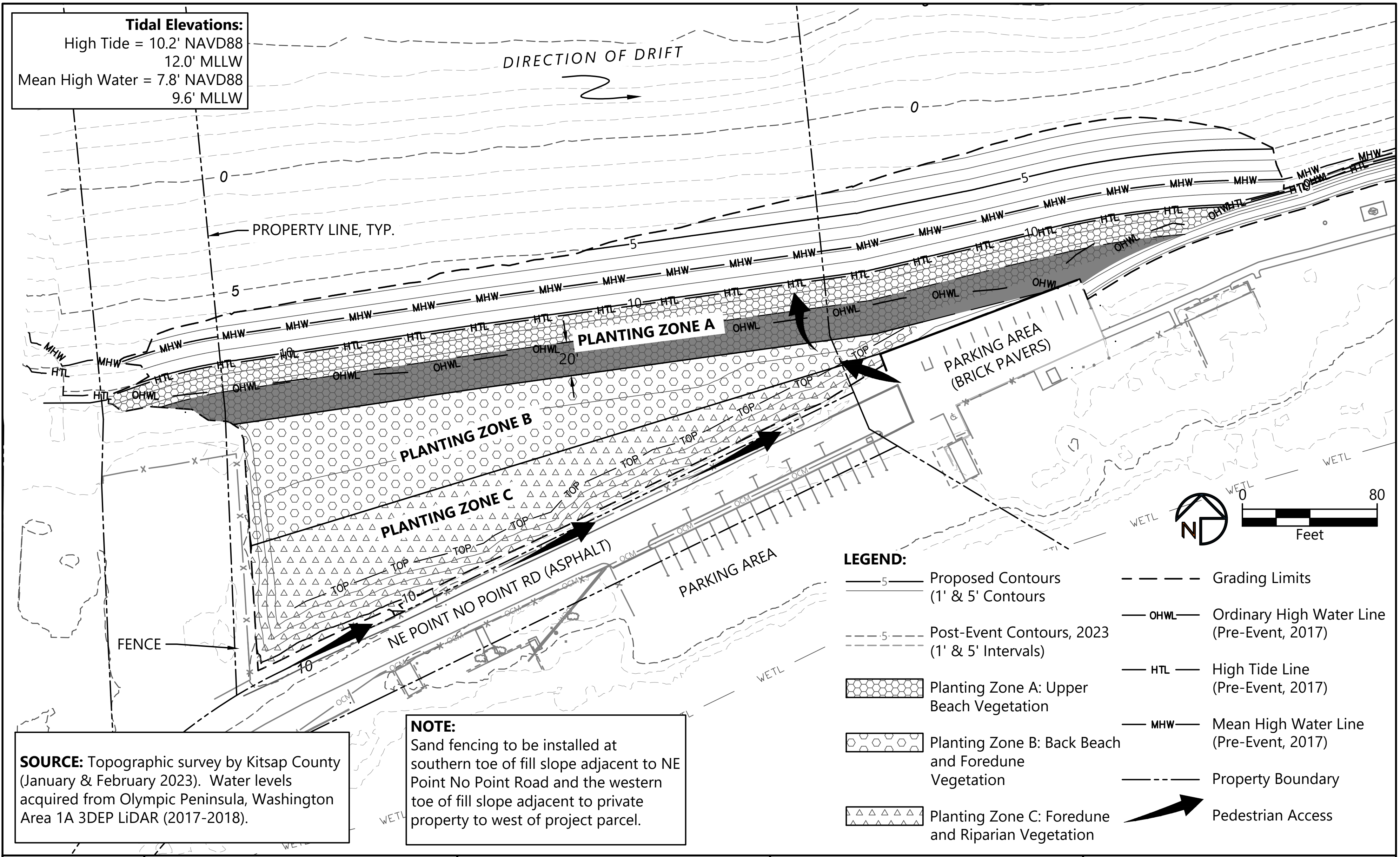

SOURCE: Topographic survey by Kitsap County (January & February 2023). Water levels acquired from Olympic Peninsula, Washington Area 1A 3DEP LiDAR (2017-2018).

NOTE:
Sand fencing to be installed at southern toe of fill slope adjacent to NE Point No Point Road and the western toe of fill slope adjacent to private property to west of project parcel.

LEGEND:

—5—	Proposed Contours (1' & 5' Contours)
- - 5 - -	Post-Event Contours, 2023 (1' & 5' Intervals)
⬡	Planting Zone A: Upper Beach Vegetation
○	Planting Zone B: Back Beach and Foredune Vegetation
△	Planting Zone C: Foredune and Riparian Vegetation
— — —	Grading Limits
—OHWL—	Ordinary High Water Line (Pre-Event, 2017)
—HTL—	High Tide Line (Pre-Event, 2017)
—MHW—	Mean High Water Line (Pre-Event, 2017)
—·—·—	Property Boundary
➚	Pedestrian Access

BLUE COAST
ENGINEERING

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PLANTING PLAN

P:\CO_Kitsap_1103\2301_Point no Point\10_Design\CAD\Dwg\JARPA\PNP-JA-04-Planting.dwg 14 CANDIDATE PLANT LIST

May 17, 2023 3:50pm bluecoast

CANDIDATE PLANT LIST

Scientific Name	Common Name
Coniferous Trees	
Pinus contorta	Shore Pine
Pseudotsuga menziesii	Douglas Fir
Shrubs	
Rosa nutkana	Nootka Rose
Amelanchier alnifolia	Serviceberry
Salix hookeriana	Hooker's Willow
Symphoricarpos albus	Snowberry
Holodiscus discolor	Oceanspray
Grasses/Perennials/Ferns	
Eleocharis palustris	Spike Rush
Grindelia integrifolia	Puget Sound Gumweed
Cakile edentula	American Searocket
Calystegia soldanella	Seahorse False Bindweed
Fragaria Chiloensis	Coastal Strawberry
Elymus mollis	American Dunegrass
Argentina Pacifica	Pacific Silverweed
Deschampsia cespitosa	Tufted hairgrass
Abronia villosa	Sand Verbena

BLUE COAST
ENGINEERING

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BONNIE LOU & LEOTA M, RYAN DAN AND MARY,
POINT NO POINT

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CANDIDATE PLANT LIST

Appendix D
Curb Wall Design Technical Memorandum

Point No Point Parking Lot Curb Design in Support of Shoreline Restoration

100% Basis of Design

Contract No. **KC-093-23**

Produced By:

ART ANDERSON

830 Pacific Ave., Bremerton, WA, 98337

December 6th, 2023

Table of Contents

1 Project Description

This report describes Art Anderson's design of a new boundary curb along the northeastern parking lot at Point No Point Park. The curb design is in support of a larger effort by Blue Coast to restore the north beach of Point No Point Park after damage and erosion from storms and the king tide in Winter 2022-2023. During this event, the parking lot flooded, sand and debris were carried into the parking lot, and beach erosion of up to 5 to 7 feet occurred adjacent to the parking area, causing erosion at the edge of the parking lot.

The objective of the overall project is to restore the north beach, mitigate against flooding during future king tides, reduce flood impacts along the northern and eastern shoreline, and align with planned restoration led by others. There is an existing concrete curb that runs along the edge of the northeastern parking area. As shown in Figure 1, the existing curb is roughly 1 foot deep, and is flush with the parking surface. The goal is to design a new taller curb designed with an appropriate toe that will prevent erosion of the parking lot boundary in the event of future severe events. In addition to the curb, the beach side of the curb will be restored by Blue Coast, and it is planned to place beach cobbles to further prevent erosion at this interface.

The design objectives for the new curb are to provide a boundary between the parking area and the beach interface, to extend deep enough to prevent undermining of the parking area under future potential erosion events, and to withstand all potential loading conditions. The curb is not meant to be a seawall, it is not designed to prevent water from passing or topping.

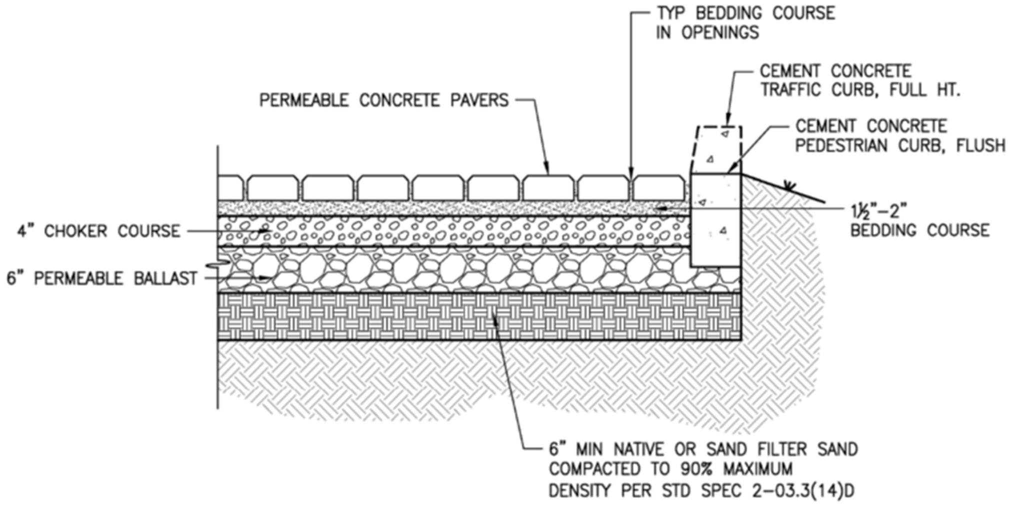


Figure 1: Parking lot cross section from Parametrix drawings (Reference 3).

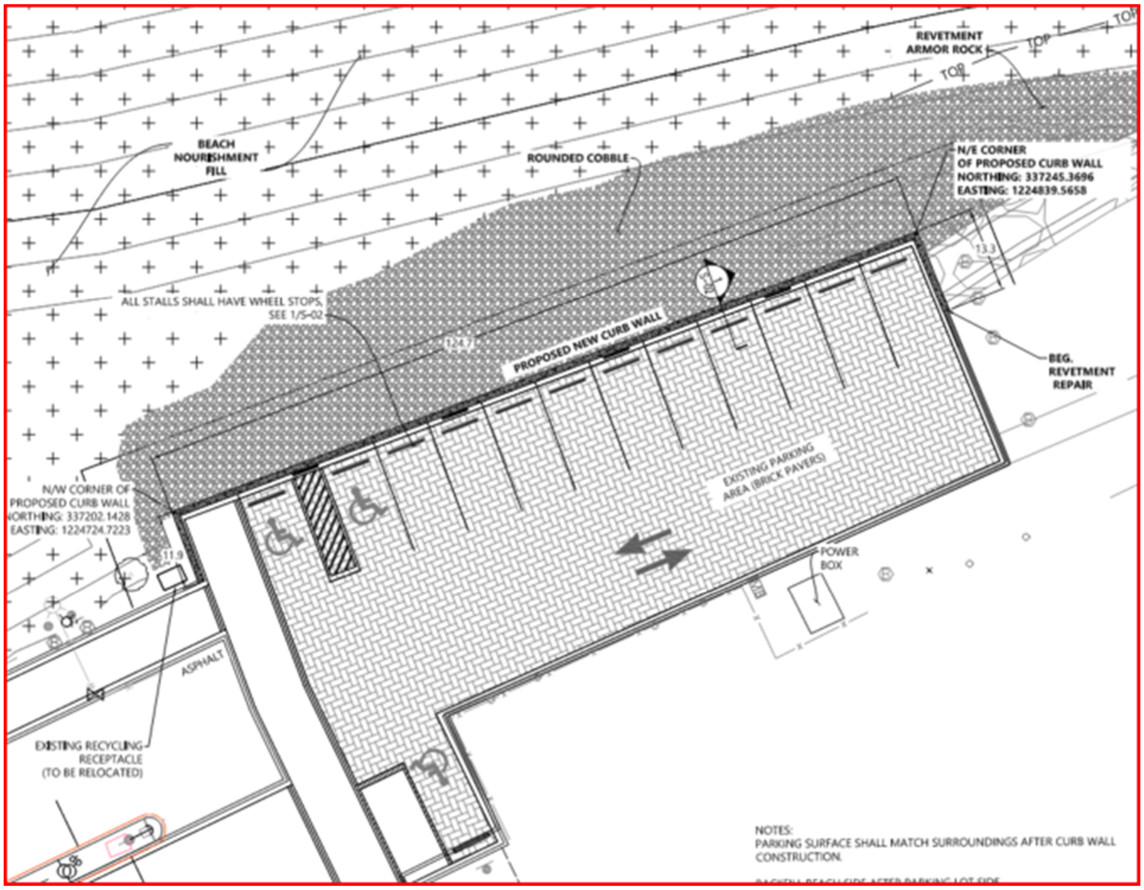


Figure 2: Proposed new curb alignment from Blue Coast

2 References and Standards

1. Aspect Consulting (2022) Geotechnical Memo No. 190275-B-03 August 26, 2022
2. Blue Coast (2023) Point No Point Coastal Engineering Restoration
3. Parametrix (2014) Point No Point Park Parking Lot LID Retrofit, Bid Set Drawings 02/19/24
4. United States Army Corps of Engineers (USACE). 2006. Coastal Engineering Manual. Engineer Manual 1110-2-1110, U.S. Army Corps of Engineers, Washington, D.C. (6 volumes).

3 Curb Design

3.1 Curb Alignment

The curb alignment will be as shown in Figure 2. The curb will extend along the 122-foot northern edge of the parking lot. There will be a return wall wrapping around the edges of the parking lot where it borders the beach. The purpose of the return walls are to retain adjacent beach fill and revetment rock as it slopes down to the level of the parking surface.

3.2 Project Elevations

The parking lot surface adjacent to the curb ranges from about 11.5 feet to 12 feet NAVD88.

The proposed finish grade of the beach fill adjacent to the curb is 12.5 feet NAVD88.

The proposed top of the curb is 13 feet NAVD88.

The proposed bottom of the curb footing is 6 feet NAVD88. This is equal to the maximum depth of erosion that was experienced during the damaging storm and tide events. This is also maximum erosion/loss of beach material that will be assumed in the wall design.

Tidal datums were provided by Blue Coast and are listed below. The wall will be designed for a maximum tide elevation of 12.3 ft NAVD88, corresponding to the FEMA SWL (1% AEP).

Table 1: Tidal Datums at Point No Point, from Blue Coast

Datum / Elevation	Point No Point[1]	
	Elevation (ft MLLW)	Elevation (ft NAVD88)
FEMA BFE (1% AEP) includes wave effects	14.8	13.0
FEMA SWL (1%AEP), coastal transect 18	14.1	12.3
December 27, 2022	13.6[3]	11.8[3]
January 7, 2022 observed	12.8[4]	11.0[4]
100-year water level (1% AEP)[2]	13.4	11.6
10-year water level (10% AEP)[2]	13.1	11.3
2-year water level (50% AEP)[2]	12.6	10.8
1-year water level (99% AEP)[2]	11.9	10.1
High Tide Line (HTL)	12.0	10.2
Highest Astronomical Tide (HAT)[5]	12.3	10.5
Mean Higher High Water (MHHW)	10.5	8.7
Mean High Water (MHW)	9.6	7.8
Mean Tide Level (MTL)	6.2	4.4
Mean Sea Level (MSL)	6.1	4.3
Mean Low Water (MLW)	2.8	1
Mean Lower Low Water	0	-1.8

Notes: [1]Datums for project site are calculated based on NOAA Vdatum online tool; [2]Extrapolated from NOAA-NOS Seattle station (#9497130) extreme water level trend analysis; [3]Estimated based on Seattle station measured tides and subordinate station temporal and height offsets provided for the Hansville, WA Station (9447130) [4]Measured by Blue Coast using offshore water level gage located at +4 feet NAVD88 at Point No Point; [5]NOAA Nearshore Conservation Calculator webmap (Cereghino et al. 2022).

3.3 Waves

Wave parameters are provided by Blue Coast and are shown below.

Table 2: Design wind speeds at the Whidbey NAS and Point No Point meteorological stations for northerly wind directions and associated wind-wave hindcast estimates for Point No Point

Return Period (years)	Northerly Wind Directions (300° to 40°)		
	Wind Speed (mph)	Significant Wave Height (ft)	Peak Wave Period (sec)
Typical	10	0.5	1.6
1	34	3.1	3.6
25	48	4.7	4.4
50	50	5.0	4.5
100	51	5.1	4.5
Notes: N/A: not applicable: 1: Prevailing wind speed from the northerly sector which occurs approximately 15% of the time based on analysis of the Point No Point meteorological station data record (Blue Coast 2023b)			

3.4 Soil Parameters

Soil data is provided in Reference 1, a geotechnical memo from Aspect Consulting prepared in 2022. This memo describes site soils as beach deposits described as loose, sand, pebbles, pebbly sand, cobbles, silt, clay, shells, and isolated boulders. Alluvium was found below the topsoil in a boring near the parking lot, described as gray to gray-brown sand (SP) to sand with silt (SP-SM) to silty sand (SM) with varying gravel and organics.

Groundwater monitoring from Reference 1 indicates tidal effects are attenuated in monitoring wells that are roughly 200 feet or more from the beach. It is unclear if tidal effects would be attenuated behind the retaining wall, which is closer to the shore than the monitoring wells. In several load cases, it is assumed that the water level in the soil will equal the tide water level and that the curb will not retain the water table on one side, so the wall will be buoyant below the tide level for the range of tides. The wall was not designed to resist hydrostatic pressure from an unbalanced water table. An unbalanced water table is not a concern with the beach fill in place, because the soil height only differs by about 1 foot. However, in the load cases where the beach side has eroded, weep holes will be included in the wall design to drain any water buildup on the parking lot side.

Lateral soil pressures for design of the retaining wall are as shown in Table 3.

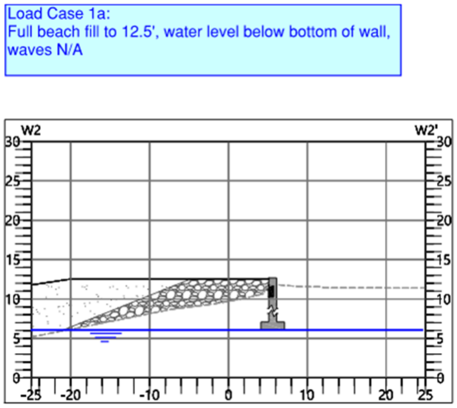
Table 3: Lateral soil pressures used in retaining wall design

	Wet Weight (pcf)	Submerged Weight (pcf)
Parking Lot Side: Native loose to medium dense sand, fine to medium	139 pcf	75 pcf

3.5 Retaining Wall Design

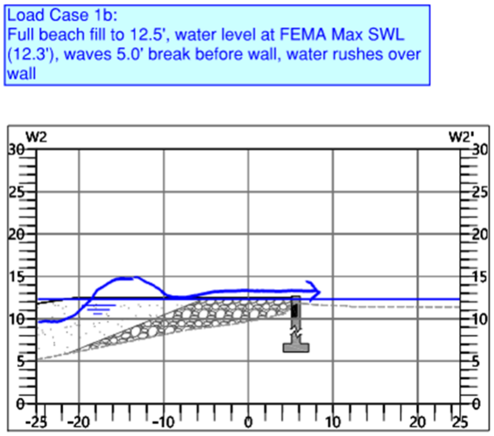
The retaining wall/curb is 146’ long with two corners that wrap around the parking lot on either side. The toe will be covered with the beach nourishment on the north side and the heel will be under the parking lot on the south side. The new retaining wall will be in the same location as the original curb and is designed to withstand the potential for wave action.

The load cases were developed to address the different situations regarding beach nourishment and potential for wave action. Load cases 1a (Figure 3) and 1b (Figure 4) show the retaining wall with full beach nourishment while cases 2a, 2b, 2c, and 2d show none. The focus of the calculations was load cases 2a, 2b, 2c, and 2d as there is no soil on the toe resulting in the worst-case scenarios from the backfill driving forces. The retaining wall was designed to be large enough to resist these cases and meet the requirements for overturning and sliding checks.



Load Case 1a:
Full beach fill to 12.5', water level below bottom of wall, waves N/A

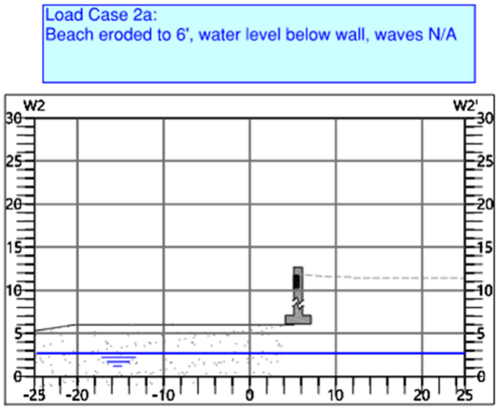
Figure 3: Load Case 1a



Load Case 1b:
Full beach fill to 12.5', water level at FEMA Max SWL (12.3'), waves 5.0' break before wall, water rushes over wall

Figure 4: Load Case 1b

There is no water behind the wall for load case 2a (Figure 5) and the driving force of the active backfill and surcharge loads are the focus. Load case 2b (Figure 6) still has the driving force still the main consideration with the wave force also impacting the wall in the opposite direction. The retaining wall was first analyzed the same way as 2a and then reversed to also account for the moment about the heel caused by the waves. The design also passes the overturning moment in this direction; however, the analysis assumes that there is no passive soil pressure acting against it which would increase the resistance to the waves. The load case also assumes water on both sides of the wall. Load cases 2a and 2b are considered the most impactful.



Load Case 2a:
Beach eroded to 6', water level below wall, waves N/A

Figure 5: Load Case 2a

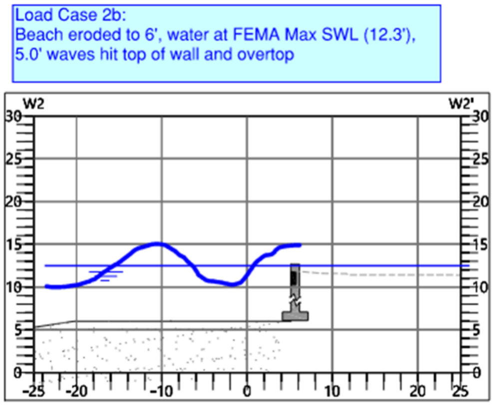

Load Case 2b:
Beach eroded to 6', water at FEMA Max SWL (12.3'),
5.0' waves hit top of wall and overtop

Figure 6: Load Case 2b

Load case 2c (Figure 7) is like 2b except in wave and water height. The driving force is still the main consideration however the wave force also impacts the wall in the opposite direction. The retaining wall was analyzed in the same way as 2b, and also passes the overturning check when considering wave action. Load case 2d is shown in Figure 8. Load cases 2b, 2c, and 2d had water behind the wall resulting in using the buoyant densities for the backfill soil and concrete.

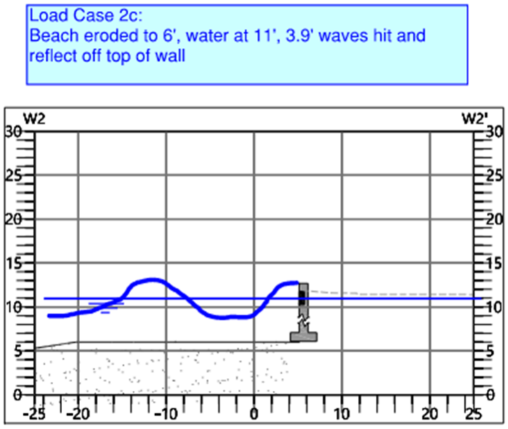
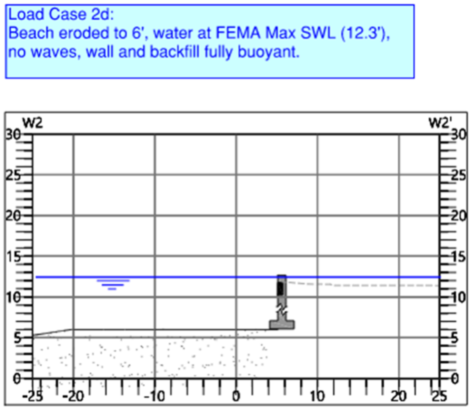

Load Case 2c:
Beach eroded to 6', water at 11', 3.9' waves hit and
reflect off top of wall

Figure 7: Load Case 2c



Load Case 2d:
Beach eroded to 6', water at FEMA Max SWL (12.3'),
no waves, wall and backfill fully buoyant.

Figure 8: Load Case 2d

Based on the results from the load case calculations, the retaining wall has a total base length of 6’, total overall height of 7’, toe length of 2’, heel length of 3’, and thickness of 1’. The rebar is #5 at 12-inch spacing with 3” cover. This size passes all overturning and sliding checks for the analyzed load cases as well as the shear and bending moments regarding the rebar design.

3” diameter weep holes spaced on 12-foot centers located 2 feet above the top of the footing, including filters, have been specified on the drawings. In most design cases where the beach side has full backfill and has not eroded, it is assumed that the groundwater level will generally follow the tides and equalize on both sides. In this case, tide water would flow each direction through the weep holes as the tide rises and falls. The load cases described above account for the buoyant weight of soil and wall concrete in stability calculations. In cases where there is no erosion and the tide does not fully equalize, and is higher on the beach side, the slight unbalanced hydrostatic force is not a concern, because the soil on both sides will ensure stability of the wall.

For the case where the beach has eroded down to the toe of the wall, the weep holes would allow any groundwater on the parking lot side to drain through to the beach side. This is important, because for Load Case 2a described above, the wall is not designed for an unbalanced hydrostatic force, and the weep holes are needed to relieve that force.

It was noted that ponding frequently occurs during rain events on the parking lot surface. The original parking lot design included permeable paving blocks. It was noted in a discussion between Art Anderson, Blue Coast, and Kitsap County Parks that, given the proximity to the beach and shoreline, it would likely be very difficult to perform the maintenance typically required of a permeable pavement system in order to keep it properly draining, and that it is likely that the gaps between pavers and the base layer are likely filled with finer sand and silt particles that have impaired the free draining of the base layers. It was suggested that regrading the parking surface to include a slightly higher slope to the west would help drain surface water building up in the parking lot. Other potential, more intensive solutions, would be to regrade the parking area with thicker base layers, and ensure filter fabric is present.

4 Parking Layout Revision

4.1 Overview

As built drawings for the PNP parking lot were provided along with the WSDOT standard plan for parking spaces which is what we designed to. Kitsap County believes that adding new wheel stops inside the new curb will not change the size of the parking space and should therefore not affect the turnaround space. The final design will need to be approved by the Fire Marshall.

Appendix E
Engineer's Opinion of Construction Cost

Kitsap County - Point No Point County Park Repairs

Engineer's Estimate of Probable Costs (May 2025)[1,2]

Phase 2 - Restoration and Repair (Beach Dune, Plantings, Parking Curb & Revetment)					
Site Preparation					
Mobilization and Demobilization	1	LS	10%	$	65,641
Surveying and Record Drawings	1	LS	$27,000.00	$	27,000
Clearing and Grubbing	1	LS	$7,000.00	$	7,000
Temporary Erosion Control Measures	1	LS	$7,000.00	$	7,000
Subtotal - Site Preparation				**$**	**106,641**
Beach Nourishment, Plantings, Pedestrian Access					
Furnish and Place Beach Nourishment	7,430	TON	$71.48	$	531,086
Salvage and Place Supersack Material	490	CY	$40.00	$	19,600
Furnish and Place Coir Matting	1,160	SY	$9.00	$	10,440
Furnish and Place Beach Gravel (East Beach)	360	TON	$71.48	$	25,732
Salvage Large Wood	1	LS	$20,000.00	$	20,000
Topsoil, Plantings, Compost	1	LS	$90,296.33	$	90,296
Remove and Re-install Dune Fencing	570	LF	$15.00	$	8,550
Remove and Re-install Dune Fencing	200	LF	$22.50	$	4,500
Gravel Trail Crushed Surfacing	83	TON	$63.67	$	5,295
Gravel Trail Limestone Surfacing	42	TON	$98.40	$	4,092
Subtotal - Dune and Foredune Plantings				**$**	**719,591**
Parking Area Repairs and Curb Replacement					
Curb Wall Removal	17	TON	$300.00	$	5,100
Excavate and Sidcast Beach Sand	130	CY	$40.00	$	5,200
Excavation, Haul, and Dispose of Upland Soil	78	TON	$96.90	$	7,559
Excavation, Haul, and Reuse Upland Soil	128	CY	$40.00	$	5,120
Procure and Place Curb Wall Fill (Adjacent to Curb Wall)	58	TON	$98.40	$	5,668
Procure and Place Parking Lot Fill (Adjacent to Wetland)	163	TON	$98.40	$	16,072
Replace Paver Parking Area	2,780	SF	$5.00	$	13,900
Procure and Place Cobble	470	TON	$92.61	$	43,527
Curb Installation	135	LF	$600.00	$	81,000
Subtotal - Revetment Setback and Parking Curb				**$**	**183,145**
Revetment Repair					
Excavate, Haul, and Disposal of Concrete Rubble & Shoreline Debris	12	TON	$149.10	$	1,789
Excavate, Haul, and Disposal of Revetment Setback Soils	614	TON	$96.90	$	59,499
Excavate, Haul, and Disposal of Revetment Setback Armor Rock	167	TON	$96.90	$	16,183
Excavate, Stockpile, and Place of Revetment Setback Armor Rock	351	CY	$80.00	$	28,080
Import and Place Armor Rock	999	TON	$95.31	$	95,212
Import and Place Filter Rock	328	TON	$72.73	$	23,857
Import and Place Chinking Rock	136	TON	$94.93	$	12,910
Subtotal - Revetment Repair				**$**	**237,530**
Subtotal for All Work Elements Phase 2				**$**	**1,246,907**
			Construction Contingency (20%)	$	249,381
			Combined Sales Tax (9.2%)	$	137,659
			Phase 2 - Total Cost[2]	**$**	**1,634,000**

1. All costs are in January 2025 dollars.

2. In providing opinions of probable construction cost, Kitsap County understands that the Consultant has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, expressed or implied, that the bids or the negotiated cost of the work will not vary from the Consultant's opinion of probable construction cost.

Appendix F

Calculation Sheets

Calculation Sheet
Designer: GC Date: 11-30-23
Project: 1103-2301 PNP Flood Protection Final Design
Subject: Armor Rock Sizing

Sheet 1 of 2
Calc #:
Rev #: 0
Checked by:
Checked date:

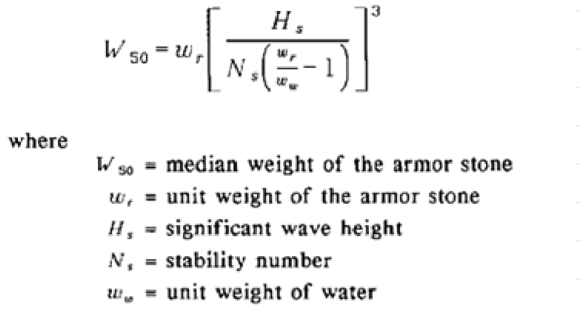
Riprap armor stability formula for irregular wave conditions from USACE ACES software

Reference:

Leenknecht, D.A., Szuwalski, A. and Sherlock, A.R. 1992. "Automated Coastal Engineering System (ACES): Technical Reference," U.S. Army Corps of Engineers, Coastal Engineering Research Center, Waterways Experiment Station, CPD-66, Vicksburg, MS. Volume II.

where:

W_{50} = median weight of armor stone
w_r = unit weight of armor stone
H_s = significant wave height
T_s =significant wave period
N_s = stability number
w_w =unit weight of water
S =damage level
P=permeability coefficient
$cot\theta$ =structure slope
ζ =surf similarity parameter
N= number of wave events



$$W_{50} = w_r \left[\frac{H_s}{N_s \left(\frac{w_r}{w_w} - 1 \right)} \right]^3$$

where

W_{50} = median weight of the armor stone
w_r = unit weight of the armor stone
H_s = significant wave height
N_s = stability number
w_w = unit weight of water

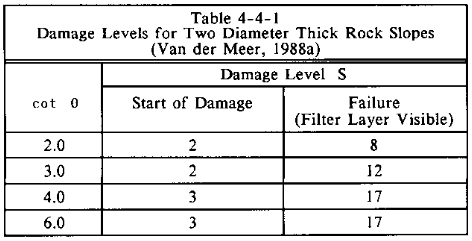


Table 4-4-1
Damage Levels for Two Diameter Thick Rock Slopes
(Van der Meer, 1988a)

cot θ	Damage Level S	
	Start of Damage	Failure (Filter Layer Visible)
2.0	2	8
3.0	2	12
4.0	3	17
6.0	3	17

INPUTS:

$H_s := 5.0\ ft \qquad H_s = 1.52\ m$

$T_s := 4.5 \qquad P := .1 \qquad S := 2 \qquad cot\theta := 2.5$

$w_w := 1024\ \frac{kg}{m^3} \qquad w_w = 63.9\ \frac{lb}{ft^3}$

$w_r := 2643\ \frac{kg}{m^3} \qquad w_r = 165\ \frac{lb}{ft^3}$

$N := 1135$

$g = 9.807\ \frac{m}{s^2}$

$T_z := T_s \cdot \left(\frac{.67}{.80} \right) = 3.769$

$$\zeta := \frac{\left(\frac{1}{cot\theta} \right)}{\left(\frac{2 \cdot \pi \cdot H_s}{g \cdot T_z^{\ 2}} \right)^{0.5}} = 1.526\ \frac{1}{s}$$

$$\zeta := \frac{\zeta}{\text{UnitsOf}(\zeta)} = 1.526$$

CERC stability number

$$N_{szero} := \frac{1.45}{1.27} \cdot (cot\theta)^{\frac{1}{6}} = 1.33$$

Dutch stability number

$$N_{s\_surging} := 1.0 \cdot P^{-0.13} \cdot \left(\frac{S}{\sqrt{N}} \right)^{0.2} \cdot \zeta^P \cdot \left(cot\theta^{0.5} \right) = 1.265$$

$$N_{s\_plunging} := 6.2 \cdot P^{0.18} \cdot \left(\frac{S}{\sqrt{N}} \right)^{0.2} \cdot (\zeta)^{-0.5} = 1.885$$

$$\zeta_{ztp} := \left(6.2 \cdot P^{0.31} \cdot \sqrt{\frac{1}{cot\theta}} \right)^{\left(\frac{1}{P+0.5} \right)} = 2.967$$

if $\zeta_{ztp} > \zeta_s$, use $N_{s\_plunging}$,
otherwise use $N_{s\_surging}$

UPDATE BASED ON LOGIC AT LEFT:

$N_s := 1.885$

Calculation Sheet

Designer: GC Date: 11-30-23

Project: 1103-2301 PNP Flood Protection Final Design

Subject: Armor Rock Sizing

Sheet 2 of 2

Calc #: ________

Rev #: 0

Checked by: ______________

Checked date: _____

OUTPUT (ARMOR LAYER):

$$W_{50} := w_r \cdot \left(\frac{H_s}{N_s \cdot \left(\frac{w_r}{w_w} - 1 \right)} \right)^3 = 353.4\ kg \qquad W_{50} = 779\ lb$$

$$W_{85} := 1.96 \cdot W_{50} = 693\ kg \qquad W_{85} = 1527\ lb$$

$$W_{15} := 0.4 \cdot W_{50} = 141.4\ kg \qquad W_{15} = 312\ lb$$

$$D_{n50} := \left(\frac{W_{50}}{w_r} \right)^{\frac{1}{3}} = 0.511\ m \qquad D_{n50} = 1.68\ ft$$

$$D_{15} := \left(\frac{W_{15}}{w_r} \right)^{\frac{1}{3}} = 0.377\ m \qquad D_{15} = 1.24\ ft$$

$$D_{50} := \frac{D_{n50}}{0.84} = 0.609\ m \qquad D_{50} = 2\ ft$$

square opening sieve size

$$t_{armor} := 2 \cdot \left(\frac{W_{50}}{w_r} \right)^{\frac{1}{3}} = 1.02\ m \qquad t_{armor} = 3.36\ ft$$

OUTPUT (FILTER LAYER):

$$t_{filter} := \frac{t_{armor}}{4} = 0.26\ m \qquad t_{filter} = 0.84\ ft$$

$$D_{85fil} := \frac{D_{15}}{4} = 0.09\ m \qquad D_{85fil} = 0.31\ ft$$

$$D_{50fil} := \frac{D_{85fil}}{e^{(0.01157 \cdot 85 - 0.5785)}} = 0.06\ m \qquad D_{50fil} = 0.21\ ft$$

BLUE COAST
ENGINEERING

Calculation Sheet Sheet
Designer: CH Date: 11/20/2024 Calc #: 1 Rev #:0
Project: 1103-2301 Point no Point Checked by: _ Checked date:
Subject: Wave Runup and Overtopping - Scenario 1

Inputs:

$T_p := 1.6\ s$ $B := 0\ ft = 0\ m$

$H_{m0} := 0.5\ ft = 0.2\ m$ $L_{Berm} := 1\ ft = 0.3\ m$ $h_{prom} := 0\ m$

$slope := 1.75$ $\beta := 0°$, with $0°$ being shore normal.

$swl := 10.1\ ft = 3.1\ m$ $h_{crest} := 13\ ft = 4\ m$

$\gamma_f := .55$ depends on element roughness on slope. Guidance available in section 5 of Eurotop (2016)

Reference:

EurOtop, 2016. Manual on Wave Overtopping of Sea Defences and Related Structures. An Overtopping Manual Largely based on European Research, but for Worldwide Application. Van der Meer, J.W., Allsop, N.W.H., Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P. and Zanuttigh, B., www.overtopping-manual.com.

EurOtop (2016) equation 5.4 and 5.5 for calculating wave runup, R_{u2}, is expressed as:

$$R_{u2} = \sqrt{H_{m0}} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m$$

$$R_{u2max} = 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right)$$

Where:

γ_b: Berm influence factor
γ_f: Roughness influence factor
γ_β: Oblique wave influence factor
ξ_m: Breaker parameter (Iribarren number)

and overtopping, q, is expressed in Eurotop (2016) equations 5.12 and 5.13 as:

$$q = \sqrt{g \cdot {H_{m0}}^3} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot e^{\left(-\left(\frac{2.5 \cdot R_{u2}}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0}}\right)^{1.3}\right)}$$

$$q_{max} = \sqrt{g \cdot {H_{m0}}^3} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)}$$

and is applicable when the foreshore is not too steep, checked by: $\frac{h}{H_{m0\_deep}} > 1$ and is valid when $\xi_m < 5$.

Where:

γ_{prom}: Promenade influence factor

slope: $\cot(\alpha)$

Calculations:

$$R_c := h_{crest} - swl = 0.9\ m$$

$$T_m := \frac{T_p}{1.2} = 1.3\ s$$

$$L_0 := \frac{g \cdot {T_m}^2}{2 \cdot \pi} = 2.8\ m$$

$$\xi_m := \frac{\frac{1}{slope}}{\sqrt{\left(\frac{H_{m0}}{L_0}\right)}} = 2.4$$

$$d_b := h_{crest} - swl = 0.9\ m$$

$$rdb := 0.5 - \left(0.5 \cdot \cos\left(\pi \cdot \frac{d_b}{2 \cdot H_{m0}}\right)\right) = 1$$

$$r_B := \frac{B}{L_{Berm}} = 0$$ For a berm below still water line

$$\gamma_b := 1 - \left(r_B \cdot \left(1 - rdb\right)\right) = 1$$ for $0.6 \le \gamma_b \ge 1.0$

$$\gamma_{fsurging} := \left\| \begin{array}{l} \text{if } 5 \ge \xi_m \ge 1.8 \\ \quad \left\| \gamma_f + \frac{\left(\xi_m - 1.8\right) \cdot \left(1 - \gamma_f\right)}{8.2} \right. \\ \text{if } \xi_m \ge 5.0 \\ \quad \left\| \gamma_f + \frac{\left(\xi_m - 5\right) \cdot \left(1 - \gamma_f\right)}{5} \right. \\ \text{if } 1.799 \ge \xi_m \\ \quad \left\| \gamma_f \right. \end{array} \right. = 0.6$$

Calculation Sheet Sheet
Designer: CH Date: 11/20/2024 Calc #: 1 Rev #:0
Project: 1103-2301 Point no Point Checked by: _ Checked date:
Subject: Wave Runup and Overtopping - Scenario 1

$$\gamma_{prom} := \left\| \begin{array}{l} \text{if } h_{prom} > 0 \\ \quad \left\| 3.06 \cdot e^{\left(\frac{-1.5 \cdot h_{prom}}{H_{m0}}\right)} \right. \\ \text{if } h_{prom} = 0 \\ \quad \left\| 1 \right. \end{array} \right. = 1$$

$\gamma_\beta := 1 - 0.0063 \cdot |\beta| = 1$ For $0.6 \le |\beta| \ge 1.0$, if $|\beta| \ge 80$, use results for $\beta = 80$

$$R_{u2} := H_{m0} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m = 0.4\ m$$

$$R_{u2max} := 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right) = 0.3\ m$$

$$q_{calc} := \sqrt{g \cdot {H_{m0}}^3} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot \gamma_b \cdot e^{\left(-\left(\frac{2.5 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = \left(4 \cdot 10^{-12}\right) \frac{m^2}{s}$$

$$q_{max} := \sqrt{g \cdot {H_{m0}}^3} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = \left(3.7 \cdot 10^{-16}\right) \frac{m^2}{s}$$

$$q := \left\| \begin{array}{l} \text{if } q_{calc} < q_{max} \\ \quad \left\| q_{calc} \right. \\ \text{if } q_{max} < q_{calc} \\ \quad \left\| q_{max} \right. \end{array} \right. = \left(3.7 \cdot 10^{-16}\right) \frac{m^2}{s}$$

$$q_l := q \cdot \frac{1000\ s}{1\ m^2} = 3.7 \cdot 10^{-13}$$

$$q_{cfs} := \frac{q_l \cdot .03531}{3.2808} = 4 \cdot 10^{-15}$$

Calculation Sheet Sheet

Designer: CH Date: 11/20/2024 Calc #: 1 Rev #:0

Project: 1103-2301 Point no Point Checked by: _ Checked date:

Subject: Wave Runup and Overtopping - Scenario 1

Results:

$R_{u2}=0.4\ m$ $R_{u2}=1.2\ ft$

$R_{u2max}=0.3\ m$ $R_{u2max}=1\ ft$

$q_l=4 \cdot 10^{-13}$ liters/s per linear meter $q_{cfs}=4 \cdot 10^{-15}$ ft^3/s per linear foot

Calculation Sheet Sheet

Designer: CH Date: 11/20/2024 Calc #: 1 Rev #:0

Project: 1103-2301 Point no Point Checked by: _ Checked date:

Subject: Wave Runup and Overtopping - Scenario 2

Inputs:

$T_p := 1.6\ s$ $B := 0\ ft = 0\ m$

$H_{m0} := 0.5\ ft = 0.2\ m$ $L_{Berm} := 1\ ft = 0.3\ m$ $h_{prom} := 0\ m$

$slope := 1.75$ $\beta := 0°$, with $0°$ being shore normal.

$swl := 11.6\ ft = 3.5\ m$ $h_{crest} := 13\ ft = 4\ m$

$\gamma_f := .55$ depends on element roughness on slope. Guidance available in section 5 of Eurotop (2016)

Reference:

EurOtop, 2016. Manual on Wave Overtopping of Sea Defences and Related Structures. An Overtopping Manual Largely based on European Research, but for Worldwide Application. Van der Meer, J.W., Allsop, N.W.H., Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P. and Zanuttigh, B., www.overtopping-manual.com.

EurOtop (2016) equation 5.4 and 5.5 for calculating wave runup, R_{u2}, is expressed as:

$$R_{u2} = \sqrt{H_{m0}} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m$$

$$R_{u2max} = 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right)$$

Where:

γ_b: Berm influence factor

γ_f: Roughness influence factor

γ_β: Oblique wave influence factor

ξ_m: Breaker parameter (Iribarren number)

and overtopping, q, is expressed in Eurotop (2016) equations 5.12 and 5.13 as:

$$q = \sqrt{g \cdot H_{m0}^{\ 3}} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot e^{\left(-\left(\frac{2.5 \cdot R_{u2}}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0}}\right)^{1.3}\right)}$$

$$q_{max} = \sqrt{g \cdot H_{m0}^{\ 3}} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)}$$

and is applicable when the foreshore is not too steep, checked by: $\frac{h}{H_{m0\_deep}} > 1$ and is valid when $\xi_m < 5$.

Where:

γ_{prom} : Promenade influence factor

slope: $\cot(\alpha)$

Calculations:

$$R_c := h_{crest} - swl = 0.4\ m$$

$$T_m := \frac{T_p}{1.2} = 1.3\ s$$

$$L_0 := \frac{g \cdot {T_m}^2}{2 \cdot \pi} = 2.8\ m$$

$$\xi_m := \frac{\frac{1}{slope}}{\sqrt{\left(\frac{H_{m0}}{L_0}\right)}} = 2.4$$

$$d_b := h_{crest} - swl = 0.4\ m$$

$$rdb := 0.5 - \left(0.5 \cdot \cos\left(\pi \cdot \frac{d_b}{2 \cdot H_{m0}}\right)\right) = 0.7$$

$$r_B := \frac{B}{L_{Berm}} = 0$$ For a berm below still water line

$$\gamma_b := 1 - \left(r_B \cdot (1 - rdb)\right) = 1$$ for $0.6 \le \gamma_b \ge 1.0$

$$\gamma_{fsurging} := \begin{array}{l} \text{if } 5 \ge \xi_m \ge 1.8 \\ \quad \gamma_f + \frac{(\xi_m - 1.8) \cdot (1 - \gamma_f)}{8.2} \\ \text{if } \xi_m \ge 5.0 \\ \quad \gamma_f + \frac{(\xi_m - 5) \cdot (1 - \gamma_f)}{5} \\ \text{if } 1.799 \ge \xi_m \\ \quad \gamma_f \end{array} = 0.6$$

$$\gamma_{prom} := \left\| \begin{array}{l} \text{if } h_{prom} > 0 \\ \quad \left\| 3.06 \cdot e^{\left(\frac{-1.5 \cdot h_{prom}}{H_{m0}}\right)} \right. \\ \text{if } h_{prom} = 0 \\ \quad \left\| 1 \right. \end{array} \right. = 1$$

$\gamma_{\beta} := 1 - 0.0063 \cdot |\beta| = 1$ For $0.6 \le |\beta| \ge 1.0$, if $|\beta| \ge 80$, use results for $\beta = 80$

$$R_{u2} := H_{m0} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m = 0.4\ m$$

$$R_{u2max} := 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right) = 0.3\ m$$

$$q_{calc} := \sqrt{g \cdot {H_{m0}}^3} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot \gamma_b \cdot e^{\left(-\left(\frac{2.5 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = \left(3 \cdot 10^{-6}\right) \frac{m^2}{s}$$

$$q_{max} := \sqrt{g \cdot {H_{m0}}^3} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = \left(9.2 \cdot 10^{-8}\right) \frac{m^2}{s}$$

$$q := \left\| \begin{array}{l} \text{if } q_{calc} < q_{max} \\ \quad \left\| q_{calc} \right. \\ \text{if } q_{max} < q_{calc} \\ \quad \left\| q_{max} \right. \end{array} \right. = \left(9.2 \cdot 10^{-8}\right) \frac{m^2}{s}$$

$$q_l := q \cdot \frac{1000\ s}{1\ m^2} = 9.2 \cdot 10^{-5}$$

$$q_{cfs} := \frac{q_l \cdot .03531}{3.2808} = 9.9 \cdot 10^{-7}$$

Results:

$R_{u2}=0.4\ m$ $R_{u2}=1.2\ ft$

$R_{u2max}=0.3\ m$ $R_{u2max}=1\ ft$

$q_l=9 \cdot 10^{-5}$ liters/s per linear meter $q_{cfs}=10 \cdot 10^{-7}$ ft^3/s per linear foot

Calculation Sheet Sheet

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Subject: Wave Runup and Overtopping - Scenario 3

Inputs:

$T_p := 4.3\ s$ $B := 0\ ft = 0\ m$

$H_{m0} := 4.5\ ft = 1.4\ m$ $L_{Berm} := 1\ ft = 0.3\ m$ $h_{prom} := 0\ m$

$slope := 1.75$ $\beta := 0°$, with $0°$ being shore normal.

$swl := 10.1\ ft = 3.1\ m$ $h_{crest} := 13\ ft = 4\ m$

$\gamma_f := .55$ depends on element roughness on slope. Guidance available in section 5 of Eurotop (2016)

Reference:

EurOtop, 2016. Manual on Wave Overtopping of Sea Defences and Related Structures. An Overtopping Manual Largely based on European Research, but for Worldwide Application. Van der Meer, J.W., Allsop, N.W.H., Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P. and Zanuttigh, B., www.overtopping-manual.com.

EurOtop (2016) equation 5.4 and 5.5 for calculating wave runup, R_{u2}, is expressed as:

$$R_{u2} = \sqrt{H_{m0}} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m$$

$$R_{u2max} = 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right)$$

Where:

γ_b: Berm influence factor

γ_f: Roughness influence factor

γ_β: Oblique wave influence factor

ξ_m: Breaker parameter (Iribarren number)

and overtopping, q, is expressed in Eurotop (2016) equations 5.12 and 5.13 as:

$$q = \sqrt{g \cdot {H_{m0}}^3} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot e^{\left(-\left(\frac{2.5 \cdot R_{u2}}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0}}\right)^{1.3}\right)}$$

$$q_{max} = \sqrt{g \cdot {H_{m0}}^3} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)}$$

and is applicable when the foreshore is not too steep, checked by: $\frac{h}{H_{m0\_deep}} > 1$ and is valid when $\xi_m < 5$.

Where:

γ_{prom} : Promenade influence factor

slope: $\cot(\alpha)$

Calculations:

$$R_c := h_{crest} - swl = 0.9\ m$$

$$T_m := \frac{T_p}{1.2} = 3.6\ s$$

$$L_0 := \frac{g \cdot {T_m}^2}{2 \cdot \pi} = 20\ m$$

$$\xi_m := \frac{\frac{1}{slope}}{\sqrt{\left(\frac{H_{m0}}{L_0}\right)}} = 2.2$$

$$d_b := h_{crest} - swl = 0.9\ m$$

$$rdb := 0.5 - \left(0.5 \cdot \cos\left(\pi \cdot \frac{d_b}{2 \cdot H_{m0}}\right)\right) = 0.2$$

$$r_B := \frac{B}{L_{Berm}} = 0$$ For a berm below still water line

$$\gamma_b := 1 - \left(r_B \cdot (1 - rdb)\right) = 1$$ for $0.6 \le \gamma_b \ge 1.0$

$$\gamma_{fsurging} := \left\| \begin{array}{l} \text{if } 5 \ge \xi_m \ge 1.8 \\ \quad \left\| \gamma_f + \frac{(\xi_m - 1.8) \cdot (1 - \gamma_f)}{8.2} \right. \\ \text{if } \xi_m \ge 5.0 \\ \quad \left\| \gamma_f + \frac{(\xi_m - 5) \cdot (1 - \gamma_f)}{5} \right. \\ \text{if } 1.799 \ge \xi_m \\ \quad \left\| \gamma_f \right. \end{array} \right. = 0.6$$

$$\gamma_{prom} := \left\| \begin{array}{l} \text{if } h_{prom} > 0 \\ \quad \left\| 3.06 \cdot e^{\left(\frac{-1.5 \cdot h_{prom}}{H_{m0}}\right)} \right. \\ \text{if } h_{prom} = 0 \\ \quad \left\| 1 \right. \end{array} \right. = 1$$

$\gamma_\beta := 1 - 0.0063 \cdot |\beta| = 1$ For $0.6 \le |\beta| \ge 1.0$, if $|\beta| \ge 80$, use results for $\beta = 80$

$$R_{u2} := H_{m0} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m = 2.9 \ m$$

$$R_{u2max} := 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right) = 2.5 \ m$$

$$q_{calc} := \sqrt{g \cdot H_{m0}^{\ 3}} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot \gamma_b \cdot e^{\left(-\left(\frac{2.5 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = \left(8.7 \cdot 10^{-2}\right) \frac{m^2}{s}$$

$$q_{max} := \sqrt{g \cdot H_{m0}^{\ 3}} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = \left(8.5 \cdot 10^{-2}\right) \frac{m^2}{s}$$

$$q := \left\| \begin{array}{l} \text{if } q_{calc} < q_{max} \\ \quad \left\| q_{calc} \right. \\ \text{if } q_{max} < q_{calc} \\ \quad \left\| q_{max} \right. \end{array} \right. = \left(8.5 \cdot 10^{-2}\right) \frac{m^2}{s}$$

$$q_l := q \cdot \frac{1000 \ s}{1 \ m^2} = 84.8$$

$$q_{cfs} := \frac{q_l \cdot .03531}{3.2808} = 0.9$$

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Results:

$R_{u2}=2.9\ m$		$R_{u2}=9.5\ ft$	
$R_{u2max}=2.5\ m$		$R_{u2max}=8.2\ ft$	
$q_l=85$	liters/s per linear meter	$q_{cfs}=9\cdot10^{-1}$	ft^3/s per linear foot

Calculation Sheet Sheet

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Subject: Wave Runup and Overtopping - Scenario 4

Inputs:

$T_p := 4.3\ s$ $B := 0\ ft = 0\ m$

$H_{m0} := 4.5\ ft = 1.4\ m$ $L_{Berm} := 1\ ft = 0.3\ m$ $h_{prom} := 0\ m$

$slope := 1.75$ $\beta := 0°$, with 0° being shore normal.

$swl := 11.6\ ft = 3.5\ m$ $h_{crest} := 13\ ft = 4\ m$

$\gamma_f := .55$ depends on element roughness on slope. Guidance available in section 5 of Eurotop (2016)

Reference:

EurOtop, 2016. Manual on Wave Overtopping of Sea Defences and Related Structures. An Overtopping Manual Largely based on European Research, but for Worldwide Application. Van der Meer, J.W., Allsop, N.W.H., Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P. and Zanuttigh, B., www.overtopping-manual.com.

EurOtop (2016) equation 5.4 and 5.5 for calculating wave runup, R_{u2}, is expressed as:

$$R_{u2} = \sqrt{H_{m0}} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m$$

$$R_{u2max} = 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_\beta \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right)$$

Where:

γ_b: Berm influence factor

γ_f: Roughness influence factor

γ_β: Oblique wave influence factor

ξ_m: Breaker parameter (Iribarren number)

and overtopping, q, is expressed in Eurotop (2016) equations 5.12 and 5.13 as:

$$q = \sqrt{g \cdot {H_{m0}}^3} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot e^{\left(-\left(\frac{2.5 \cdot R_{u2}}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \xi_m \cdot H_{m0}}\right)^{1.3}\right)}$$

$$q_{max} = \sqrt{g \cdot {H_{m0}}^3} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)}$$

and is applicable when the foreshore is not too steep, checked by: $\frac{h}{H_{m0\_deep}} > 1$ and is valid when $\xi_m < 5$.

Where:

γ_{prom} : Promenade influence factor
slope: $\cot(\alpha)$

Calculations:

$$R_c := h_{crest} - swl = 0.4\ m$$

$$T_m := \frac{T_p}{1.2} = 3.6\ s$$

$$L_0 := \frac{g \cdot {T_m}^2}{2 \cdot \pi} = 20\ m$$

$$\xi_m := \frac{\frac{1}{slope}}{\sqrt{\left(\frac{H_{m0}}{L_0}\right)}} = 2.2$$

$$d_b := h_{crest} - swl = 0.4\ m$$

$$rdb := 0.5 - \left(0.5 \cdot \cos\left(\pi \cdot \frac{d_b}{2 \cdot H_{m0}}\right)\right) = 5.9 \cdot 10^{-2}$$

$$r_B := \frac{B}{L_{Berm}} = 0$$ For a berm below still water line

$$\gamma_b := 1 - \left(r_B \cdot \left(1 - rdb\right)\right) = 1$$ for $0.6 \le \gamma_b \ge 1.0$

$$\gamma_{fsurging} := \begin{Vmatrix} \text{if } 5 \ge \xi_m \ge 1.8 \\ \quad \left\Vert \gamma_f + \frac{\left(\xi_m - 1.8\right) \cdot \left(1 - \gamma_f\right)}{8.2} \right. \\ \text{if } \xi_m \ge 5.0 \\ \quad \left\Vert \gamma_f + \frac{\left(\xi_m - 5\right) \cdot \left(1 - \gamma_f\right)}{5} \right. \\ \text{if } 1.799 \ge \xi_m \\ \quad \left\Vert \gamma_f \right. \end{Vmatrix} = 0.6$$

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$$\gamma_{prom} := \left\| \begin{array}{l} \text{if } h_{prom} > 0 \\ \quad \left\| 3.06 \cdot e^{\left(\frac{-1.5 \cdot h_{prom}}{H_{m0}}\right)} \right. \\ \text{if } h_{prom} = 0 \\ \quad \left\| 1 \right. \end{array} \right. = 1$$

$\gamma_{\beta} := 1 - 0.0063 \cdot |\beta| = 1$ For $0.6 \leq |\beta| \geq 1.0$, if $|\beta| \geq 80$, use results for $\beta = 80$

$$R_{u2} := H_{m0} \cdot 1.75 \cdot \gamma_b \cdot \gamma_f \cdot \gamma_{\beta} \cdot \xi_m = 2.9\ m$$

$$R_{u2max} := 1.07 \cdot H_{m0} \cdot \gamma_{fsurging} \cdot \gamma_{\beta} \cdot \left(4 - \frac{1.5}{\sqrt{\gamma_b \cdot \xi_m}}\right) = 2.5\ m$$

$$q_{calc} := \sqrt{g \cdot H_{m0}^{\ 3}} \cdot \frac{.026}{\sqrt{\frac{1}{slope}}} \cdot \xi_m \cdot \gamma_b \cdot e^{\left(-\left(\frac{2.5 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_{\beta} \cdot \xi_m \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = 0.2\ \frac{m^2}{s}$$

$$q_{max} := \sqrt{g \cdot H_{m0}^{\ 3}} \cdot .1035 \cdot e^{\left(-\left(\frac{1.35 \cdot R_c}{\gamma_b \cdot \gamma_f \cdot \gamma_{\beta} \cdot H_{m0} \cdot \gamma_{prom}}\right)^{1.3}\right)} = 0.3\ \frac{m^2}{s}$$

$$q := \left\| \begin{array}{l} \text{if } q_{calc} < q_{max} \\ \quad \left\| q_{calc} \right. \\ \text{if } q_{max} < q_{calc} \\ \quad \left\| q_{max} \right. \end{array} \right. = 0.2\ \frac{m^2}{s}$$

$$q_l := q \cdot \frac{1000\ s}{1\ m^2} = 214.1$$

$$q_{cfs} := \frac{q_l \cdot .03531}{3.2808} = 2.3$$

Results:

$R_{u2} = 2.9\ m$ $R_{u2} = 9.5\ ft$

$R_{u2max} = 2.5\ m$ $R_{u2max} = 8.2\ ft$

$q_l = 214$ liters/s per linear meter $q_{cfs} = 2$ ft^3/s per linear foot