Snyder Cove Point Bulkhead Removal

Feasibility Study Report

Prepared for
South Puget Sound Salmon Enhancement Group

Prepared by
Blue Coast Engineering LLC

November 2021

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APPENDICES

1 Introduction

At the request of the South Puget Sound Salmon Enhancement Group (SPSSEG), Blue Coast Engineering LLC (Blue Coast) has completed a feasibility study and alternatives analysis for bulkhead removal and shoreline restoration at Snyder Cove Point. The project site is located on property owned by The Evergreen State College (TESC) in Olympia, WA. The site consists of an approximate 220-foot-long concrete bulkhead wall around Snyder Cove Point which terminates to the east and west at concrete staircases that provide beach access to the stie. The goals and objectives of the project include:

- Remove shoreline armor to restore coastal process including bank sediment erosion and sediment deposition
- Retain native shoreline and nearshore vegetation and provide additional vegetation to provide slope stability and shade to the upper beach
- Retain or construct low impact sustainable beach access from the upland
- Retain existing parking areas and house structure upland of the project shoreline
- Minimize impacts to adjacent properties
- Identify potential monitoring and/or research opportunities associated with the restoration effort for TESC students and faculty

This report summarizes the site characterization (physical and biological evaluation), development of conceptual restoration alternatives, alternatives evaluation and summary of preferred conceptual alternative for the project site. This report also provides a list of potential monitoring and research activities that could be completed by TESC students and faculty associated with the proposed restoration project.

2 Site Characterization

Blue Coast compiled and reviewed existing site data and conducted a site reconnaissance on August 10, 2021, to identify relevant physical, geological, and biological processes at the site. Existing site data reviewed as part of this work included the following:

1. Existing topographic and bathymetric information
2. Property boundaries (parcel information only)
3. Tidal datums, extreme water levels, and long-term wind data
4. Locations of existing shoreline structures, utilities, and other upland structures adjacent to the shoreline
5. Documented geologic hazards, including steep and unstable slopes, and geologic information.
6. Littoral drift direction and shoreline type mapping
7. Existing sensitive biological and ecological habitats, and shoreline and nearshore vegetation.
8. Previous studies and design reports for the project site and vicinity

Site photographs which show the condition of the project site at the time of the site visit are provided in Appendix A. In addition to the site photos, targeted topographic information was collected to inform the feasibility study.

All this information was used to characterize coastal processes at the site and identify constraints for the proposed restoration project, as described in the following subsections.

2.1 Site Description

The project site is located along the northern shoreline at TESC and spans two parcels (#12806410000). The limits of work for the restoration project include approximately 0.75-acres of upland area and 500 linear feet of shoreline (220) feet of which are armored) along Eld Inlet and Snyder Cove. The project shoreline extends from the lower parking area to the west around the point and to the eastern staircase (Figure 1).

The site is used primarily for recreation and public access to the beach for TESC students, staff, and faculty. Beach access is provided at three locations within the project area: a ramp from the lower parking area and an eastern and western staircase down to the beach from the upper parking lot. The site is armored with a concrete bulkhead wall that spans the shoreline between the two access staircases. The crest of the wall is approximately 18 to 18.5 feet NAVD88 and is currently about 3 to 5 feet in height above the adjacent beach. The elevation of the beach at the toe of the concrete bulkhead varies but is generally between 12 and 14 feet NAVD88. The wall appears to be in good condition with no visible damage or areas of spalling. The exact year that the bulkhead was constructed is unknown but was likely constructed in 1990 or 1991 (CGS, 2009). An older rubble mound bulkhead was constructed in the 1980's to protect a large conifer tree on the western end of the point. It is likely that this older bulkhead is still located behind the existing concrete bulkhead (CGS, 2009). The eastern staircase does not appear to be connected to the bulkhead and is in good condition. The western staircase is in poor condition and is connected structurally to the concrete bulkhead.

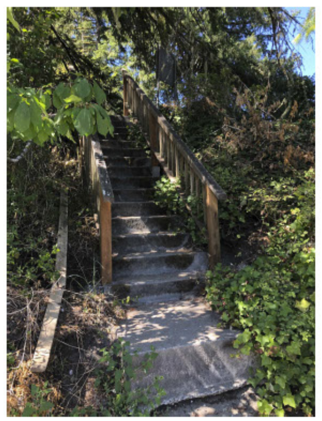
The upland area includes a grass lawn, lower parking area (2 to 3 stalls), upper parking lot (4 to 5 stalls) and an asphalt path from the parking lot to the eastern staircase along the eastern edge of the lawn. The western staircase is accessible from the parking lot via a gravel path. A house is located just south of the upper parking lot. The upland area slopes down gradually from the parking lot to the north and then slopes down steeply at the concrete bulkhead to the east, north and west, with an average topographic relief from the top of the slope to the toe of the bulkhead of about 15 to 20 feet. The slope above the concrete bulkhead is vegetated by a buffer of second growth forest with a mix of native trees and shrubs, there is also a significant amount of English ivy. Beyond the vegetated buffer the upland is paved or grass. A large Douglas fir tree is located just up slope from the concrete bulkhead at the north-west corner of the site.

The site is bounded to the east by Snyder Creek, a small creek that drains approximately 0.25 square miles of upland area (Fisheries Consultants, Inc, 2007). During the site visit, visual signs of bank erosion along the eastern bank of the creek on private property were observed where the creek alignment turns to the north downstream of the new bridge at Sunset Beach Drive NW. The creek channel runs northward (downstream of the bridge) adjacent to the private properties east of the site. The creek alignment is constrained to the west by a concrete pad that is located along the western bank of the creek on the project site (TESC property).

The mouth of the creek, eastern bank of the creek, and adjacent shorelines to the east are all privately owned. Privately owned bulkheads have been constructed along the eastern bank of Snyder Creek and a privately owned boat dock is located at the mouth of Snyder Creek.

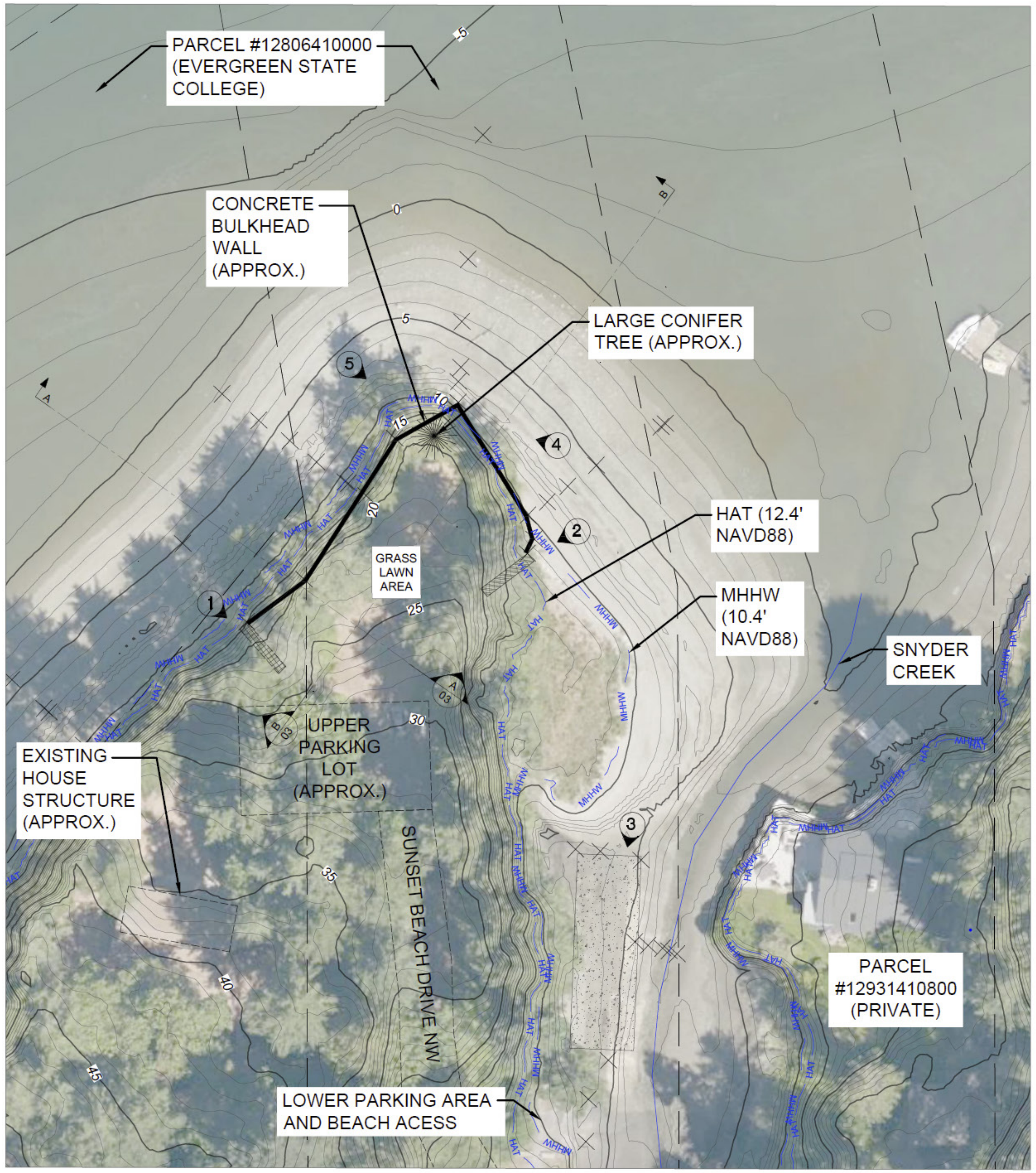
BLUE COAST ENGINEERING

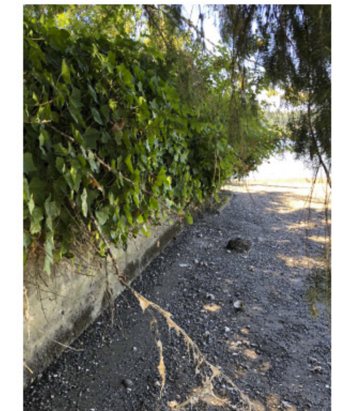
1 WEST BEACH ACCESS STAIRCASE



2 EAST BEACH ACCESS STAIRCASE

3 CONCRETE PAD





4 CONCRETE BULKHEAD WALL

5 LARGE CONIFER TREE

LEGEND

— 10.0 —	ELEVATION CONTOURS (1 FT) - SEE NOTES
HAT	HIGHEST ASTRONOMICAL TIDE (HAT) +12.4 FT NAVD88
MHHW	MEAN HIGHER HIGH WATER (MHHW) +10.4 FT NAVD88
	EXISTING CONCRETE BULKHEAD WALL (SEE NOTE 5)
	PARCEL BOUNDARY
	LARGE CONIFER TREE
	SECTION LOCATION
	CONCRETE PAD (SEE NOTE 5)
	GPS SURVEY POINT (SEE NOTE 5)
	WEST BEACH ACCESS STAIRCASE
	EAST BEACH ACCESS STAIRCASE

0 50 100 Feet

N

SURVEY NOTES:
1. PARCEL BOUNDARIES FROM THURSTON COUNTY GIS DEPARTMENT, DATED MAY 6, 2020. PROPERTY LINE SURVEY WILL BE REQUIRED PRIOR TO CONSTRUCTION TO PRECISELY LOCATE BOUNDARIES
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH, NAD83, U.S. SURVEY FEET
3. VERTICAL DATUM: NAVD88, FEET
4. CONTOURS SHOWN ARE FROM USGS COASTAL NATIONAL ELEVATION DATABASE (CoNED) WHICH INCLUDES LIDAR AND BATHYMETRY DATA.
5. SURVEY POINTS COLLECTED BY BLUE COAST ENGINEERING ON AUGUST 10, 2021.
6. EXISTING ACCESS ROAD, PARKING AREA, AND CONIFER TREE OF CONCERN ARE SHOWN WITH APPROXIMATE SIZE AND LOCATION FOR SCHEMATIC REPRESENTATION PURPOSES ONLY.

Figure 1: Project Site Map

2.2 Coastal Processes

The following sections describe the coastal processes (water levels, hydrology, wind and wind-waves, geomorphology, and geology) at the site. The information is derived from review of available site data, previous site studies, desktop analysis and information gained during the project site visit (August 10, 2021).

2.2.1 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 Snyder Cove.

Tidal datum elevations are not available from the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) near to the project site. Therefore, tidal datums relative to MLLW and North American Vertical Datum of 1988 (NAVD88) were developed using NOAA's Vdatum tool (https://vdatum.noaa.gov/welcome.html). An estimate of highest astronomical tide (HAT) was taken from tidal predictions that are available near the site; on the western side of Eld Inlet) at NOAA Station #TWC115 at Rocky Point. Tidal information is summarized in Table 1.

Mean higher high water (MHHW) is elevation 10.2 feet NAVD88 and highest astronomical tide is 13.0 feet NAVD88 at the site. These water levels do not include additional local increase in water level during storm events due to storm surge or wave run-up. The elevation at the crest of the r bulkhead is around 18 to 18.5 feet NAVD88 and the elevation at the toe of the bulkhead varies between approximately 12 and 14 feet NAVD88. Therefore, MHHW levels do not reach the toe of the bulkhead, but higher tides (i.e., HAT also known as king tides) will reach the toe of the bulkhead several times per year. During storm events, the combination of storm surge and wave run-up can increase water levels several feet. Therefore, during storm events water levels will reach the toe of the bulkhead and run up the face of the bulkhead when storm events occur during king tides.

FEMA 100-year flood elevation for the site, which includes wave run-up, is 19 feet NAVD88 (FEMA Map #52067C0153F). The FEMA 100-year still-water flood elevation (not including wave run-up) for the site is 13.4 feet NAVD88 (FEMA, 2020). Based on this information, it is possible for the existing concrete bulkhead to be overtopped but only during the 100-year storm event that occurs during or close to highest astronomical tide.

Table 1: Tidal Datums in Feet at Snyder Cove (From VDatum[1])

DATUM	Elevation (NAVD88)	Elevation (MLLW)
HAT[2]	13.0	16.9
MHHW	10.2	14.1
MHW	9.2	13.1
MSL	4.3	8.2
NAVD88	0.0	3.9
MLW	-1.0	2.9
MLLW	-3.9	0.0

Notes:

1. VDatum: https://vdatum.noaa.gov/welcome.html
2. HAT (Highest Astronomical Tide) based on review of king tide elevations predicted at NOAA TWC 1115 Rocky Point, Eld Inlet

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 (RCP 4.5) and high (RCP 8.5) greenhouse gas scenarios and local estimates of vertical land motion. The estimate for SLR used for long-term shoreline planning at the site were selected as the 50% exceedance, RCP 8.5 (high greenhouse scenario) values. These predictions at Snyder Cove are summarized in Table 2 for years 2050, 2070, and 2100 and range from 0.8 to 2.2 feet. These estimates should be considered for long-term shoreline use planning at the site.

Table 2: Static Water Levels (feet, NAVD88) based on Median SLR Values for Snyder Cove[1]

DATUM	2050 (+0.8 ft)	2070 (+1.3 ft)	2100 (+2.2 ft)
HAT[2]	13.8	14.3	15.2
MHHW	11.0	11.5	12.4
MSL	5.1	5.6	6.5

Notes:
1. Miller et al. (2018)

2.2.2 Wind and Wind-Waves

Wind-waves are a controlling factor for sediment transport and beach morphology on Puget Sound beaches. Wind-waves are formed in response to the force of the wind acting over the water surface. The height and period of wind-generated waves depends on wind duration (i.e., length of the windstorm), fetch (i.e., distance over which wind is interacting with water surface) and water depth. Generally, the longer the windstorm lasts and the larger the fetch distance, the larger the height and longer the period of the wave generated.

The site at Snyder Cove is exposed to fetch distances along Eld Inlet from the southwest, north and northeast between approximately 250° to 40° (Figure 2). The longest fetches are 2.2 and 2.6 miles, from the southwest and northeast, respectively. Waves in Puget Sound are usually fetch-limited, meaning even during the strongest windstorms the wave heights are limited in growth by the fetch distance. Wave parameters can also be limited by the water depth in shallow water, such as in the nearshore area along the entrance to Snyder Cove. The shallow areas within Snyder Cove refract (bend) waves such that arriving waves are primarily perpendicular to the shoreline and lose some energy prior to reaching the shoreline.

Wind data from three wind stations were evaluated for this study, Joint Base Lewis-McChord Station (JBLM), Olympia Airport Station (OAS) and Shelton Sanderson Airport station (SSA). Olympia Airport station wind data were selected due to the continuity of the time series, closeness to the project site and overall data quality.

The characterization of the wave climate was performed using hourly wind records from the selected station (OAS), located 9 miles to the southeast. A wind rose for the station record from 1970 to 2021 (Figure 3) shows the bimodal wind distribution (two dominant directions; southwesterly and northeasterly) which aligns primarily with the local topography. The most frequently occurring and strongest winds are from the south and southwest (170° to 250°) consistent with the broader regional wind patterns in western Washington. The prevailing wind direction in western Washington 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.

An extreme value analysis of the wind record was completed following the methods of Goda (1988) to identify peak wind events and fit them to a Weibull extreme value probability distribution for the southwesterly, northerly, and northeasterly fetch directions at the site (Table 3). A wind-wave hindcast following the United States Army Corps of Engineers (USACE) methodology (Leenknecht et al. 1992) was completed to estimate wind-wave parameters at the site for each direction of wind exposure at 30° increments (Table 4).

Storm waves at the site up to the 100-year storm event range from about 1.5 to 2.0 feet in height. The largest waves are from the north and south-west. These storm wave conditions are relatively small compared to other areas within the South with greater exposure to long fetch distances. Waves in these locations can be 2 to 3 times higher than those predicted for the project site. Based on this comparison, the Snyder Cove shoreline is generally a low wave-energy environment.

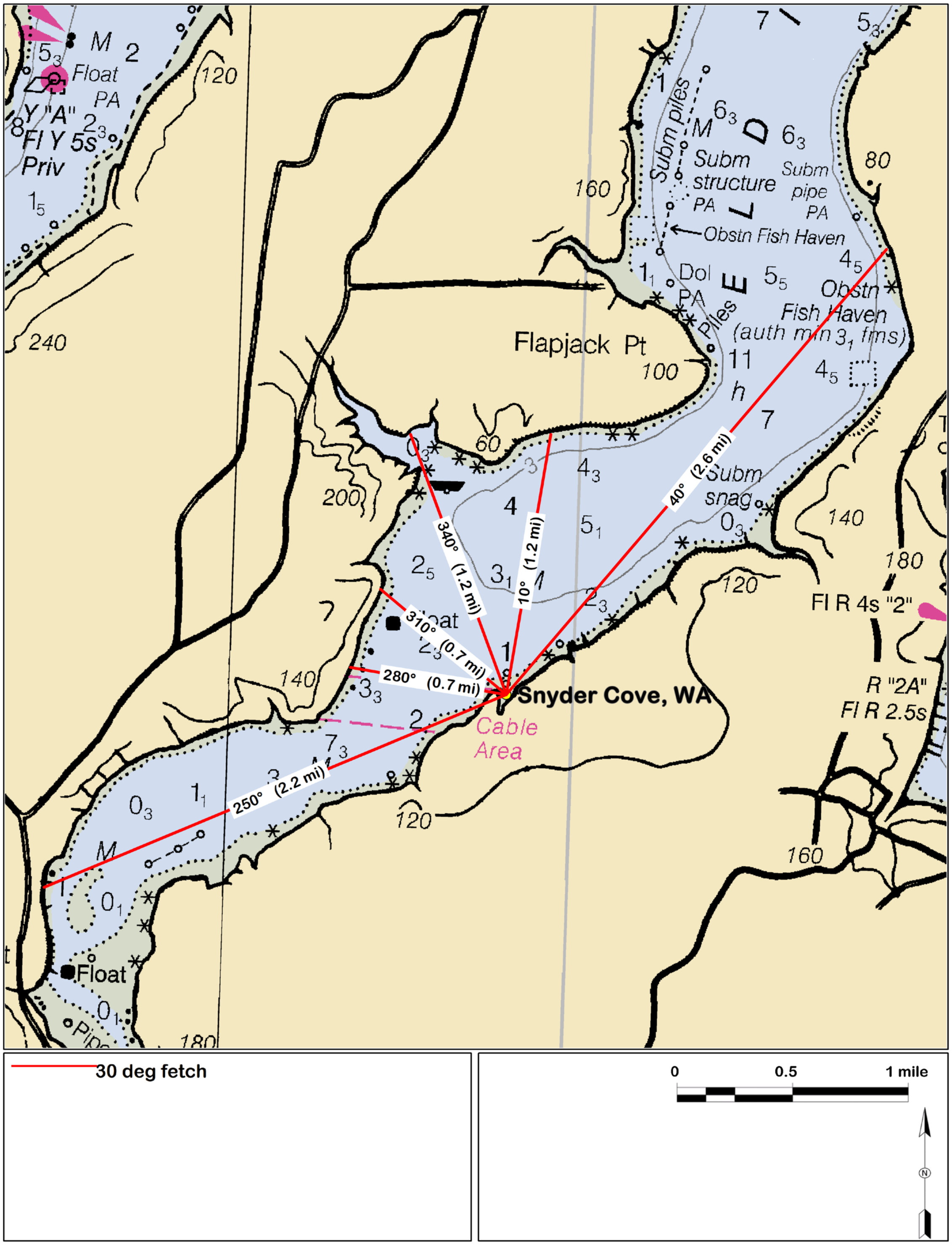


Figure 2: Schematic of Fetch Distances and Directions at Snyder Cove

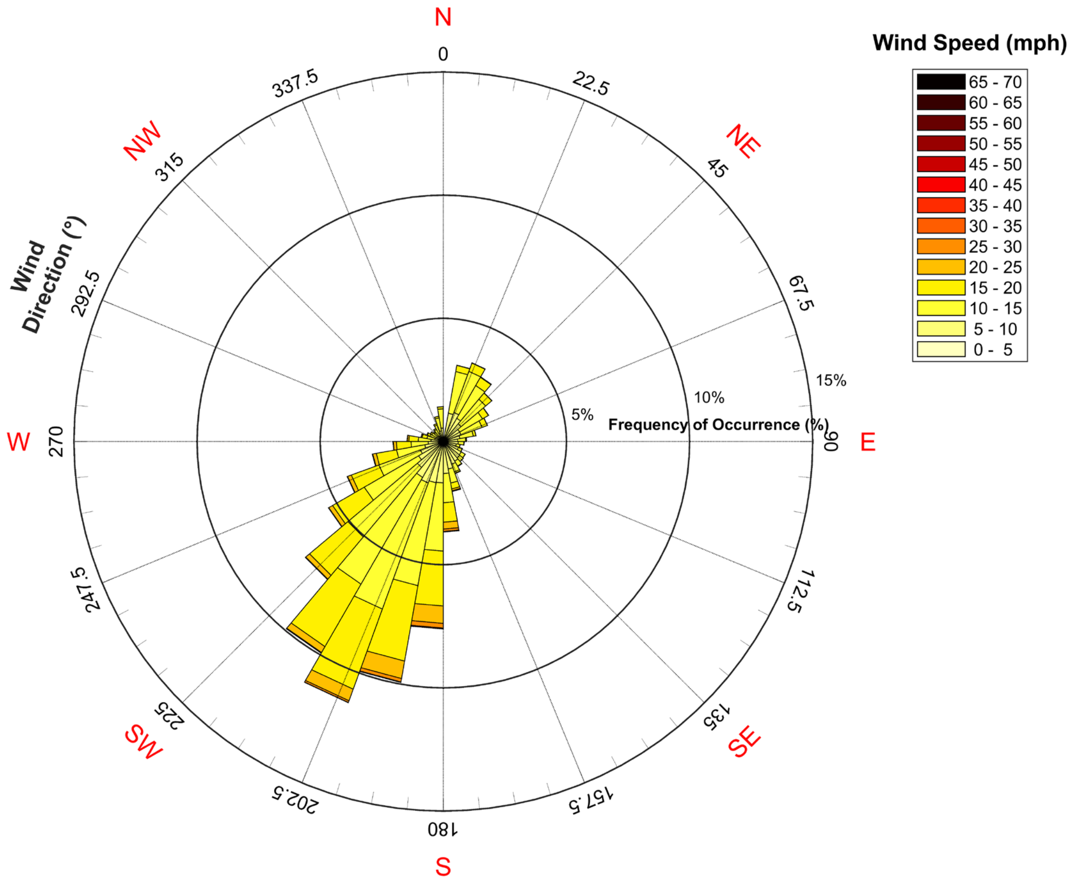


Figure 3. Wind rose for the hourly wind record at the Olympia Airport station from 1970 to 2021.

Table 3: Extremal wind speeds at Olympia Airport used in wind-wave analysis

Return Period (years)	250° Fetch Length 2.2 miles	280° Fetch Length 0.7 miles	310° Fetch Length 0.7 miles	340° Fetch Length 1.2 miles	10° Fetch Length 1.2 miles	40° Fetch Length 2.6 miles
	Wspd (mph)	Wspd (mph)	Wspd (mph)	Wspd (mph)	Wspd (mph)	Wspd (mph)
1	17.1	17.2	9.6	9.9	12.8	14.6
2	20.7	19.3	13.3	12.3	15.0	16.4
5	23.3	22.3	16.4	13.8	19.0	18.8
10	24.9	24.6	18.3	14.7	22.6	20.6
25	26.8	27.7	20.5	15.7	28.0	22.9
50	28.1	30.0	22.0	16.4	32.3	24.7
100	29.3	32.4	23.5	17.0	36.9	26.5

Table 4: Wind-wave hindcast estimate for Snyder Cove for the shoreline exposed wind directions.

Return Period (years)	250°		280°		310°		340°		10°		40°	
	Hs (ft)	Tp (s)	Hs (ft)	Tp (s)	Hs (ft)	Tp (s)	Hs (ft)	Tp (s)	Hs (ft)	Tp (s)	Hs (ft)	Tp (s)
1	0.8	1.9	0.5	1.3	0.2	1.0	0.3	1.3	0.4	1.4	0.7	1.9
10	1.4	2.3	0.8	1.6	0.5	1.4	0.5	1.5	0.9	1.8	1.2	2.2
25	1.5	2.4	0.9	1.6	0.6	1.4	0.6	1.5	1.2	2.0	1.3	2.3
50	1.6	2.4	1.0	1.7	0.7	1.5	0.6	1.6	1.4	2.1	1.5	2.4
100	1.7	2.5	1.1	1.8	0.7	1.5	0.6	1.6	1.7	2.2	1.6	2.5

2.2.3 Hydrology (Snyder Creek)

Snyder Creek (creek) is a small tidally influenced creek that borders the project site to the east. The creek has a drainage basin of approximately 0.25 miles and the watershed is largely intact and is protected within TESC property. Fish use of Snyder Creek is known to include coastal cutthroat trout, sculpin, and brook lamprey (Fisheries Consultants, Inc, 2007). In 2011, Wild Fish Conservancy and South Puget Sound Salmon Enhancement Group completed a culvert replacement project at Sunset Beach Drive to provide fish passage to the upper creek. The project replaced an existing 36" culvert pipe with a 14-foot free span bridge. Hydrology for the creek is provided in the design report for the culvert replacement project (Fisheries Consultants, Inc., 2007) is summarized below:

- Low Fish Passage Flow (60-day low flow conditions) – 1 cubic foot per second (cfs)
- High Fish Passage Flow (Monthly 10% exceedance flow) – 10 cfs
- 100-year Flow – 50 cfs

The alignment of Snyder Creek adjacent to the project site (see Figure 1) is influenced by high flow events in the creek and transport of sediment due to littoral drift to the east along the project shoreline into the creek channel. The creek channel at the mouth is characterized by a slight meander within the limited creek delta. The creek channel alignment at the creek mouth did not significantly change following replacement of the 36" culvert with a 14' bridge at the Sunset Beach Drive NW crossing in 2011. Figure 4 shows the channel alignment in 2006 (prior to culvert replacement) and Figure 5 shows the channel alignment in 2013 (following culvert replacement). Both images show that the creek meanders 3 to 4 times within the Delta before discharging to Puget Sound.

The number and size of creek meanders and the location of the creek channel itself is constrained by a concrete pad that armors much of the western bank of the creek (which is on the project site) and a large bulkhead on a private property along the eastern bank of the creek that protrudes out into the creek delta (see Figures 4 and 5). Removal of the concrete pad as part of the armor removal project would widen the creek delta and allow for additional natural creek processes to be restored at the mouth. In addition, as sediment moves around the point and towards the creek delta following bulkhead removal, removal of the concrete pad will provide additional area for the creek to adjust.

Figure 4: Snyder Creek Channel Alignment at Mouth, 2006 (WA Dept. of Ecology, 2021)

Figure 5: Snyder Creek Channel Alignment at Mouth, 2013 (Google Earth Imagery)

2.2.4 Geomorphology

The beaches in Puget Sound are comprised of sediment derived from the erosion and re-working of landslides and sloughing from coastal bluffs and discharge from small streams. These sediment supplies are episodic in nature and depend on larger scale processes such as the amount of precipitation and upland land use activities. The beach shape and sediment transport patterns along the shorelines in Puget Sound are controlled primarily by (1) wind-wave attack along the middle to upper intertidal portion of the beach and (2) larger storm events that have enough energy to mobilize the coarse sediments found on Puget Sound beaches (Finlayson 2006). Sediment is primarily transported by wind-wave energy interacting with the intertidal beach and movement along the shoreline.

The length of shoreline in which sediment can move alongshore transported by wind-waves without interruption is called a littoral drift cell. Shoreline structures (also known as armoring) and management practice which block or reduce the sediment supply influence the entire littoral drift cell. The project site is located at the northern end of an approximate 1.5-mile-long drift cell which extends around the point to the mouth of Snyder Creek to the bulkhead adjacent to the Lower Parking Area (see Figures 1, 6 and 7). The net littoral drift direction is from south to north, driven by southerly- and westerly-aligned wind events (see Figure 3). Mapping, as part of the 2017 Beach Strategies Phase 1 project (CGS 2017), found the shoreline within the drift cell to the south of the site to be primarily feeder bluff[1] (see Figure 8). Feeder bluffs actively erode and supply sediment to the beach if there is not armoring blocking the discharge of sediment. The feeder bluff to the south of the project site is unarmored and supplying much of the sediment within this drift cell. Net littoral drift to the north transports the sediment from the feeder bluffs to the project site.

Shorelines to the east and north of Snyder Creek are mapped as armored (see Figure 7) with a variety of vertical bulkheads and rip-rap slopes. The mouth of Snyder Creek is identified as a creek delta with no appreciable transport of sediment (i.e., drift), so provides no sediment source to the project area.

As stated, the summary of the wind-wave evaluation (Section 2.2.2), the project site is in a relatively low-energy wave environment (compared to other shorelines within Puget Sound) due to limited fetch distances to the north, south and south-west. Storm waves for the 100-year return period wind speed are largest from the north and south-west and are just under 2 feet in height.

The shoreline at the project site is currently armored with a concrete bulkhead between both access staircases. The project shoreline is mapped as a transport zone[2] along the western facing shoreline

[1] An eroding coastal bluff that delivers sediment to a beach over time
[2] An area along the shoreline where sediment is moving with no supply from upland feeder bluffs

and an accretionary shoreform[3] around the point (see Figure 8). This, along with the lower energy wave climate, suggests that the shoreline fronting the concrete bulkhead is relatively stable under natural processes and that if the concrete bulkhead was removed significant long-term erosion of the shoreline is not expected. There will be a period of initial adjustment after the bulkhead is removed as the site adjusts to a more natural condition following over 30 years of structural stabilization. After this period of adjustment, however, the erosion rate at the project shoreline is expected to be relatively slow. Shoreline change at the site can be observed at the eastern staircase where the northern side of the staircase is armored with the concrete bulkhead, but the southern side is unarmored. There is an obvious setback at the natural shoreline to the south of about 4 feet from armored shoreline alignment to the north. If the concrete bulkhead was constructed around 1990, this accounts for an average erosion rate of less than 0.2 feet per year. Therefore, the rate of erosion of the bluff once the bulkhead is removed is expected to be small following a period of initial adjustment of the bluff immediately following armor removal.

The amount of shoreline retreat and erosion of the project site during the period of initial adjustment is difficult to predict with precision. However, it is expected to be small relative the distance between the concrete bulkhead location and the upper parking lot (about 100 feet). Erosion along the western facing shorelines is expected to be similar to what is observed at the natural shoreline to the south of the western staircase, which was is estimated to be 4 feet of retreat over a 30-year time period. At the point, or northern facing shorelines, erosion may be slightly higher due to impact from larger storm waves from the north that impact that area. The rate of erosion at the point is still expected to be small following the initial adjustment period. The erosion is expected to be episodic in response to large storm events where several feet of shoreline may erode during one storm event with little to no erosion occurring for several years at a time.

Median sea level rise is predicted to be 0.8 feet by 2050 and up to 2.2 feet by 2100. At present, the elevation at the toe of the bulkhead varies from 12 feet to 14 feet NAVD88. Current tidal levels are summarized in Table 1 and future predicted tidal levels with sea level rise are summarized in Table 2. MHHW and HAT elevations at the site are currently 10.2 and 13.0 feet NAVD88, respectively. By 2050 these elevations are expected to increase to 11.0 and 13.8 feet NAVD88, respectively and by 2100 to 12.4 and 15.2 feet NAVD88, respectively. At present, the highest tides can reach the toe of the bluff, but MHHW is waterward of the toe of bluff. This will also be true in 2050; but by 2100 portions of the toe of the bluff are expected to be inundated at MHHW and all of the bluff toe is expected to be inundated at HAT.

If left in place, the toe of the concrete bulkhead will be impacted by wave runup and tidal inundation more often as sea levels rise. This will result in increased localized erosion at the toe of the bulkhead

[3] An area along the shoreline where sediment tends to build up over time

and lowering of the beach elevation in front of the bulkhead, which are well understood impacts of seawalls/bulkheads on beaches (Ruggiero 2010). As the elevation in front of the bulkhead lowers due to sea level rise in the future, the wall will be undermined at the toe, become structurally unsound, and will need to be replaced with a larger structure. In contrast, the natural bluff will provide sediment to the upper beach, as well as large wood as sea levels rise and the bluff erodes. This influx of sediment results in the beach elevation increasing at the toe of the bluff and the supply of large wood can provide additional toe protection to the bluff when present. Because of these processes, and since the project site is not located along a high energy wave shoreline, the natural unarmored bluff is expected to be more resilient to sea level rise than the existing concrete bulkhead.

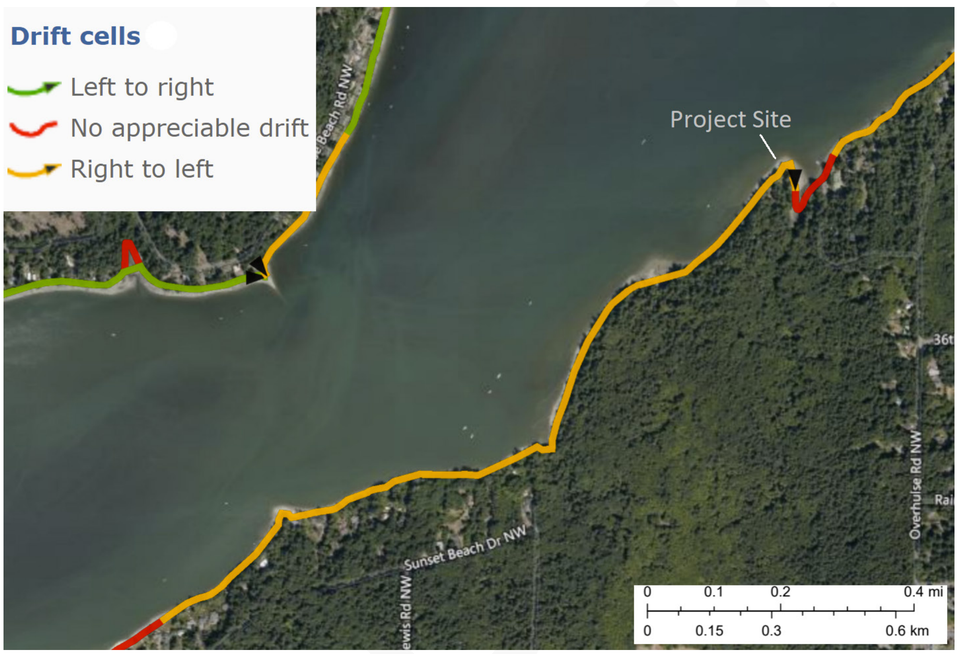


Figure 6: Regional Littoral Drift Cell Mapping ((WA Dept. of Ecology, 2021)

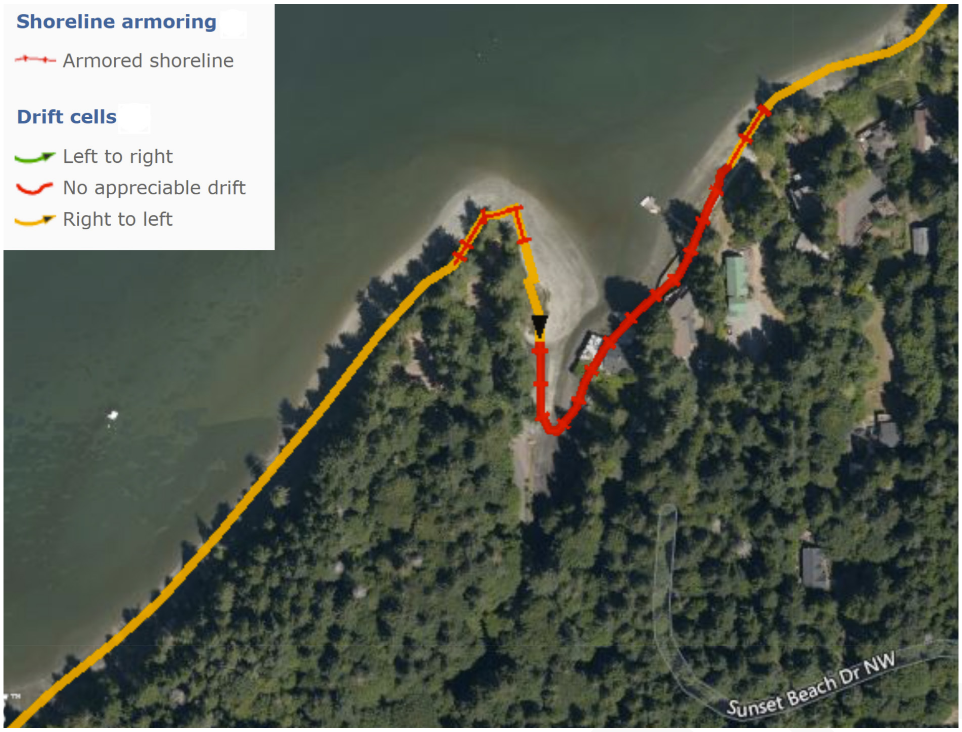


Figure 7: Littoral Drift and Armored Shorelines at the Project Site (WA Dept. of Ecology, 2021)

Figure 8: Coastal Landforms (CGS 2017)

2.2.5 Geology and Slope Stability

Geology mapping of the area (Logan et. al., 2003) shows that Pre-Vashon (Olympia) sandy sediments are located within most of the project site (Qps) with intermittent Pre-Vashon gravel deposits in some locations (CGS, 2009) (see Figure 9). Upland of the project site, surface sediments are Vashon Recessional Outwash (Qgo) which consists of a mixture of sand, gravel, and till.

The sediments on the upper beach consist primarily of coarse sand, gravel, and small cobble material. The lower beach transitions to fine mud (silt and clay) deposits lower in the intertidal zone at and to the west of the point within the Snyder Creek delta. Beach sediments are larger lower in the intertidal zone away from the creek delta to the west and sandy sediments are located in the upper intertidal, including at the base of the concrete bulkhead, throughout the site.

Slopes along the project shoreline are mapped as unstable within approximately a 20 to 70-foot setback area from the shoreline along the entire project site (see Figure 10). The instability is due to the slopes along the shoreline being primarily sand which is easily eroded by precipitation, burrowing animals, and freezing and thawing. Slopes are mapped as stable back from the shoreline area in-line with where the geology changes from Pre-Vashon sandy to Vashon Recessional Outwash (see Figure 9). The site will be susceptible to shallow landslides within the Pre-Vashon sand deposits along the shoreline which is part of the feeder bluff shoreform characteristic. Landslides have been identified through LiDAR analysis to the south and north of the concrete bulkhead (Washington Division of Geology and Earth Resources, 2009). However, the site does not appear to be susceptible to deep seated landslides because of the presence of the Vashon Outwash landward of the sandy deposits.

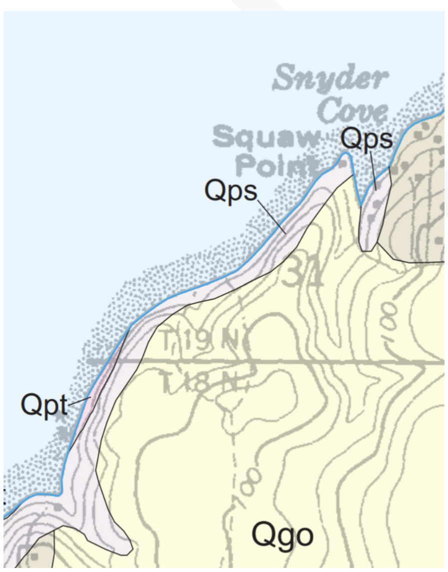


Figure 9: Surface Geology Map (1:24,000 scale, Tumwater 7.5-minute quadrangle)

Figure 10: Slope Stability (Washington Department of Ecology, 2021)

2.3 Vegetation

The upland vegetation in the project area is a second growth mixed conifer and deciduous forest. The Snyder Creek watershed extends to the TESC campus and much of this area is protected in the forest owned by TESC. Tree species noted on the project site and throughout the forest included Douglas fir, western hemlock, western red cedar, big leaf maple, and red alder. The shrub layer included salmonberry, oceanspray, Oregon grape, and thimbleberry with a mix of smaller annual species and ferns. On the project site there is a significant band of invasive English Ivy growing above the bulkhead, small amounts of invasive Himalayan blackberry were also noted on the parcel. On the upper beach there was sporadic halophytic vegetation including saltgrass, pickleweed, and Pacific gumweed. There are also areas of lawn on the project property, primarily around the home and above the bulkhead adjacent to the parking area.

2.4 Habitat

Eld Inlet lies within the southern Puget Sound sub-basin in between Budd and Totten Inlets. Eld Inlet is relatively undeveloped compared to Budd Inlet to the east. Swift Creek and McLane Creek drain into the head of Eld Inlet and create a large salt marsh and muflat complex, referred to as Mud Bay, that transitions to forest freshwater wetlands. These creeks are the largest drainages flowing into Eld Inlet and have documented presence of coastal cutthroat, and steelhead trout as well as coho, chum, and Chinook salmon according to Washington Department of Fish and Wildlife (WDFW) Statewide Integrated Fish Distribution map. Spawning chum are documented in this system as well as other creeks flowing into Eld Inlet. Steelhead spawning is documented in Green Cove creek, to the north of the project site. In Snyder Creek chum and coho have documented presence and other species are presumed to utilize the system for temporary refuge.

Surf smelt spawning is ubiquitous along the shores of Eld Inlet until the extreme southern end around Mud Bay. There is documented spawning near the project area, but precise locations are not provided in the (WDFW) database and sampling/spawning may not occur directly in front of the bulkhead. There is some documented sand lance spawning in throughout the inlet but none at the project site.

The intertidal zone in Eld Inlet supports a large diversity of benthic species and the TESC shellfish club uses the beach for aquaculture. Kelp and eelgrass are uncommon this far couth in Puget Sound and none were observed during the site visit although other species of kelps and algae were noted at low tide.

The uplands around Snyder Creek have some single-family residences and the creek terminates at the main campus area for TESC. There is extensive forest and riparian habitat that would support many upland species and provide areas to safely move between habitats. WDFW Priority Habitat and Species (PHS) indicates this area as an area with big and little brown bats.

3 Development and Analysis of Alternatives

3.1 Project Goals

Blue Coast used site characterization information developed as part of this work (see Section 2), as well as information obtained from previous studies and discussions with SPSSEG, TESC, and other project stakeholders to develop conceptual alternatives for restoration at the site. High level goals for the project are summarized below:

1. Restore coastal processes to the point through armor removal
2. Reconnect nearshore area with upland riparian zone through armor removal
3. Improve forage fish spawning habitat
4. Provide pedestrian access to the beach
5. Avoid impacts to upland parking area and habitable structure (i.e., the house on project site)
6. Minimize impacts to adjacent properties to the east of Snyder Creek

These goals were used to develop and prioritize proposed project elements, develop concepts, and select the preferred conceptual alternative for the site.

3.2 Conceptual Alternatives

Conceptual alternatives were developed for the project site using full removal of the concrete bulkhead as the baseline alternative. From visual inspection, the concrete bulkhead is a continuous structure along its length and would be difficult to remove in sections without damaging the remaining wall length. In addition, partial removal of the concrete bulkhead would not achieve the primary goal for the project, which is to restore coastal processes to the site.

Additional conceptual alternatives were built upon the baseline alternative. Conceptual alternatives are summarized in Table 5.

Table 5: Summary of Restoration Concepts at Snyder Cove

Concept	Description
Remove Shoreline Armor (Baseline, Concept #1)	• Remove the concrete bulkhead, excavate non-native fill behind the bulkhead (if present), and regrade slope (if fill removed) • Remove both the eastern and western access staircases. • Place beach nourishment material along upper intertidal beach where bulkhead was removed
Concept #1 + Remove Concrete Pad and Upland Plantings (Concept #2)	• All project elements in Concept #1 (baseline) • Remove concrete pad along western side of Snyder Creek • Plant upland area north or the upper parking lot with a mix of shrubs and trees to improve riparian habitat, replace trees removed during demolition of the concrete bulkhead and provide slope stability.
Concept #2 + Remove Eastern Staircase/Path and Additional Upland Plantings (Concept #3)	• All project elements in Concept #2 • Remove eastern staircase and asphalt path between stairs and upper parking lot -all beach access would be from the lower parking area. • Additional upland plantings to restore riparian within the footprint of the existing asphalt path • Provide signage to direct visitors parking in the upper parking lot to the beach access at the lower parking area

3.3 Alternatives Analysis

Each restoration concept summarized in Table 5 was evaluated quantitatively based on the ability of each concept to meet the stated project goals listed in Section 3.1. Information provided in the site characterization (Section 2) was used to inform the evaluation.

3.3.1 Restore Coastal Processes

All three conceptual alternatives restore coastal processes by removing shoreline armoring (the concrete bulkhead), providing beach nourishment at the toe of the bluff within the area of armor removal and reconnecting feeder bluff areas with the nearshore.

Landslides and eroding bluffs to the south provide sediment to the littoral system that moves north through the project location to the mouth of Snyder Creek. Removal of the armor at the project site restores natural transport processes within majority (Alternatives 1 and 2) or the entire (Alternative 3) littoral drift cell that extends from the south through the project shoreline to the mouth of Snyder Creek.

Beach nourishment at the toe of the bluff is included in all three alternatives to provide beach sediment at the toe of bluff that would have been naturally recruited in that location over the years if the shoreline had not been armored. The beach nourishment is also expected to reduce the magnitude of the initial adjustment of the bluff once the armoring is removed.

Concept #3 includes removal of all shoreline structures (both staircases, concrete pad, asphalt path). This removes all impediments to natural coastal processes along the project shoreline and adjacent riparian area. Concept #1 retains both staircases and the concrete pad while Concept #2 retains just the eastern staircase. Each staircase impacts feeder bluff processes at the location where it is constructed and may cause localized erosion around its base during storm events. The concrete pad limits movement of Snyder Creek within its delta. Therefore, Concept #3 restores more of the natural processes at the site than Concept #2. That said, impacts to coastal processes from retaining the staircases or concrete pad is minor compared to impacts to processes due to the presence of the concrete bulkhead.

3.3.2 Reconnect Nearshore with Riparian Zone

Removal of the shoreline armoring at Snyder Cove would improve habitat along the shoreline and at the stream delta. It would also improve marine riparian habitat and increase connectivity between the uplands and marine shoreline. The project should increase channel complexity of intertidal portion on the Snyder Creek, thus creating more areas for fish refuge in the delta and more access options to higher portions of the stream which are now further accessible after the culvert replacement completed in 2012. Removing the bulkhead and sloping back the shoreline would make a more gradual transition for larger animals, such as deer to access the shoreline. Addressing the English ivy on site would diversify the understory of the site and depending on plant selection would improve forage for animals. Any replacement of grass on the parcel with native vegetation would improve slope stability and drainage while also expanding upland habitat and improving water quality from any runoff from the property.

All concepts remove shoreline armor and reconnect the upland riparian zone to the nearshore. Similar to the discussion of restoring coastal processes (Section 3.2.1), Concept #3 removes all shoreline structures and connects the entire project shoreline to the upland riparian zone. Concept #1 leaves several structures in place that block that connection. Concept #2 retains only the eastern staircase. Concepts #2 and #3 reestablish the riparian zone between the Upper Parking lot and the shoreline through plantings. However, Concept #2 retains the asphalt walkway in the upland that connects the parking lot to the eastern staircase.

3.3.3 Restore Forage Fish Spawning Habitat

All concepts restore forage fish spawning habitat through removal of the concrete bulkhead, which restores supply of sandy sediments to the nearshore appropriate for forages fish spawning. Concepts #2 and #3 restore additional forage fish spawning habitat through removal of the concrete pad.

Concept #3 also removes the eastern staircase (retained in Concept #2), but this does not significantly improve forage fish spawning habitat compared to Concept #2.

3.3.4 Provide Pedestrian Access to the Beach

Concept #1 retains both staircases that provide access to the shoreline from the Upper Parking Lot. The western staircase is in poor condition; the wooden railings need to be replaced and the concrete stairs have some areas of spalling. In addition, the western staircase appears to be structurally connected to the concrete bulkhead, and it may not be feasible to remove the bulkhead without damaging the staircase. Concept #2 retains only the eastern staircase, which appears to be in good condition and is not connected structurally to the concrete bulkhead (from visual inspection). The eastern staircase also leads to an asphalt path from the top of the staircase to the Upper Parking Area, which is also retained in Concept #2. Concept #3 removes both staircases and the asphalt walkway and limits beach access to the access ramp/walkway currently located at the lower parking area. Signs would need to be installed at the upper parking lot directing pedestrians to the lower parking area to access the beach.

3.3.5 Avoid Impacts to Upland Parking Lot and House

All concepts avoid impacts to the upland parking lot and house located at the project site. As discussed in Section 2.2.4, shoreline erosion following removal of the concrete bulkhead is not expected to threaten the upper parking lot or the house. Concepts #2 and #3 also include planting the grass lawn north of the upper parking lot, which will provide additional stability to that area, especially over the long-term as sea levels rise and shoreline erosion rates increase.

3.3.6 Minimize Impacts to Adjacent Properties

All three concepts are expected to have minimal impacts to adjacent properties to the east of the Snyder Creek. The primary concern is migration of the Snyder Creek channel to the east as sediment from the restored feeder bluffs moves eastward under littoral drift. It is possible the creek channel could incise along one or more of the bulkheads located on those private properties causing scour at the toe of the structures. Removal of the concrete pad along the western bank of Snyder Creek, as proposed in Concepts #2 and #3, would provide some additional area for the creek to move within its delta as sediment moves into the creek mouth. Removal of the concrete pad may also limit movement of the creek to the east towards private properties. That said, it will be important to monitor the movement of the creek channel once the concrete bulkhead is removed. If the creek moves too close to the privately owned bulkhead(s), mitigation measures may be required to protect those bulkheads from scour at their base due to creek flows. Additional project elements, such as strategic placement of large wood, could be implemented in final design of the project to further minimize this impact.

4 Preferred Alternative

4.1 Select Preferred Alternative

Each concept was given a score for how completely the concept achieved each stated goal based on the alternatives analysis in Section 3 according to the following scoring rubric:

- 3 – Fully achieves the stated goal
- 2 – Achieves the stated goal with minor deficiencies
- 1 – Partially achieves the stated goal with significant deficiencies
- 0– Does not achieve the stated goal.

Individual scores for each project goal will be added up to develop a total score for each concept. The higher the total score the more completely the concept meets the stated project goals. A summary of the scoring for each conceptual alternative is provided in Table 6.

Concept #2 has the highest total score, but only slightly higher than Concept #3. Although Concept #3 removes all structures from the shoreline to fully restore coastal processes to the site, it significantly limits pedestrian access to the beach by removing both access staircases and providing no direct access to the beach from the upper parking lot. As discussed previously in this report, retaining the eastern staircase and asphalt pathway that connects this staircase to the upper parking lot does not significantly impact restoration of coastal processes or potential for riparian reconnection at the site.

In addition, there are no significant impacts to upland infrastructure or adjacent shoreline expected from implementation of Alternative 2 (or any of the proposed alternatives), as previously discussed in this report.

Table 6: Summary of Qualitative Evaluation (Scoring) of Conceptual Alternatives

Concept #	Project Goals						Total Score
	Improve Coastal Processes	Reconnect Riparian to Nearshore	Improve Forage Fish Habitat	Pedestrian Beach Access	Avoid Impacts to Parking Lot/House	Minimize Impacts to Adjacent Properties	
Concept #1	1	2	3	3	2	2	13
Concept #2	2	2	3	3	3	3	16
Concept #3	3	3	3	0	3	3	15

4.2 Description of Preferred Alternative

Drawings illustrating the preferred alternative (Concept #2) are provided in Appendix B. Project elements included in the preferred alternative (Concept #2) are summarized in Table 7.

Table 7: Preferred Alternative – Summary of Project Elements

Project Element	Description
Remove Concrete Bulkhead	• Remove approximately 220 linear feet of concrete bulkhead. Concrete should be recycled if feasible. Excavate and dispose of artificial fill or other non-native materials behind the bulkhead. Re-grade slope, if needed, in areas where artificial fill or materials were removed. • Some smaller conifer trees and other vegetation located near the crest of the bulkhead wall may need to be removed prior to demolition of the wall. • Madrone trees along the crest of the concrete wall will be protected in place during demolition. • The large conifer tree at the north-western corner of the wall will be protected in place during demolition. It is possible that the tree may need to be removed for safety reasons during construction. If this is the case, the trunk of the tree will be cut 2 to 3 feet above the ground leaving the stump and root structure in place. The limbs of the tree will be removed, and the trunk will be placed on the beach.
Remove the Western Staircase	• Remove the western staircase, including footers that may be present at the top and base of the stairs. Concrete should be recycled if feasible.
Remove the Concrete Pad	• Remove the concrete pad located along the western bank of Snyder creek. Concrete should be recycled if feasible.
Place Beach Nourishment	• Place beach nourishment material in the upper 5 feet of intertidal beach where the concrete bulkhead was removed. • Place beach nourishment material in the area where the concrete pad was removed and fill up to match adjacent natural grades.
Upland Planting	• Plant a mix of shrubs and trees within the grass lawn between the parking lot to the south, asphalt path to the east and the top of bank to the north and west following removal of the concrete bulkhead.

The preferred alternative for restoration at Snyder Cove will accomplish the following:

- Restore natural physical and geological processes to the project site
- Remove remaining armor within the 1.5-mile drift cell inclusive of the project site
- Restore the riparian zone upland of the existing bulkhead
- Improve forage fish habitat along the shoreline where armor is removed

- Restore nearshore habitat (sediment supply, large wood supply, beach slopes) along the shoreline adjacent to Snyder Creek where a small culvert just upstream of the creek mouth was replaced with a fish passable culvert in 2011
- Retain the public access staircase located at the eastern extent of the project site

No significant risks to upland infrastructure or adjacent shorelines are expected following restoration of the site (implementation of the preferred alternative). Wave energy is relatively low at the project site (compared to other locations in Puget Sound), due to small fetch distances to the north, west, and south-west. Bluff erosion just south of the armored shoreline (where the armor meets the natural bluff) has been approximately 4 feet over about 30 years. This rate of erosion of the bluff once armor is removed is expected to be about the same following a brief period of adjustment directly following armor removal. Placement of beach nourishment material at the toe of the bluff in the area where armor is removed should reduce the amount of bluff movement occurs during this initial adjustment period.

Proposed armor removal and upland plantings with also increase the resiliency of the project site to sea level rise (compared to the existing bulkhead), by providing an upland source of sediment to the nearshore to offset increase in water levels, increase large wood supply to the nearshore area to provide additional stability at the toe of slope, and increasing the stability of the bluff through revegetation of the riparian zone.

The alignment of Snyder Creek may move around within its historical footprint following armor removal as additional sediment is supplied to the nearshore downdrift. It is possible that the creek may move closer to the armored shorelines on private properties to the east. However, the risk of the creek moving to the base of the adjacent shoreline armoring is small because of the following reasons:

- Littoral drift is a slow process at the project site due to the low wave energy along the project shoreline
- Littoral drift still occurs along the project shoreline and the creek alignment has remained stable over at least the past two decades
- The creek alignment did not change following replacement of the upstream undersized culvert with a larger fish passable culvert in 2011
- Removal of the concrete pad on the west side of the creek near its mouth (as part of the restoration project at Snyder Cove) will restore the left bank of the creek near its mouth and provide additional area for creek to move to the west (away from adjacent armored shorelines)

The preferred restoration alternative will restore coastal processes, improve nearshore habitat, and restore upland riparian along the project shoreline with no anticipated risk to upland infrastructure and little to no risk to adjacent shorelines. If there is continued concern about the creek alignment impacting adjacent armored shorelines (to the east), cobble could be placed at the base of that bulkhead as part of the restoration project or as an adaptive management action in the future (triggered by monitoring).

4.3 Engineer's Estimate of Construction Cost (EOC)

An engineer's opinion of construction cost (EOC) for the preferred conceptual alternative described above was developed by Blue Coast as summarized in Table 8. A 30% mobilization cost and 30% contingency were included in the cost estimate to account for challenges associated with construction access at the site (mobilization) and current conceptual level of design (contingency). Mobilization was also increased as a percentage of the total work due to the relative low cost of the project.

Table 8: Engineer's Estimate Construction of Summary

Project Element	Unit	Unit Cost[1]	Total
Remove Concrete Bulkhead and Dispose of Concrete Debris	220 linear feet	$200/linear foot	$44,000
Remove the Western Staircase and Dispose of Concrete Debris	lump sum	$8,000	$8.000
Remove the Concrete Pad (90' x 30') and Dispose of Concrete Debris	300 square yards	$60/square yard	$18,000
Place Beach Nourishment	250 cubic yards	$100/cubic yard	$25,000
Remove Large Conifer Tree[2]	1	$10,000	$10,000
Upland Plantings	5,000 square feet	$2/square foot	$10,000
		Subtotal Project Elements	*$115,000*
20% Mobilization[3]	n/a	n/a	~$23,000
		Total Cost	***$138,000***

Notes:
1. Unit costs assume construction can be completed from the land side of the site. Unit costs are conservative based on potential for increase in construction costs by 2023 (within the anticipated construction timeframe for the project)
2. Root structure and stump would be left in place. Trunk (or sections of the truck) of the tree would be placed on the beach.
3. Mobilization includes all site preparation, clearing and grubbing and protection of large trees and infrastructure to remain. Mobilization set to 20% (above standard 10%) due to difficulty in accessing the site and small quantities required for the work.

5 Monitoring and Research Opportunities

Restoration of the project shoreline as described in Section 4.2 provides an opportunity for numerous monitoring and basic research activities that could be undertaken by TESC students and/or faculty. A list of some of the potential opportunities are provided in Table 9. Activities labeled as "monitoring" are focused on site response to the project. For these actions, there is a good understanding of the basic physical or geological process and the focus is on how the project site changes over time. Research activities are actions that could inform similar work at other locations.

Table 9: Potential Monitoring and Research Opportunities Associated with Restoration Project

Monitoring or Research Based Activity	Relevant Fields of Study	Description of Activity
Monitoring	Coastal Geomorphology	Monitor changes to the shoreline post-restoration, including bank erosion, shoreline accretion and substrate changes.
Monitoring	Coastal and fluvial Geomorphology	Monitor changes to the alignment of Snyder Creek post-project. Couple this activity with monitoring in changes to the shoreline post-restoration.
Monitoring	Botany	Install and monitor native vegetation plantings.
Monitoring	Fisheries	Conduct forage fish spawning surveys.
Monitoring and Research	Fisheries	Evaluate fish use in the creek pre- and post- construction.
Research	Botany	Conduct a field experiment to evaluate effectiveness of various methods of ivy control/removal.
Research	Fisheries	Conduct snorkel surveys pre- and post-construction to see if fish use and behavior changes after bulkhead is removed.
Research	Engineering	The current drainage for the home on the property is not functional, design and install a new system. Test efficacy of different methods.
Research	Social Sciences	Document the project and create educational outreach materials.
Research	Chemistry/Aquaculture	Install mussel cages and using WDFW methods analysis mussels for changes in water quality pre- and post-construction.

6 References

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Appendix A
Site Photographs (August 10, 2021)

Appendix A – Site Visit Photographs (August 10, 2021)
Snyder Cove Point Bulkhead Removal Feasibility Report

Photograph #-1. Lower Parking Area and Access to Project Shoreline; Snyder Creek Bulkhead to Left

Photograph #-2. Snyder Creek with Project Shoreline on the Right and Private Property to the Left (looking north)

Photograph #-3. Concrete Pad Along Left Bank of Snyder Creek on Project Shoreline (looking north)

Photograph #-4. Right Bank of Snyder Creek on Private Property

Photograph #-5. Snyder Creek Near Mouth Along Private Properties to East of Project Shoreline

Photograph #-6. Mount of Snyder Creek at Snyder Cove During Low Tide (looking North)

Photograph #-7. Eastern Beach Access Staircase (Concrete with Wood Railing)

Photograph #-8. Toe of Concrete Bulkhead to the West of the Eastern Access Staircase

Photograph #-9. Northwestern Corner of Concrete Bulkhead (looking east)

Photograph #-10. Large Conifer Tree at Northwestern Corner of Bulkhead (looking east)

Photograph #-11. Concrete Bulkhead (under overlying vegetation) At Western Facing Shoreline

Photograph #-12. Western Beach Access Staircase (Concrete with Wood Railing), Natural Shoreline to Right

Photograph #-13. Natural Shoreline Just South of the Western Beach Access Staircase

Photograph #-14. Natural Shoreline Conditions South of the Project Shoreline

Photograph #-15. Area Upland Between the Bulkhead and the Parking Lot (looking south)

Photograph #-16. Upper Parking Lot and House Upland of Bulkhead (looking west)

Photograph #-17. Access Path and Eastern Beach Access Staircase Viewed from the Uplands (looking east)

Appendix B
Preferred Alternative Drawings

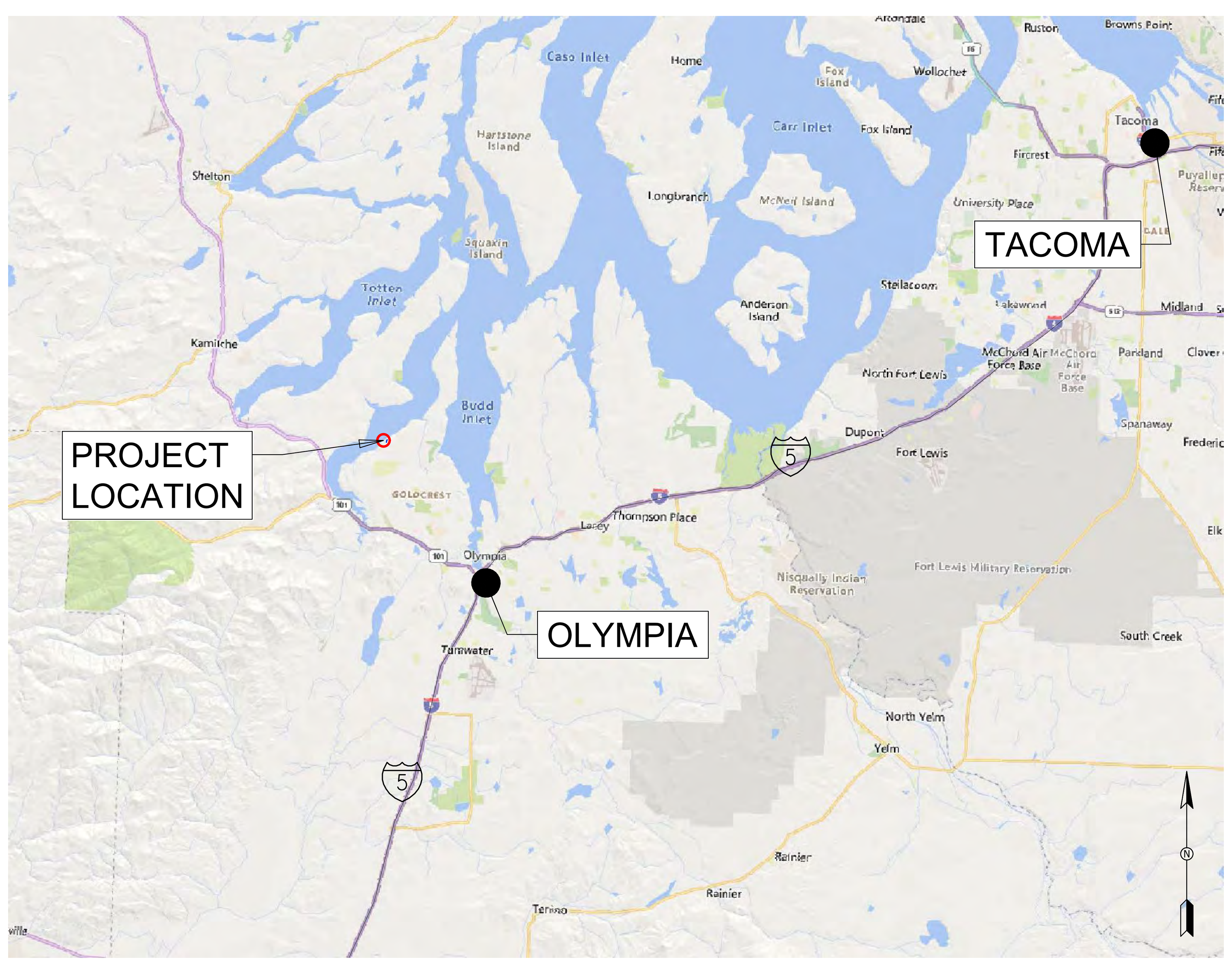
PRELIMINARY DESIGN DRAWINGS

SNYDER COVE POINT BULKHEAD REMOVAL - CONCEPTUAL DESIGN

SHEET INDEX	
SHEET NUMBER	**SHEET TITLE**
1	COVER SHEET
2	EXISTING CONDITIONS
3	EXISTING CONDITIONS SECTIONS
4	CONCEPTUAL DESIGN LAYOUT
5	CONCEPTUAL DESIGN SECTIONS

VICINITY MAP

NOT TO SCALE



SITE MAP

SURVEY NOTES:

1. PARCEL BOUNDARIES FROM THURSTON COUNTY GIS DEPARTMENT, DATED MAY 6, 2020. PROPERTY LINE SURVEY WILL BE REQUIRED PRIOR TO CONSTRUCTION TO PRECISELY LOCATE BOUNDARIES
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH, NAD83, U.S. SURVEY FEET
3. VERTICAL DATUM: NAVD88, FEET
4. TOPOGRAPHIC SURFACE IS BASED ON THE FOLLOWING:
   - 4.1. USGS coNED TOPO-BATHYMETRY ELEVATION DATA, USGS 2017
   - 4.2. SURVEY POINT ELEVATION DATA COLLECTED BY BLUE COAST ENGINEERING, 8/10/2021
5. WATER LEVELS BASED ON NOAA-NOS STATION #9446807 AT BUDD INLET, SOUTH OF GULL HARBOR, WA:
   - HIGHEST ASTRONOMICAL TIDE (HAT) = +12.4 FT NAVD88; +16.5 FT MLLW
   - MEAN HIGHER HIGH WATER (MHHW) = +10.4 FT NAVD88; +14.5 FT MLLW
   - MEAN SEA LEVEL (MSL) = +4.2 FT NAVD88; +8.3 FT MLLW
   - MEAN LOWER LOW WATER (MLLW) = -4.1 FT NAVD88; 0.0 FT MLLW

LOCATION NOTES:
LOCATION: SUNSET BEACH DR NW
LAT/LON: 48.76°N 122.51°W
SEC:06 T:18 R:2W
WATERBODY: SNYDER COVE, ELD INLET
NEAR: OLYMPIA
COUNTY: THURSTON
STATE: WASHINGTON

BLUE COAST ENGINEERING

DRAFT NOT FOR CONSTRUCTION

REVISIONS

REV:	DESCRIPTION:	BY:	DATE:

DESIGNED: KK
DRAWN: KL
CHECKED: GC
DATE: 10/19/21
SCALE: AS NOTED

SNYDER COVE BULKHEAD REMOVAL CONCEPTUAL DESIGN

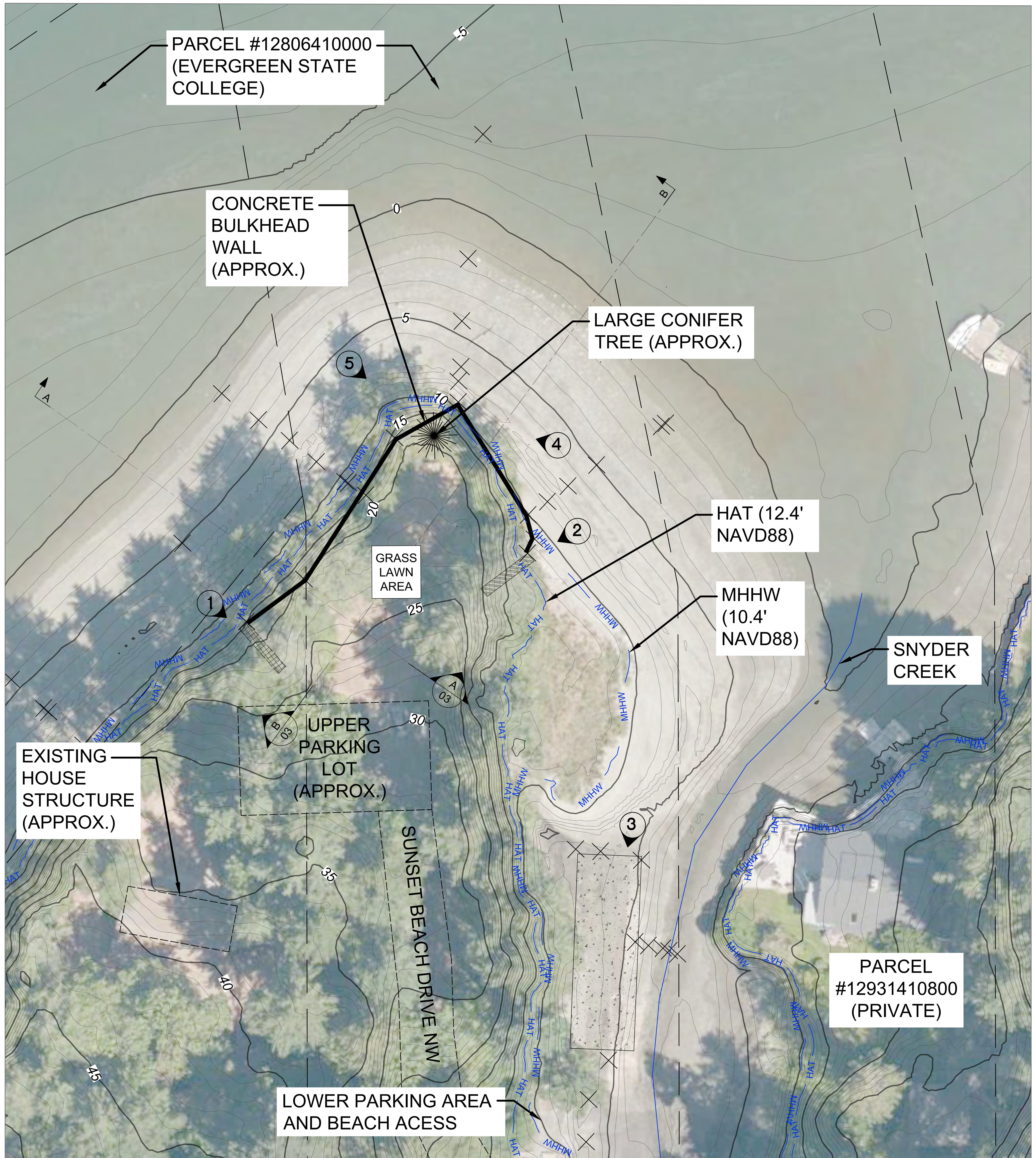
COVER SHEET

SHEET NO: 01

1 WEST BEACH ACCESS STAIRCASE

2 EAST BEACH ACCESS STAIRCASE

3 CONCRETE PAD



4 CONCRETE BULKHEAD WALL

5 LARGE CONIFER TREE

LEGEND

10.0	ELEVATION CONTOURS (1 FT) - SEE NOTES
HAT	HIGHEST ASTRONOMICAL TIDE (HAT) +12.4 FT NAVD88
MHHW	MEAN HIGHER HIGH WATER (MHHW) +10.4 FT NAVD88
	EXISTING CONCRETE BULKHEAD WALL (SEE NOTE 5)
	PARCEL BOUNDARY
	LARGE CONIFER TREE
	SECTION LOCATION
	CONCRETE PAD (SEE NOTE 5)
	GPS SURVEY POINT (SEE NOTE 5)
	WEST BEACH ACCESS STAIRCASE
	EAST BEACH ACCESS STAIRCASE

0 50 100 Feet

N

SURVEY NOTES:

1. PARCEL BOUNDARIES FROM THURSTON COUNTY GIS DEPARTMENT, DATED MAY 6, 2020. PROPERTY LINE SURVEY WILL BE REQUIRED PRIOR TO CONSTRUCTION TO PRECISELY LOCATE BOUNDARIES
2. HORIZONTAL DATUM: WASHINGTON STATE PLANE SOUTH, NAD83, U.S. SURVEY FEET
3. VERTICAL DATUM: NAVD88, FEET
4. CONTOURS SHOWN ARE FROM USGS COASTAL NATIONAL ELEVATION DATABASE (CoNED) WHICH INCLUDES LIDAR AND BATHYMETRY DATA.
5. SURVEY POINTS COLLECTED BY BLUE COAST ENGINEERING ON AUGUST 10, 2021.
6. EXISTING ACCESS ROAD, PARKING AREA, AND CONIFER TREE OF CONCERN ARE SHOWN WITH APPROXIMATE SIZE AND LOCATION FOR SCHEMATIC REPRESENTATION PURPOSES ONLY.

BLUE COAST ENGINEERING

DRAFT NOT FOR CONSTRUCTION

REVISIONS

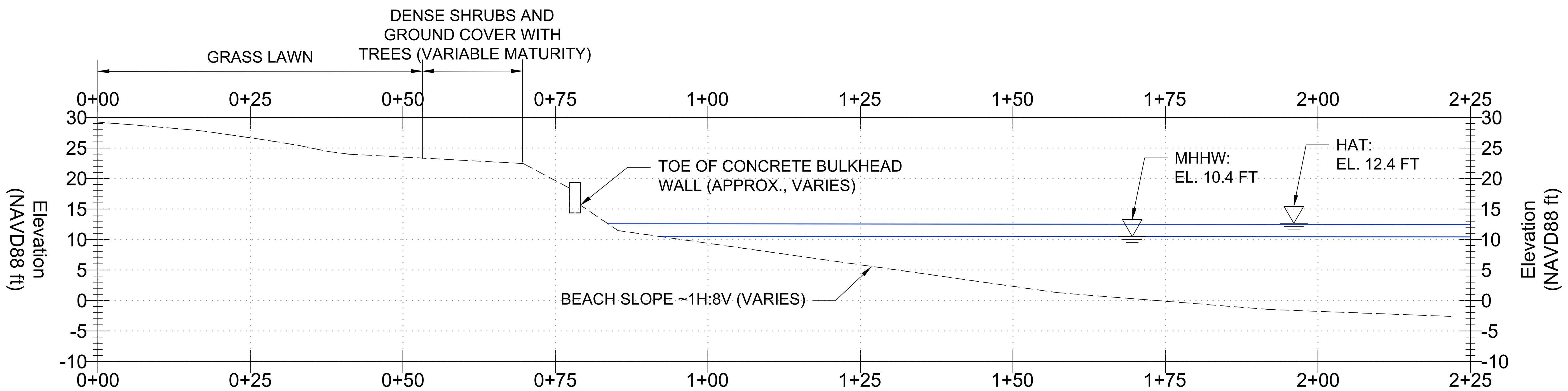
REV:	DESCRIPTION:	BY:	DATE:

DESIGNED: KK
DRAWN: KL
CHECKED: GC
DATE: 10/19/21
SCALE: AS NOTED

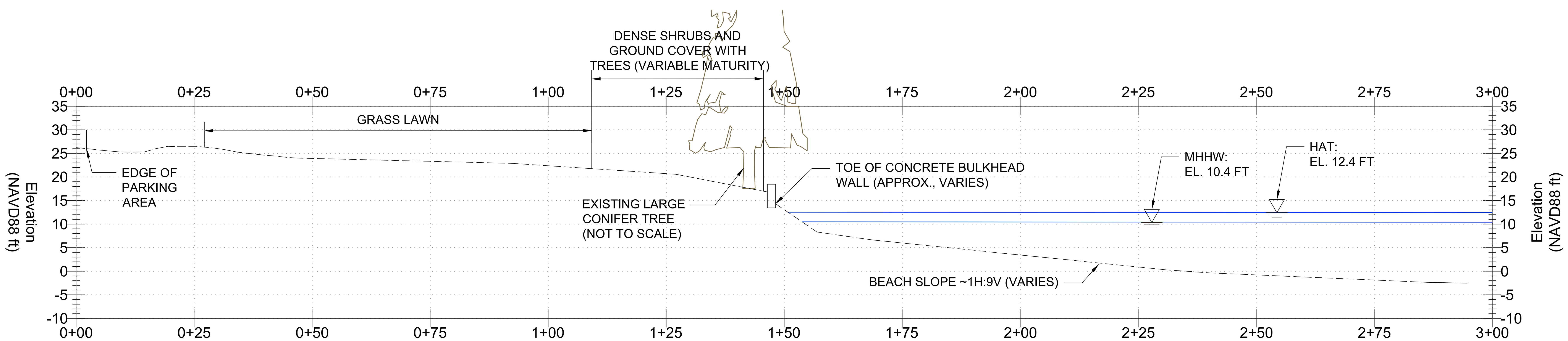
SNYDER COVE BULKHEAD REMOVAL CONCEPTUAL DESIGN

EXISTING CONDITIONS

SHEET NO: 02



A
02
SECTION A
Scale: 1:15



B
02
SECTION B
Scale: 1:15

BLUE COAST ENGINEERING

DRAFT NOT FOR CONSTRUCTION

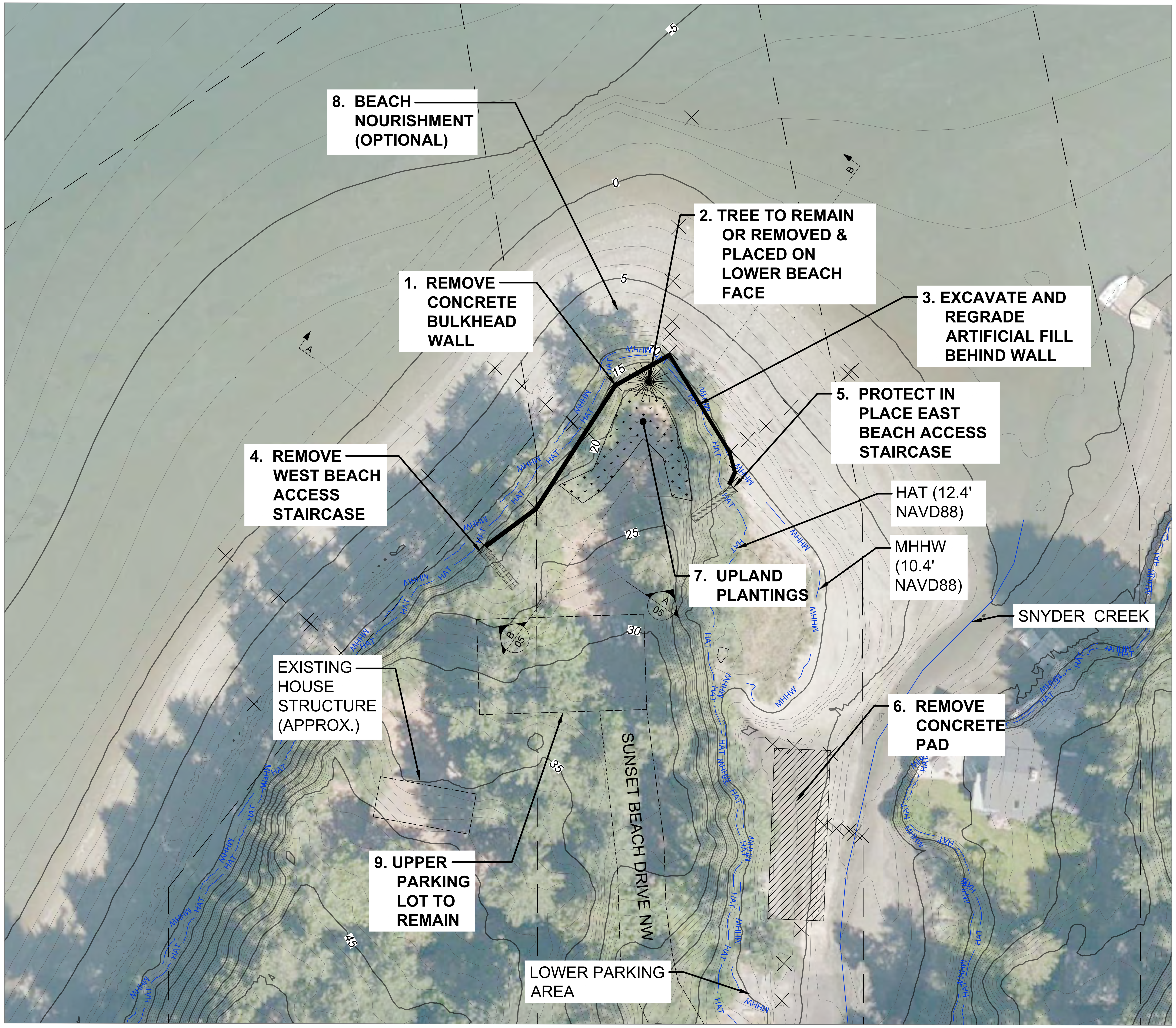
REVISIONS			
REV:	DESCRIPTION:	BY:	DATE:

DESIGNED: KK
DRAWN: KL
CHECKED: GC
DATE: 10/19/21
SCALE: 1:15

SNYDER COVE BULKHEAD REMOVAL CONCEPTUAL DESIGN

EXISTING CONDITIONS SECTIONS

SHEET NO: 03



LEGEND

	WEST BEACH ACCESS STAIRCASE (REMOVED)	10.0	ELEVATION CONTOURS (1 FT) - SEE NOTES
	EAST BEACH ACCESS STAIRCASE (PROTECT IN PLACE)	HAT	HIGHEST ASTRONOMICAL TIDE (HAT) +12.4 FT NAVD88
	CONCRETE PAD (REMOVED)	MHHW	MEAN HIGHER HIGH WATER (MHHW) +10.4 FT NAVD88
	EXISTING CONCRETE BULKHEAD WALL (REMOVED)		PARCEL BOUNDARY
	UPLAND PLANTING AREA		LARGE CONIFER TREE
	SECTION LOCATION		

NOTES:
1. SEE SURVEY NOTES ON SHEET 2 FOR DATA INFORMATION

0 50 100 Feet

N

CONCEPTUAL DESIGN ELEMENTS:
1. EXCAVATE AND REMOVE CONCRETE BULKHEAD WALL IN ITS ENTIRETY.
2. DURING REMOVAL OF THE WALL, RETAIN IN PLACE LARGE CONIFER TREE OR TRIM AND PLACE ON LOWER BEACH FACE DEPENDING ON STABILITY AFTER REMOVAL OF THE WALL.
3. REMOVE ARTIFICIAL FILL (IF PRESENT) ALONG EXISTING CONCRETE BULKHEAD WALL AND ALIGN BANK TO A NATURAL ANGLE OF REPOSE WITH THE BEACH.
4. EXCAVATE AND REMOVE THE WEST STAIRCASE.
5. PROTECT IN PLACE THE EAST STAIRCASE DURING WALL DEMOLITION.
6. EXCAVATE AND REMOVE EXISTING CONCRETE PAD.
7. UPLAND PLANTINGS OF NATIVE VEGETATION TO PROMOTE UPPER DUNE STABILITY
8. PLACE BEACH NOURISHMENT ON UPPER INTERTIDAL BEACH WHERE WALL WAS REMOVED (OPTIONAL).
9. PROTECT IN PLACE THE UPPER PARKING LOT AND EXISTING ACCESS ROAD.

BLUE COAST ENGINEERING

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REVISIONS

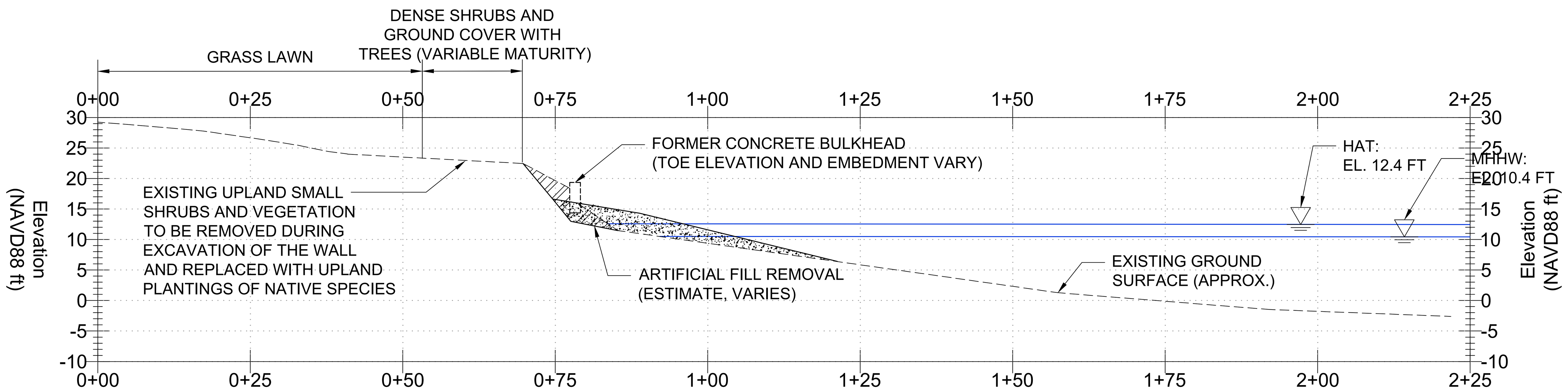
REV:	DESCRIPTION:	BY:	DATE:

DESIGNED: KK
DRAWN: KL
CHECKED: GC
DATE: 10/19/21
SCALE: AS NOTED

SNYDER COVE BULKHEAD REMOVAL CONCEPTUAL DESIGN

CONCEPTUAL DESIGN LAYOUT

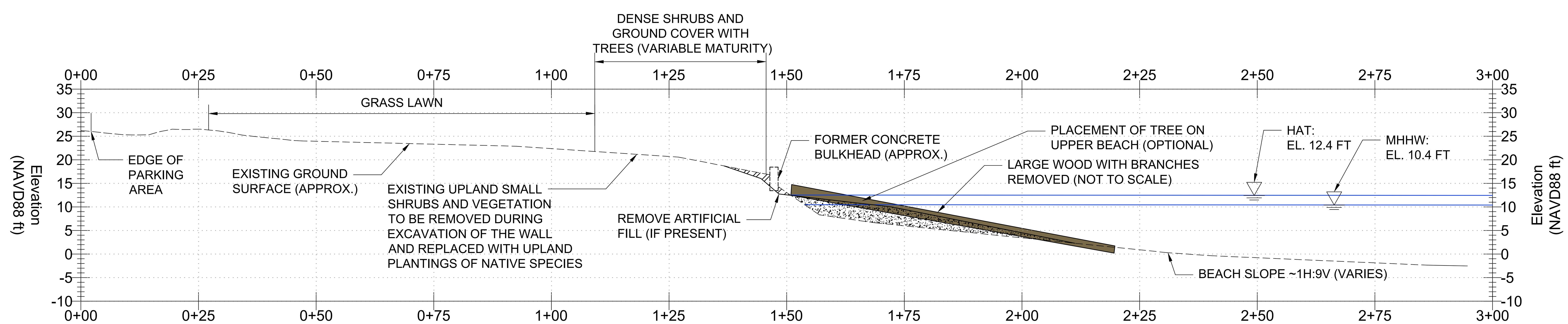
SHEET NO: 04



A SECTION A
04 Scale: 1:15

REMOVE ARTIFICIAL FILL (IF PRESENT)

PLACE BEACH NOURISHMENT (EXAMPLE ONLY)



B SECTION B
04 Scale: 1:15

REMOVE ARTIFICIAL FILL (IF PRESENT)

PLACE BEACH NOURISHMENT (EXAMPLE ONLY)

CONCEPTUAL DESIGN NOTES:

1. PLACEMENT OF THE LARGE TREE ONT HE BEACH MAY BE REQUIRED IF IT BECOMES UNSTABLE DURING DEMOLITION OF THE EXISTING CONCRETE BULKHEAD WALL.
2. BEACH NOURISHMENT MAY BE USED ON THE UPPER INTERTIDAL BEACH POST REMOVAL OF THE CONCRETE BULKHEAD WALL.
3. EXTENT OF UPLAND PLANTINGS TO BE DETERMINED DURING PRELIMINARY DESIGN.

BLUE COAST ENGINEERING

DRAFT NOT FOR CONSTRUCTION

REVISIONS

REV:	DESCRIPTION:	BY:	DATE:

DESIGNED: KK
DRAWN: KL
CHECKED: GC
DATE: 10/19/21
SCALE: 1:15

SNYDER COVE BULKHEAD REMOVAL CONCEPTUAL DESIGN

CONCEPTUAL DESIGN SECTIONS

SHEET NO: 05