COUNTY: Island

Grant Number: SEANWS-2019-IsCoPH-00005

PROJECT TITLE: Island County Marine Resources Committee Operations and Projects

TASK NUMBER: 4.1 and 4.2 – Hoypus Point and Possession Point Feasibility study, including summary of priorities to select one site for preliminary design, and preliminary design of the selected site

PERIOD COVERED: Oct 2019-Jun 2020

DATE SUBMITTED: 7/10/2020

This project has been funded wholly or in part by the United States Environmental Protection Agency. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency under Assistance Agreement [CE-01J65401]. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Hoypus Point and Possession Point Restoration

Feasibility Report

Prepared for:

Island County Marine Resources Committee and Northwest Straits Foundation

Blue Coast Engineering

18320 47th Pl NE

Lake Forest Park, WA 98155

June 25, 2020

Table of Contents

List of Figures

List of Tables

List of Appendices

1 Introduction

1.1 Project Purpose

Blue Coast Engineering, LLC (Blue Coast) assisted Northwest Straits Foundation (NWSF) and Island County Marine Resources Committee (ICMRC) with a feasibility study to evaluate potential for armor and debris removal to restore nearshore processes at two sites on Whidbey Island. The two proposed project locations are both owned and maintained by Washington State Parks (Parks). One, Hoypus Point, is on the north end of Whidbey Island, east of Deception Pass. The other, Possession Point, is on the south end of Whidbey Island, near the Clinton Ferry Terminal (Figure 1).

The goal of the feasibility study was to select one of the two site locations to move forward into conceptual design. Site selection was based on the results of the feasibility evaluation, which included evaluation of ecological benefit, site constraints and construction cost for the proposed restoration work at each site. A conceptual design, including an engineer's opinion of construction cost, was developed for the preferred site.

This report summarizes the feasibility study, documents selection process for the preferred site location, and outlines the conceptual design for the preferred site.

1.2 Project Partners and Funding

In addition to NWSF and ICMRC, Washington State Parks and Washington Department of Natural Resources were collaborative partners during completion of this work.

This project has been funded in part by the Puget Sound Partnership, National Fish and Wildlife Foundation, Shell Oil Company, SeaWorld Parks & Entertainment, and the U.S. Fish and Wildlife Service.

The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government or the National Fish and Wildlife Foundation and its funding sources. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government, or the National Fish and Wildlife Foundation or its funding sources.

This project has also been funded in part by the United States Environmental Protection Agency under Assistance Agreement CE-01J65401. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

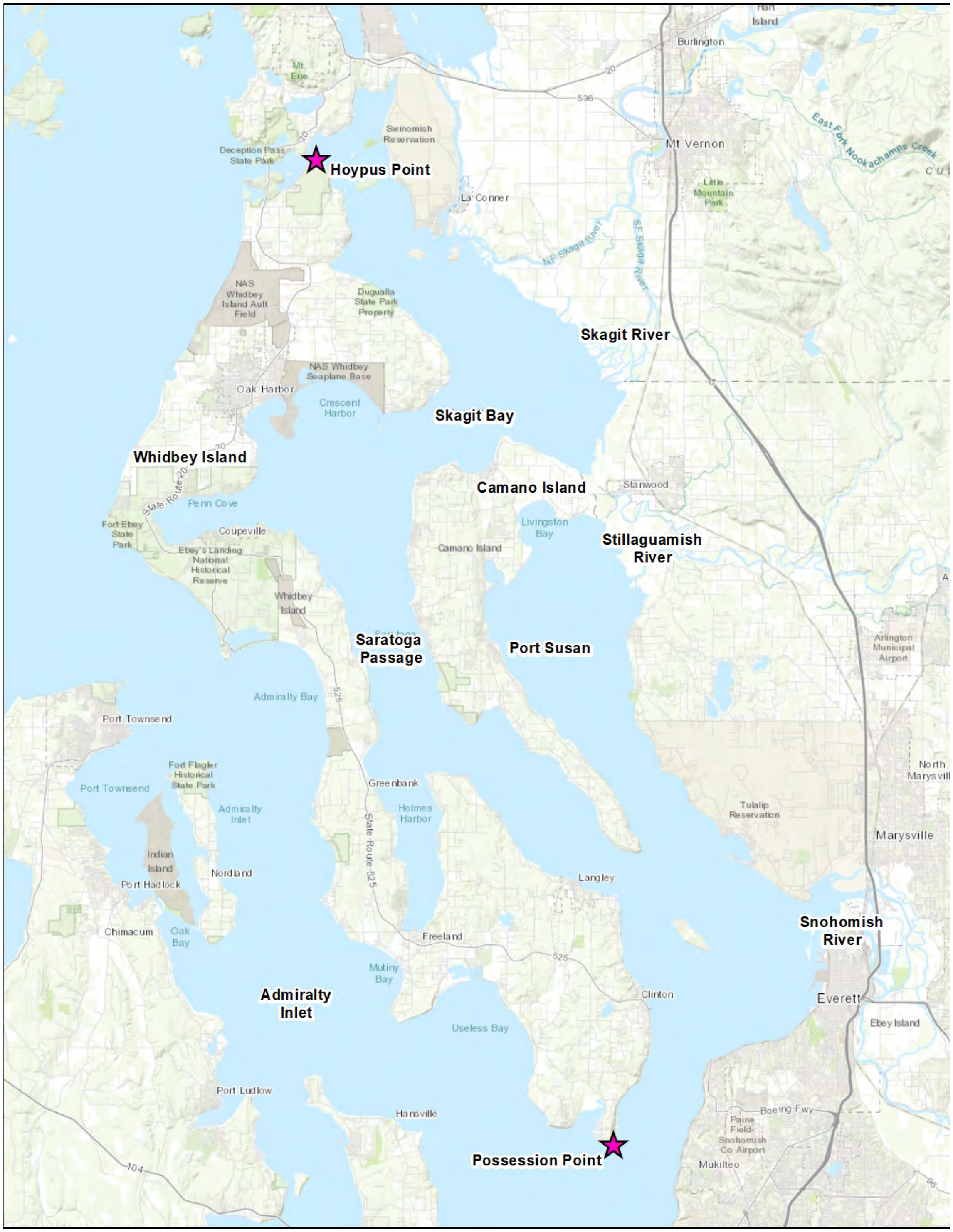


Figure 1. Overview map showing location of Possession Point and Hoypus Point.

2 Site Characterization

The following sections provide background information for the Hoypus Point and Possession Point project sites. This information provides the basis for evaluating the benefits and costs of shoreline restoration at both sites. Photos of the sites are provided in Appendix A and site maps summarizing conditions described in the below sections are presented in Appendix B.

2.1 Hoypus Point

2.1.1 Site Background and Current Use

Hoypus Point is the northeastern headland on Whidbey Island, east of Deception Pass (Figure 1). The point and project area are entirely within Deception Pass State Park. In the early 1900s the location was the southern terminus for a ferry that crossed Deception Pass to Yokeko Point on Fidalgo Island. Once the Deception Pass bridge was constructed in 1935 the ferry became obsolete, however some infrastructure from the ferry remains on site (see Section 2.1.4). Currently the site is the terminus of an approximately 1.0 mile road/trail that originates at Cornet Bay. Previous restoration work has been completed at Cornet Bay that includes riparian plantings and removal of shoreline armoring. Parks uses the road/trail to access a maintenance area that is located between Cornet Bay and Hoypus Point. The road/trail is accessible and is popular with visitors to Deception Pass State Park.

2.1.2 Infrastructure and Utilities

The site is accessed by a paved road/trail, with some amount of organic material covering the asphalt in most locations. The road/trail is gated at the entrance at Cornet Bay but is used by Parks Staff to access a maintenance yard approximately 0.75 miles to the east of the entrance. Past the maintenance area is a second gate. The road/trail is generally in good condition from the entrance to the maintenance yard. There is a small area (20 ft) past the maintenance yard that has slumped as shown in the photos in Figure A8, most likely due to surface water and groundwater observed onsite at the locations indicated in Figure B1. State Park staff utilize the road/trail and maintenance yard and will continue to require motorized access to that point. Vehicle access past the second gate is not required by Parks. The road/trail provides access to two other hiking trails that go up the slope from the shoreline. It also provides access and/or views of the shoreline in some locations. There are several benches along the road/trail leading to Hoypus Point and one bench at the flat upland area at the terminus of the road (Figure B1).

The project area is at the end of the access road/trail at a flat upland area created by fill and surrounded by armoring. This infrastructure at the site location is primarily remnants from the historic ferry operation. Remaining infrastructure includes a large abutment, pilings that have been cut off at grade, and a flat upland area that has been filled and surrounded with rock and concrete debris armoring. Armoring extends from the flat upland area to the west for approximately 350 ft (Figure B2). Photographs of the infrastructure are shown in Figures A3 through A5 and the location of this infrastructure is shown in Figure B2. The shoreline armoring is generally in poor condition. Sections of concrete debris armoring along the western extent of the armored slope are overturned towards the water. Fronting the flat upland area at the end of the road/trail, there is visible erosion behind the armoring due to a combination of wave overtopping and surface water runoff.

There is documentation for two fiber-optic cables that run along the south side of the road/trail, behind the flat upland area at the project site, then turn towards the water across the beach and are laid one on each side of the abutment (Figure B2). Documentation from the Washington State Department of Natural Resources indicates the lines were laid and buried approximately five ft below grade. Initial research into the ownership of the lines and easements or rights-of-way indicate that one line is owned by Frontier and one line is owned by Comcast. The project team was able to communicate with Frontier, who commented that there are no right-of-way or easements for the line. The State Parks staff and Island County also indicated there are no easements or rights-of-way for the property parcel. A survey by a qualified contractor to locate utilities with the limits of work (called a "utility locate") and further research into the requirements for the project to maintain sediment cover and/or protection for the lines should be part of the next phase of the project.

2.1.3 Geology

Geology at Hoypus Point was mapped by Washington Division of Geology and Earth Resources (Dragovich et al, 2000). The uplands are classified as Pleistocene continental glacial drift and this geologic unit contains sand and gravel with minor amounts of silt and silty sand. In addition, there are occasional outcrops of Vashon Till, which is a dense to very dense mixture of clay, silt, sand, and gravel. These geological units are very common on Puget Sound shorelines and result in the mixed sand and gravel beaches as observed at the project site.

The shoreline and beach immediately southwest of the project site is mapped as Vashon Stade silt and clay deposits which have thin to thick bedded clay, silt, and silty sand. This unit is a consolidated material that has a very low permeability and can result in surface water and groundwater flow being perched on top of these sediments. The presence of clay layers and perched groundwater can result in erosion of mixed sand and gravel from the beach surface. This was observed to the southwest of the Project Area at Hoypus Point, but not within the Project Area (Figure A7).

Most of upland surrounding Hoypus Point is mapped as steep slope; areas west and east of the project site are also identified as feeder bluffs (Figure B4).). A deep-seated landslide is documented to the southwest of the project site in the area shown as feeder bluff in Figure B4 and immediately to the east of the project site where there is a large sediment deposit in the nearshore. Deep seated slides tend to be slow moving and can cover large areas, but as such occur less frequently on the order of every 150 to 500 years as compared to shallow slides which are smaller, faster moving, and can occur annually. While there are no recent slides mapped within the project area, areas mapped as feeder bluffs tend to be susceptible to shallow slides. The feeder bluffs southwest of the project area are adjacent to the Park entrance road and would be potential areas of shallow slides which discharge sediment to the beach.

Determining erosion rates is difficult without precise measurements and long-term records (Shipman et al, 2014). It is possible to use aerial photography to estimate erosion, but this method has a low degree of accuracy, particularly at a location with steep slopes and extensive overhanging vegetation such as Hoypus Point. Extensive site observations between Cornet Bay and Hoypus Point indicate this shoreline has localized pockets of erosion and accretion which are driven by complex shoreline structure such as outcrops of Vashon Till, large volumes of shore perpendicular wood, and mass wasting deposits from deep-seated landslides. While there are intermittent erosion and accretion areas, the net potential for erosion is small and expected to be within the low erosion rate of less than 1 inch per year (Johannessen and MacLennan, 2007).

2.1.4 Coastal Processes

A detailed analysis of coastal processes at this location is provided in Appendix C. A summary of that evaluation is provided in this section.

Water Levels and Waves

Tidal elevations and extreme water levels (which include influence of storm surge) for Hoypus Point are provided in Table 2.1. Mean higher high water (MHHW) at the site is 10.5 ft MLLW and highest astronomical tide (HAT) is 11.9 ft MLLW. The Federal Emergency Management Agency (FEMA) 100-year flood elevation, based on a still water elevation, is 14.1 ft MLLW (FEM, 2017a) and increases to 17.6 ft MLLW when taking into account storm surge and wave-run up for the 100-year event (FEMA, 2017b).

Table 2-1. Summary of water level elevations at Hoypus Point[1].

Datum:	Elevation (ft MLLW)	Elevation (ft NAVD88)
Highest Astronomical Tide (HAT)	11.9	10.3
Mean Higher High Water (MHHW)	10.5	8.9
Mean High Water (MHW)	9.6	8.0
Mean Tide Level (MTL)	6.1	4.5
Mean Low Water (MLW)	2.6	1.0
Mean Lower Low Water (MLLW)	0.0	-1.6

Notes: AEP = annual exceedance probability; N/A = not available

[1] Datums for project site are calculated based on NOAA Vdatum online tool; extreme water levels at Hoypus Point are an approximation based on an extrapolation of the Seattle values.

Sea level rise for Hoypus Point based on a 50% exceedance probability ranges from 0.7 to 2.1 ft for the years 2050 through 2100 (Miller et al., 2018). Using the highest estimate for sea level rise in this range, the flat upland area would still be emergent at the highest expected tidal elevation (HAT plus SLR, 14 ft MLLW). However, the armored slope would be subject to more frequent overtopping by storm waves which would increase the deterioration of the armored slope which is already in a state of disrepair.

A wind-wave analysis was also completed for the site and indicates that storm wave heights at the site are expected to range from 1 to 1.5 ft for the 1-year and 100-year return period storm events, respectively. The small difference between the 1-year and 100-year event illustrates that the site's north-facing shoreline is completely sheltered from larger storm winds and resulting waves from southerly directions. The fetch distance to the north is also small for this site, which further reduces the potential for large storm wave heights at Hoypus Point.

Sediment Transport

The elevation of the flat upland area above the armor at the site is about 15 ft MLLW and the toe at the base of the armor out on the beach is around 8 to 9 ft MLLW. Therefore, water elevations during high tide reach the toe and face of the existing armored slope but do not overtop the armoring. The 100-year FEMA flood elevation (17.6 ft MLLW) would overtop all the shoreline armor and the existing flat upland area. However, the 100-year FEMA flood elevation is likely conservative at the project site location since FEMA did not estimate wave run-up specifically at Hoypus Point. As a comparison, Blue Coast estimated the 100-year extreme water level plus the run-up from the 100-year wind-wave to be 15.2 ft MLLW at Hoypus Point (see Appendix C). This would still overtop the flat upland area, but not by as much.

The uplands at Hoypus Point are characterized by forested steep slopes which are sources of sediment and large woody debris (LWD) to the adjacent beaches (Figures A2 and B4). There is also a mapped feeder bluff updrift and to the east of the project area. Littoral drift is generally from east to west in the vicinity of the project area. Sediment grain size distributions on the beach are medium to coarse sand with small amounts of gravel (Figure A3). To the southeast of the project site is a wide low-tide terrace consisting of fine-grained sediments. The wide low-tide terrace was formed by a deep-seated slide of the upland slope as described in section 2.1.3 which deposited a large volume of sediment along the shoreline.

The armored flat upland area at Hoypus Point protrudes out onto the beach relative to the adjacent shoreline (Figure B2). This results in a slight steepening of the shoreline in front of the area and a localized area of erosion at the eastern end of the armoring (Figure B2). The concrete abutment just offshore of the flat armored area has had minimal impact to sediment transport along the beach. Some sediment has accumulated directly landward of the abutment, but this impact is localized within 5 ft of the abutment and does not impact areas of the shoreline or intertidal beach farther away. Armoring at the toe of the slope to the west of the flat upland area acts as a barrier to upland discharge of sediment and supply of LWD to the adjacent beaches.

2.1.5 Habitat

The information provided in this report related to existing habitat conditions is based on available data and observations made during visits to the site. In general, the existing habitat at Hoypus Point is relatively natural in the surrounding upland and marine areas (Figure B3). The natural shoreline around the site consists of low and high bluffs that are actively supplying sediment and large woody debris onto the shoreline (Figures A1-A2). The uplands appear to have mostly native vegetation.

There are few salmon bearing streams in Island County due to the low topographic relief of Whidbey and Camano Islands and no salmon bearing streams along the same shoreline within the project vicinity (WDFW 2020, Figure B3). Across the channel on Fidalgo Island there is a stream flowing from Campbell Lake that supports salmonids. Although there may be little stream or river habitat for adult salmon in Island County, the area of Hoypus Point lies along a migration corridor for salmon that has been identified in the Water Resource Inventory Area (WRIA) 6 multi-species recovery plan as an area of high importance due to its proximity to the mouths of the Skagit and Stillaguamish Rivers and beach seining has documented fish use of the project area shoreline. Armoring, such as is present at the project site, affects fish feeding and behavior and armoring may drive juvenile salmon into deeper water where they are more likely to be preyed on by larger fish (Toft 2010, Toft et al 2007).Skagit River System Cooperative (SRSC) has been conducting beach seine sampling at Hoypus Point, just west of the abutment, between February and October since 1996. Data from this sampling through 2019 indicates that a wide diversity of fish species and age classes use this shoreline along Hoypus Point. Adult and post-larval surf smelt, sand lance, herring, and anchovy have all been sampled and identified during beach seining. In addition, all five species of anadromous salmon have been sampled, as well as cutthroat and rainbow trout (steelhead), and bull trout. The fish with the highest abundances between 1996 and 2019 were juvenile pink and chum salmon, as well as adult herring, smelt, and sand lance (Beamer, 2020).

Forage fish (surf smelt, sand lance, and herring) are documented spawning near the project site and restoration work at Cornet Bay has succeeded in detecting forage fish spawning post-restoration. The natural shoreline around the project area is ideal for forage fish spawning as it is a northern facing shoreline with overhanging vegetation which provides shade to any eggs that are deposited, increasing the chance for survival. Currently the toe of the shoreline armoring is below MHHW, at approximately 9.6 ft MLLW. Surf smelt spawn in the upper intertidal, from approximately 7 ft MLLW to extreme high water (EHW) in mixed sand and gravel substrate. Pacific sand lance can be found slightly lower in elevation from 5 ft MLLW to mean higher high water (MHHW) in finer substrate relative to surf smelt. Herring spawn on vegetation or other submerged structures and the depth at which they spawn is dependent on the water clarity and thus the depths at which vegetation can grow (Penttila 2007). There is the potential for spawning of all three of these species near the project site and spawning or suitable habitat has been identified in the vicinity (Figure B3).

LWD and wrack accumulation in the upper intertidal provides habitat for invertebrates that are prey for fish species. Along the beaches adjacent to the project area there is significant accumulation of LWD, but due to reflection of waves and the physical presence of the structure in an area that would be occupied by LWD and wrack there is no accumulation of this material at the project site. The marine riparian vegetation at the project area is generally native vegetation that is providing shade and habitat for terrestrial insects that act as prey for juvenile salmon. The flat upland area that is part of the project site is without vegetative cover.

Submerged aquatic vegetation (SAV) is a habitat of special concern as it provides habitat for a variety of fish and shellfish species including spawning grounds for Pacific herring, out-migrating corridors for juvenile salmon and important feeding and foraging habitats for waterfowl (WAC 220-660-320). There is an extensive mudflat to the east of the project area that may support eelgrass beds (*Zostera sp*) and small patches were observed during a low tide site visit in this area and in some sandy/silty areas between Cornet Bay and the project site. Farther to the east is a kelp bed that is monitored regularly by the ICMRC. In Cornet Bay, to the west of the project site, there is additional kelp and eelgrass monitored by ICMRC.

2.2 Possession Point

2.2.1 Site Background and Current Use

Possession Point State Park is on the south end of Whidbey Island at the bottom of a natural ravine (Figure 1). Historical t-sheets show this was a drainage basin with an intermittent stream and steep bluffs to the south Figures A11-A12, B5). There is still surface water in the ravine, although it is piped once it reaches the park access road. The bluffs south of the project site have not been modified and are mapped as feeder bluff exceptional (2017, Johannessen et al). Parks took ownership of the property in 2001. The property has 25 acres and 2500 ft of shoreline. There is a house on the property that was built in 1941 and is currently inhabited by Parks staff. The property is utilized by the public for day use but does allow for overnight camping as part of the Cascadia Marine Trail. Parks currently plans to continue maintaining and inhabiting the house, as it provides security at the park after hours, but given the age and location of the house there may be a time in the future where the cost for maintenance outweighs the usefulness of the house.

2.2.2 Infrastructure and Utilities

The property has been occupied for approximately 80 years and there is significant infrastructure on the property (Figure B6). A residence is located on the property at an elevation of around 25 ft MLLW with a shed located a bit farther upland near elevation 35 ft MLLW. A relatively steep access road runs from the upland parking area for the Park down through a ravine to the residence. The residence and shed are currently being used by Parks and, at this time, cannot be removed from the Park.

Another significant infrastructure component is the septic system. This system was upgraded in 2007 (Figures A13, B6-B7). As the site is located at the bottom of a ravine there is limited flat space for the house and infrastructure, the septic system is currently situated in one of the few permittable configurations, maintaining the appropriate buffer distances between the potable water well (100 ft) and shoreline (50 ft) (ICC 8.07D.120).

There is also significant stormwater infrastructure on the site. During a site visit there were two small ephemeral streams observed along the road leading to the site. These streams as well as other stormwater infrastructure appear to be piped and there is a manhole to access this infrastructure near the shed on the property (Figure B6).

Between 2011 and 2012 a shoreline armoring replacement project was completed by PND Engineers (Figure B7). The project removed a deteriorating 430-foot creosote timber pile bulkhead and concrete boat ramp and stairs. The bulkhead was replaced with a 480-foot-long buried rock revetment, located slightly landward from the previous shoreline structure. Armor rocks that were placed were covered with a geotextile, which is now exposed, mainly on the northern side of the property. During the project, a 160-foot section of 6-inch diameter stormwater pipe was replaced with 12-inch diameter high-density polyethylene (HDPE) pipe and buried 24 inches. A stormwater energy dissipater was also installed in the southern end of the rock revetment, landward of MHHW as described in the Shoreline Substantial Development Permit for the project (see Figure B7). An energy dissipater is a section of pipe with holes that allow water flow to spread over a larger area, reducing the chance for scour. This structure is still likely functioning as designed as there are no distinct areas of erosion coming from the buried revetment that appear to be caused by stormwater flow.

2.2.3 Geology

Geology at Possession Point was mapped by Washington Division of Geology and Earth Resources (Dragovich et al, 2000). The uplands are classified as Quaternary alluvium and this unit contains a mix of clay, silt, sand, gravel, and cobble. In addition, there are occasional outcrops of organic materials including peat, muck, and diatomite. The shoreline directly seaward of the residence at the park property is a low bank which increases in elevation to the north and south of the site.

The organic deposits are characteristic of historic wetlands which existed at this site prior to development. During the site visit, surface water was observed flowing from the uplands down the ravine towards the project site but was being captured in ditches and pipes. The presence of the small streams and surface water further supports the historical presence of wetlands and could support the restoration of wetlands in the future.

Most of the upland surrounding Possession Point is mapped as steep slope (Figure B9). In addition, the shorelines around the project area are backed by feeder bluffs which discharge mixed sand and gravel sediments which feed the beaches at the project site.

2.2.4 Coastal Processes

A detailed analysis of coastal processes at Possession Point is provided in Appendix C. A summary of that evaluation is provided in this section.

Water Levels and Waves

Tidal elevations and extreme water levels (which include influence of storm surge) for Possession Point are provided in Table 2-2. Mean higher high water (MHHW) at the site is 10.9 ft MLLW and highest astronomical tide (HAT) is 12.5 ft MLLW. The Federal Emergency Management Agency (FEMA) 100-year flood elevation, based on a still water elevation, is 14.4 ft MLLW (FEMA, 2017a) and increases to 16 ft MLLW when taking into account storm surge and wave-run up for the 100-year event (FEMA, 2017c) (Figure B6). Higher 100-year flood elevations up to 20 ft MLLW are predicted south of the project site location by FEMA due to the exposed southerly fetch for those shorelines.

Blue Coast estimated the 100-year extreme water level plus the run-up from the 100-year wind-wave to be 16.3 ft MLLW at Possession Point (see Appendix C). Therefore, the 100-year elevation of 16 ft MLLW predicted for the north side of the site by FEMA is most representative of the project site.

Table 2-2. Summary of water level elevations at Possession Point[1].

Datum:	Elevation (ft MLLW)	Elevation (ft NAVD88)
Highest Astronomical Tide (HAT)	12.5	10.6
Mean Higher High Water (MHHW)	10.9	8.9
Mean High Water (MHW)	10.0	8.0
Mean Tide Level (MTL)	6.4	4.4
Mean Low Water (MLW)	2.8	0.8
Mean Lower Low Water (MLLW)	0.0	-2.0

Notes: AEP = annual exceedance probability; N/A = not available

[1] Datums for project site are calculated based on NOAA Vdatum online tool; extreme water levels at Hoypus Point are an approximation based on an extrapolation of the Seattle values.

Sea level rise for Possession Point based on a 50% exceedance probability ranges from 0.7 to 2.2 ft for the years 2050 through 2100 (Miller et al., 2018). Using the highest estimate for sea level rise in this range, the top of the bank at approximately 16 ft MLLW would still be emergent at the highest expected tidal elevation (HAT plus SLR, 14 ft MLLW). However, the exposed structure and the face of the low bank would be subject to more frequent inundation by storm waves which would increase the rate of erosion and risk for exposure of the revetment compared to existing conditions.

A wind-wave analysis was also completed for the site and indicates that storm wave heights at the site are expected to range from 2 to 3 ft for the 1-year and 100-year return period storm events respectively, from the northeast. Storm waves are larger from the southwest, ranging from about 2.5 to 4.5 ft for the 1-year and 100-year storms, respectively.

Sediment Transport

The shoreline is characterized by a low bank comprised of erodible silts, sands and gravels about 4 ft in height (on average) that ranges from an elevation of 12 ft MLLW at the toe to about 16 ft MLLW at the crest (Figure A10). The grassy upland area where the house is located slopes up from about 16 ft MLLW at the top of the bank to 30 ft MLLW near the entrance road. Mean higher high water is waterward of the base of the low bank, but highest astronomical tide inundates the base of the low bank. Runup from storm waves inundates the base of the low bank at lower tide levels depending on wave conditions. The low bank is currently eroding and there is a scarp (vertical cut) with the most significant erosion occurring along the northern shoreline at the project site. This erosion will continue and will eventually expose the buried rock revetment and geotextile that was constructed in front of the septic system and the house as part of a previous project (Figure B7It is expected that some erosion will continue, the geotextile will degrade, and rock from the revetment will become dislodged and fall onto the beach. However, the revetment is approximately 3 to 4 ft thick and enough stone should remain in place to maintain the upland slope. The shoreline condition may become unattractive, but even a somewhat degraded revetment should continue to protect the septic system and house from failure for the foreseeable future. Sea level rise will increase the current rate of erosion over time.

Farther upland from the site is a natural drainage that is heavily forested and steeply sloped (Figures A14 and A15). No visual outflow from the bank at the location where the piped creek flow terminates (see Section 2.2.2) was seen by Blue Coast during a site visit even though there was flow in the creek and pipe. The creek was most likely a sediment source to the project location historically and the site appears to be built up on the historic creek delta. In its current configuration, the creek does not provide any sediment to the nearshore area at the project site.

Sediment grain size distributions on the beach are medium to coarse sand and gravel with areas of cobble. To the south of the project site, the sediment becomes largely cobble and gravels due to exposure of that shoreline to larger storm waves from the southwest. Littoral drift is from the south to the north (Figure B9) and there are mapped feeder bluffs both updrift and downdrift of the project area. Therefore, there is an ongoing sediment supply available to the project area shoreline both from updrift feeder bluffs and from the eroding scarp along the project shoreline.

2.2.5 Habitat

The information provided in this report related to existing habitat conditions is based on available data and observations made during a visit to the site. Possession Point is developed, mostly by single-family residences, both at the project site and in the surrounding areas. The habitat consists of a nearshore that may provide forage fish spawning and salmon migration corridors and there is a freshwater wetland/riparian corridor. Historically to the north of the project area, where single-family residences are now located, there was an extensive salt marsh (Figures A8 and B5).

Along the east shoreline, to the north of the project site is Glendale Creek, one of the few creeks suitable for adult salmon in Island County (Figure B8). This creek is the site of a previous restoration project that re-established a fish passable connection between Puget Sound and the creek. Around Possession Point, to the west is Cultus Creek, which may also support adult salmon but is currently blocked for passage due to a tide gate. Smelt spawning has been identified along the shorelines to the north and west of the project area. Possession Point and Glendale Creek have nearby eelgrass beds that have been monitored by ICMRC. Just off the project site and extending to the southwest is a kelp bed that has been documented since the early 1800s (Figures B5 and B8). This kelp bed is monitored by ICMRC. The riparian vegetation along the ravine is mainly native, but some common invasive species, such as Himalayan blackberry were noted during the site visit. Marine riparian vegetation has been mostly removed at the site and was converted to manicured lawn.

3 Alternatives Analysis

3.1 Screening Level Analysis

Blue Coast developed evaluation criteria to analyze the potential for shoreline armor removal and nearshore processes restoration at both project sites and to inform selection of the preferred site/alternative. A screening analysis for both sites based on these evaluation criteria was completed following site characterization. A summary of the evaluation criteria, proposed armor removal, and the screening analysis for both sites is provided in Table 3-1.

Table 3-1. Summary of screening analysis for proposed armor removal at both sites based on evaluation criteria

Evaluation Criteria	Hoypus Point: Remove shoreline armor and artificial fill placed in the nearshore area, remove the concrete abutment	Possession Point: Remove buried shoreline armor and/or regrade shoreline waterward of armor and plant riparian buffer at the top of the shoreline
Ability to fully reestablish coastal processes and littoral drift so the restored sites are self-sustaining and require little to no maintenance	Removal of 350 linear ft of shoreline armor and nearshore fill will fully restore coastal processes at the site and within the entire drift cell, which extends from 2,500 ft east of the site to Cornet Bay (to the west of the site). There are no constraints which limit the removal of the shoreline armor and fill. Removal of the concrete abutment would have minimal impact to restoration of coastal processes and may cause more damage to the beach during removal than its current impact to the shoreline.	The armored slope at Possession Point has been constructed back into the upland and is not currently exposed along much of the project shoreline. The more natural shoreline waterward of the armor is actively eroding due to wave action and has formed a vertical scarp exposing some of the armored slope at the northern portion of the site. The house and septic system located just landward of the armored slope are currently being used by Parks and cannot be removed from the site. If the armor were removed, shoreline erosion would continue and threaten both the septic field/system and the house. Due to ongoing shoreline erosion, there is little natural shoreline material left waterward of the buried armored slope. These constraints limit opportunities for armor removal at this site at this time.
Connectivity of the sites to intact riparian corridors with high potential for remaining intact in the future	The upland riparian corridor at the project site and within the drift cell is intact, other than where the armor/fill are located at Hoypus Point. Restoration at this site would fully connect the nearshore to the uplands, which are a source of sediment and large woody material to the nearshore.	The upland area adjacent to the shoreline at the site is a grassy lawn with little to no riparian vegetation. Riparian vegetation could be planted along the top of shoreline to develop an upland riparian corridor for the existing natural shoreline (where armor is not exposed). However, the shoreline is actively eroding, and it is likely that the plantings will not survive as the shoreline erodes and moves landward towards the buried armor slope.
Ecological benefits and ability to meet the objectives of the WRIA6 Multi-Species Salmon Recovery Plan	Removal of fill and shoreline armoring would create a contiguous intact shoreline habitat from approximately Ala Spit to Cornet Bay. This project is within the highest priority area for restoration due to the proximity to three major salmon rivers (Skagit, Stillaguamish, and Snohomish). The specific area was ranked high for salmon restoration and moderate for forage fish restoration. Beach seine data collected at the site since 1996 indicates that all species of anadromous salmon, bull trout, and four species of forage fish (herring, surf smelt, pacific sand lance, and anchovy) are using the shoreline in front of the armoring. Restoration should improve habitat by increasing spawning substrate availability for forage fish and improving connectivity between the Puget Sound and marine riparian vegetation.	Removal of fill and shoreline armoring, if feasible, may improve sediment transport along the shoreline from feeder bluffs south of the site to private properties north of the site. It would also reduce debris that is currently entering the water from the failing structure. Removal or decommission of the septic system should improve water quality in the project vicinity. Removal of stormwater piping and modifications to allow natural stormwater treatment of runoff into the ravine could also greatly improve water quality. If shoreline vegetation were established, it would improve shading and invertebrate prey to the nearshore. The toe of the existing structure near or above forage fish spawning elevation and removal would not likely increase spawning. This project is within the second highest priority area for restoration as it is not as close to major rivers but is a divergence point for salmon coming from south Puget Sound. This site is also near one of the few salmon bearing streams in Island County and near a second that would likely have salmonids after restoration of tidal influence. The specific area was ranked high for salmon restoration and moderate for forage fish restoration.
Ability to maintain, enhance, or increase recreational use at the State Parks	The existing road/trail from the Park maintenance yard to Hoypus Point will be maintained as an ADA access trail to Hoypus Point (as it is currently). Asphalt on the roadway within the extent of shoreline armor (about 350 linear ft) will be removed and replaced with trail substrate and the trail will terminate at upper elevations on the beach. This will provide a more natural experience for park and trail users. If funding allows asphalt may be removed between the project site and the maintenance yard. Between the maintenance yard and Cornet Bay the road/trail needs to be maintained for vehicle traffic.	Because the existing infrastructure at the park needs to be maintained, recreational use of the Park would be maintained but would not be significantly enhanced.
Project complexity in terms of permitting and constructability	There is no infrastructure at Hoypus Point that needs to be maintained or used following restoration, and one utility (fiber optic cable) which is outside the limits of work required to restore the site. There is an access road/trail to the project location that can be used to access the site during construction. Permitting should be relatively straightforward.	There is significant infrastructure on site that would need to be removed to fully restore coastal processes and littoral drift. However, the house and septic system on the site are currently being used by Parks and cannot be removed at this time. This significantly limits the current opportunity for armor removal and nearshore restoration at the site as well as permitting given location of septic system.
Project costs and potential for grant funding in the near term	Construction costs for the proposed restoration are in the low to medium range for similar projects and the project has good potential for grant funding in the near term because proposed actions fully restore coastal processes and ecological function to the site and drift cell.	Costs to remove existing infrastructure, including the house, septic system and drain field, and stormwater system are high. In addition, this infrastructure is currently being used by Parks and cannot be removed at this time.
Resilience to Sea Level Rise (SLR) and Climate Change	The existing armored slope is being eroded upland of the crest of the structure due to wave attack. As sea levels rise, the rate of erosion and subsequent damage to the armor slope will increase. Restoration of a natural beach and toe of slope will allow the site to naturally adapt to increases in sea levels while maintaining nearshore habitat.	The rate of erosion of the shoreline, and exposure of the buried rock revetment, will increase from current rates as sea levels rise. The combination of storm events and higher sea levels may cause wave overtopping of and crest erosion along the top of the buried armor slope once it has been fully exposed. Removal of the existing armor slope and creation of a more natural mildly sloping shoreline at the project site would result in a more sustainable nearshore planform as sea level rise. However, armor removal and regrading of the shoreline would require removal of the septic system, stormwater system, and residence on the project site (see above).

3.2 Selection of Preferred Project Site

Based on the results of the screening level analysis and discussion with project partners, Hoypus Point was selected as the site to move forward into Conceptual Design (see Section 4).

This decision was based primarily on the need to maintain infrastructure at Possession Point (i.e. house, septic field) which severely limited opportunities for armor removal along the shoreline. Discussions were held with project partners about the potential to do a smaller project at this site, such as shoreline plantings. During the previous armoring project plantings were incorporated and had low survival. Based on the extent of fill and the inability to plant within the septic drain field, it was determined through discussions with project proponents that the habitat benefit of these limited actions was not in-line with the cost of design, permitting and construction.

3.3 Additional Restoration Opportunities at Possession Point

Based on the site characterization work at Possession Point and through discussions with project partners, the elements of a larger restoration effort at Possession Point is summarized below that could occur once the house on site is no longer in use. The shoreline at Possession Point is part of a historic creek delta that was developed as sediment was transported from upland areas to the nearshore by creek flows. The natural delta was likely built up with additional artificial fill when the house and other infrastructure on the site were constructed. The creek still exists on the site, coming down two ravines west of the access road, but has been routed into a pipe upland near the parking area for the Park (Figures A14 and A15). The creek remains underground in a pipe until it drains into the buried rock revetment located along the shoreline (Figure B7). The creek appears to be intermittent and based on current site elevations would have little tidal influence, thus may not act as a refuge for juvenile salmon, but restoration would have other ecological benefits.

A larger restoration opportunity at Possession Point could restore the natural flow of the creek in the ravine and re-connect the daylighted creek to its historic delta and to the nearshore. This would require removal of the house, shed, septic system and stormwater system at the site. However, the habitat benefits would extend beyond the nearshore environment to include the entire lower creek system and its floodplain. Daylighting the creek would allow water to filter through upland and wetland vegetation. This combined with the removal of the septic system could have significant impacts on the quality of water being discharged to Puget Sound. Daylighting the creek could also increase the capacity of the drainage and provide resiliency for predicted climate change (i.e. increased rainfall intensity). Removal of the infrastructure at the site would allow for plantings that would extend the upland/wetland habitat mosaic in the drainage, benefiting upland animal species. Shoreline vegetation would add shading that benefits survival of forage fish eggs. Vegetation also provides a source of terrestrial invertebrates for juvenile salmonids, which are identified as a key prey species. These site improvements would create a more natural site experience for park visitors.

In the future, when the house and other infrastructure on the project site can be removed from the Park, this larger restoration effort should be considered.

4 Conceptual Design at Hoypus Point

Blue Coast developed a conceptual (10%) design for restoration at Hoypus Point based on results of the site characterization (Section 2) and alternatives analysis (Section 3). Appendix D provides figures showing the existing conditions base map and conceptual design figure (plan and profile view) for the Hoypus Point site. The following sections summarize each of the proposed project elements, constructability considerations and engineer's opinion of construction cost.

4.1 Project Elements

Specific project elements included in the conceptual restoration design for Hoypus Point are summarized in Table 4-1. Plan and profile view of the design is provided in Appendix D.

Table 4-1: Summary of Conceptual Restoration Design at Hoypus Point

Project Element:	Description:
Clearing	Removal of small trees, as needed, to allow excavator to reach and remove armor along the shoreline. Trimming of larger trees and other vegetation along the road/trail to accommodate access to the site by construction equipment. Relocation of the memorial bench currently located at the flat upland area of the site. The bench may be placed father west along the trail; final location to be determined during later phases of design.
Shoreline Armor Removal	Remove 350 linear ft of shoreline armor. Viable armor rocks will be stockpiled in Park's maintenance yard located about 0.25 miles west of the project site. Concrete debris will be taken off site and recycled (if possible). An estimated 720 cubic yards of armor and concrete debris material will be removed from the shoreline.
Nearshore Fill Removal	Fill placed in the nearshore to build up the flat upland area previously used as the ferry terminal landing will be excavated and disposed of off-site. Non-native material will be excavated down to grades shown in the profile view in Appendix D at an approximate slope of 7H:1V. Approximately 100 cubic yards of fill are expected to be removed from the site.
Placement of Appropriate Beach Substrate	Appropriately sized beach substrate material will be imported to the site and placed over the area where nearshore fill was removed to augment natural sediment supply to the area while the system adjusts post-restoration. This material is assumed to be a 1.5-inch minus washed material comprised of sands and gravels; approximately 50 cubic yards will be placed
Remove asphalt on road/trail and replace with trail gravel substrate	Asphalt will be removed from access road/trail within the extent of shoreline armor removal and depending on funding sources may be removed to the maintenance yard. Trail gravel substrate will be imported to the site and placed on the road/trail where asphalt is removed. Asphalt will be disposed of off-site.
Planting	Cleared areas will be planted according to permitting requirements and Parks requirements.

Removal of the concrete abutment was considered and is included as a separate line item in the cost estimate provided in Section 4.3 for completeness. However, based on the results of the site characterization and discussions with project partners, removal of the concrete abutment will likely not be included in the final design for restoration at Hoypus Point. This is because the abutment does not significantly impact nearshore processes at the project site, would be expensive to remove, would require in-water work and likely dredging to remove the entire base of the abutment depending on embedment depth (which is unknown).

4.2 Permitting Considerations

Federal and state permits/approvals will be required for any selected alternative. It is assumed that the local jurisdiction will be the County as the project is outside of city limits. Table 4-2 summarizes permits that may be required. This list can be refined once the project moves to 30% design and a pre-application meeting is held with agency representatives.

Table 4-2. List of potential permits required for restoration at Hoypus Point.

Permit/Approval	Agency	Trigger
Section 10 Compliance	U.S.Army Corps of Engineers (USACE)	Work in navigable waters of the US
Section 404 Compliance	U.S.Army Corps of Engineers (USACE)	Discharge of dredge or fill material
Hydraulic Project Approval	Washington Department of Fish and Wildlife (WDFW)	Work in/near water
Section 7 Compliance	National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service	Work that may affect threatened or endangered species
Aquatic Use Authorization	Washington State Department of Natural Resources (DNR)	Work on DNR owned lands
Construction Stormwater General Permit	Washington Department of Ecology (Ecology)	Ground disturbance greater than 1 acre
Section 401 Compliance	Washington Department of Ecology (Ecology)	Work in/near water
Section 106 Compliance	Washington State Department of Archaeology and Historic Preservation	Potential to affect historic properties or archaeological sites
Shoreline permit	Island County	Work within shoreline jurisdiction
Building permit	Island County	Use of bioengineering techniques
SEPA Determination	Island County / Washington Department of Ecology (Ecology)	Any proposal which involves a government “action” as defined by WAC 197-11-704
Critical Areas Compliance	Island County	Project occurring within/near a designated critical area

4.3 Constructability Considerations

Hoypus Point is accessible by an approximately 0.75-mile-long maintained access road/trail from the parking lot at Cornet Bay to the Park’s maintenance yard to the east. The road/trail is paved and should be wide enough to be used for access during construction. From the maintenance yard east to the project site (about 0.25 mile), the access road/trail is not maintained and there is an approximate 20 ft section that is damaged limiting the width of the road/trail to about 5 to 8 ft in that area. Other than the damaged section, the road/trail is paved and appears to be in good condition. If improvements were made to the damaged section, the roadway could be used for access during construction from the maintenance yard all the way to the project site. It is possible to access the site from the water by barge. However, because there is an access road/trail to the site that is in relatively serviceable condition, it is unlikely that accessing the site from the water would be less expensive than from land even with required roadway improvements.

The flat upland area at Hoypus Point, access road/trail and maintenance yard could be used for staging of materials and equipment during construction.

To allow for construction equipment to reach and remove shoreline armor materials while operating from upland or from the water side, trees and other vegetation along the shoreline will need to be removed. The extent of removal will depend on the means and methods selected by the contractor during construction. Design documents should be prepared to limit, to the extent possible, removal of mature trees along the shoreline. Smaller native vegetation currently growing along the shoreline could be removed, stored, and replanted after restoration.

Construction equipment may need to operate along the beach to effectively reach and remove shoreline armoring. Design documents should be prepared to protect nearshore habitat during equipment operation on the beach (if required) and to require the contractor to restore impacted areas on the beach following construction activities.

The fiber optic cable that runs along the upland side of the access road/trail, around the flat armored area and under the beach and out into the water will need to be protected in place during construction. This may require use of steel plates or similar options on the beach when running construction equipment over or near the buried cable.

The concrete abutment is located at an elevation of approximately 0 MLLW. The embedment depth of the abutment below grade is not known and could be significant. Removal of abutment will require significant in-water work that would add complexity to the permitting process for the proposed restoration alternative.

4.4 Engineer's Opinion of Construction Cost

An engineer's opinion of construction cost for the proposed conceptual design was developed by Blue Coast and is provided in Appendix E. The engineer's opinion of construction cost was developed using the following assumptions:

- The current access road/trail to the site is used for all construction access and staging. No barge or waterside access will be required. Lump sum cost for roadway improvements for site access assumes that the improvements will be permanent (i.e. not removed during demobilization).
- Unit prices of some materials were increased because the required quantity of these materials is small. It can increase the unit price of a material if a relatively small quantity is required compared to typical construction projects.
- Cost for plantings assumes that significant planting may be required due to tree removal during site preparation. These costs could be significantly reduced through the use of volunteers to install and maintain the vegetation.

- Beach substrate will only be placed where material is being excavated from the nearshore; the flat upland area at the end of the road/trail and to fill the depression in the beach if the abutment is removed.
- Asphalt is removed and replaced with ADA appropriate trail gravel substrate along the length of road/trail where armor will be removed only. Asphalt removal and placement of ADA trail substrate could also be completed between the project area and maintenance yard, but funding for this work may need to come from a different funding source. The two asphalt removal areas are shown in the cost estimate as separate line items.
- Viable armor rock removed from the slope can be stockpiled in the Parks maintenance area. Concrete debris and excavated soils will be recycled and disposed of offsite, respectively.
- Mobilization has been increased to 20% (from the more typical 10%) due to the relatively low cost estimated for construction of the project and the remote site location (one-way access road/trail to the site).
- Design and construction contingency have been set at 20% to consider uncertainties in the design at the current phase of the project (conceptual or 10% design).
- Sales tax rate is assumed to be 8.7% for the project site location

The estimated cost is about $288,000 including the cost to remove the concrete abutment. If the abutment is left in place, the estimated cost lowers to about $190,000. These costs do not include cost for final design and permitting for the project.

5 References

Beamer, Eric. 2020. Personal Communication via email with Traci Sanderson, May 7, 2020.

Dragovich, J.D. Petro, Troost, M.L., Norman, D.K., Anderson, G., Cass, J., Gilbertson, L.A., McKay Jr., D.T. 2000. Geologic Map of the Anacortes South and La Conner, 7.5-minute Quadrangles, Skagit and Island Counties, Washington. WA Division of Geology and Earth Resources Geologic Map. OFR 2000-6

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM). 2017a. Island County, Washington and Incorporated Areas, Panel 65 of 500, Map Number 53029C0065F, Effective Date March 7, 2017.

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM). 2017b. Island County, Washington and Incorporated Areas, Panel 445 of 500, Map Number 53029C0445F, Effective Date March 7, 2017.

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM). 2017c. Island County, Washington and Incorporated Areas, Panel 445 of 500, Map Number 53029C0445F, Effective Date March 7, 2017.

Johannessen, J. and A. MacLennan. 2007. Beaches and Bluffs of Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-04. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Johannessen, J, et al. 2017. Beaches Strategies. Estuary and Salmon Restoration Learning Program Project #14-2308.

Penttila, D. 2007. Marine Forage Fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, U.W. Army Corps of Engineers, Seattle, Washington.

Shipman, H., MacLennan, A., and Johannessen, J. 2014. Puget Sound Feeder Bluffs: Coastal Erosion as a Sediment Source and its Implications for Shoreline Management. Shorelands and Environmental Assistance Program, Washington Department of Ecology, Olympia, WA. Publication #14-06-016.

South Whidbey State Park, 2017. Useless Bay Tidelands and Possession Point State Park Property - Land Classification and Management Planning (CAMP) Effort - Requested Action https://parks.state.wa.us/DocumentCenter/View/9149/01-Item-E-2-South-Whidbey-State-Park-Useless-Bay-Tidelands-and-Posession-Point-State-Park-CAMP-PDF

2020. Island County Municipal Code (ICMC), 2020. Accessed May 4, 2020. https://library.municode.com/wa/ island_county/

Washington Department of Fish and Wildlife (WDFW). 2019. SalmonScape. https://apps.wdfw.wa.gov/salmonscape/map.html

Water Resources Inventory Area 6 (Whidbey and Camano Islands), 2006. Multi-species Salmon Recovery Plan.

Washington Administrative Code (WAC). Title 220, Department of Fish and Wildlife and Title 197, Department of Ecology

Toft et al. 2007. Fish Distribution, Abundance, and Behavior Along City Shoreline Types in Puget Sound. North American Journal of Fisheries Management (27) p. 465-480.

Toft 2010 in Shipman, H., Dethier, M.N., Gelfenbaum, G., Fresh, K.L., and Dinicola, R.S., eds., 2010, Puget Sound Shorelines and the Impacts of Armoring—Proceedings of a State of the Science Workshop, May 2009: U.S. Geological Survey Scientific Investigations Report 2010-5254, p. 155-160

APPENDIX A

Site Photographs

Hoypus Point

Figure A-1. Looking east along the shoreline between Cornet Bay and Hoypus Point.

Figure A-2. Accumulation of large woody debris, west of Hoypus Point.

Figure A-3. Looking east from the start of armoring, abutment is visible on left.

Figure A-4. Example of armoring along the shoreline.

Figure A-5. Looking west towards the large flat area and along amoring.

Figure A-6. Grassy area along road, west of terminus of armoring.

Figure A-7. Clay sediments on the beach between Hoypus Point and Cornet Bay.

Figure A-8. The road/trail, person farthest back is alongside the slump on the trail.

Figure A-8. Looking north towards private properties.

Figure A-9. Looking south at erosion and exposed geotextiles.

Figure A-10. Looking at the house on the property from the shoreline.

Figure A-11. Bluffs south of the project area.

Figure A-12. Bluffs south of the project area.

Figure A-13. Looking towards the house and water across the septic field.

Figure A-14. Photo of southern upland drainage, the circle indicates the position of the same stormwater grate.

Figure A-15. Photo of northern upland drainage, looking upstream. Water is flowing in a ditch west side of the access road.

APPENDIX B

Site Characterization Maps (Figures)

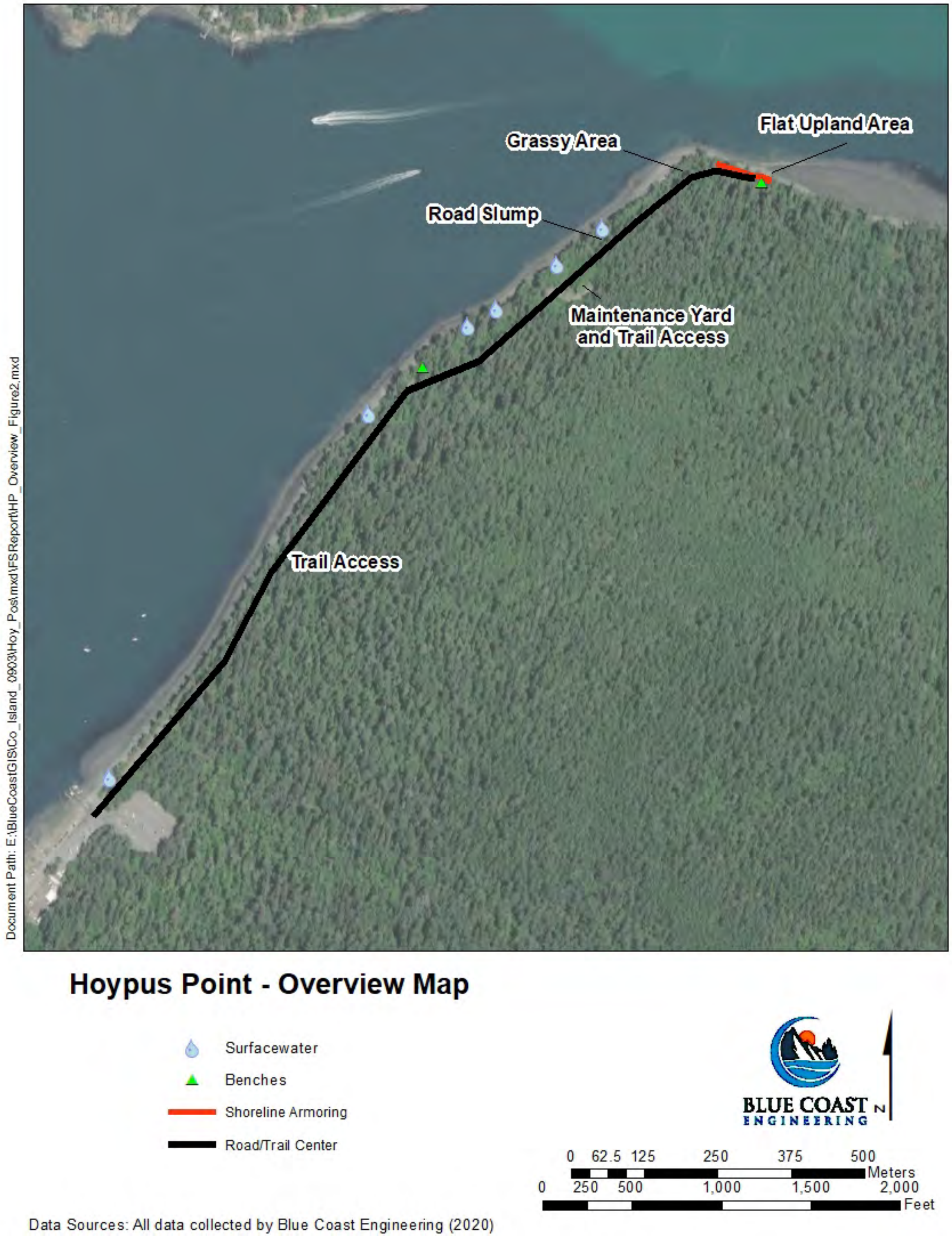


Figure B-1. Overview map of Hoypus Point project area from Cornet Bay to project area.

Hoypus Point

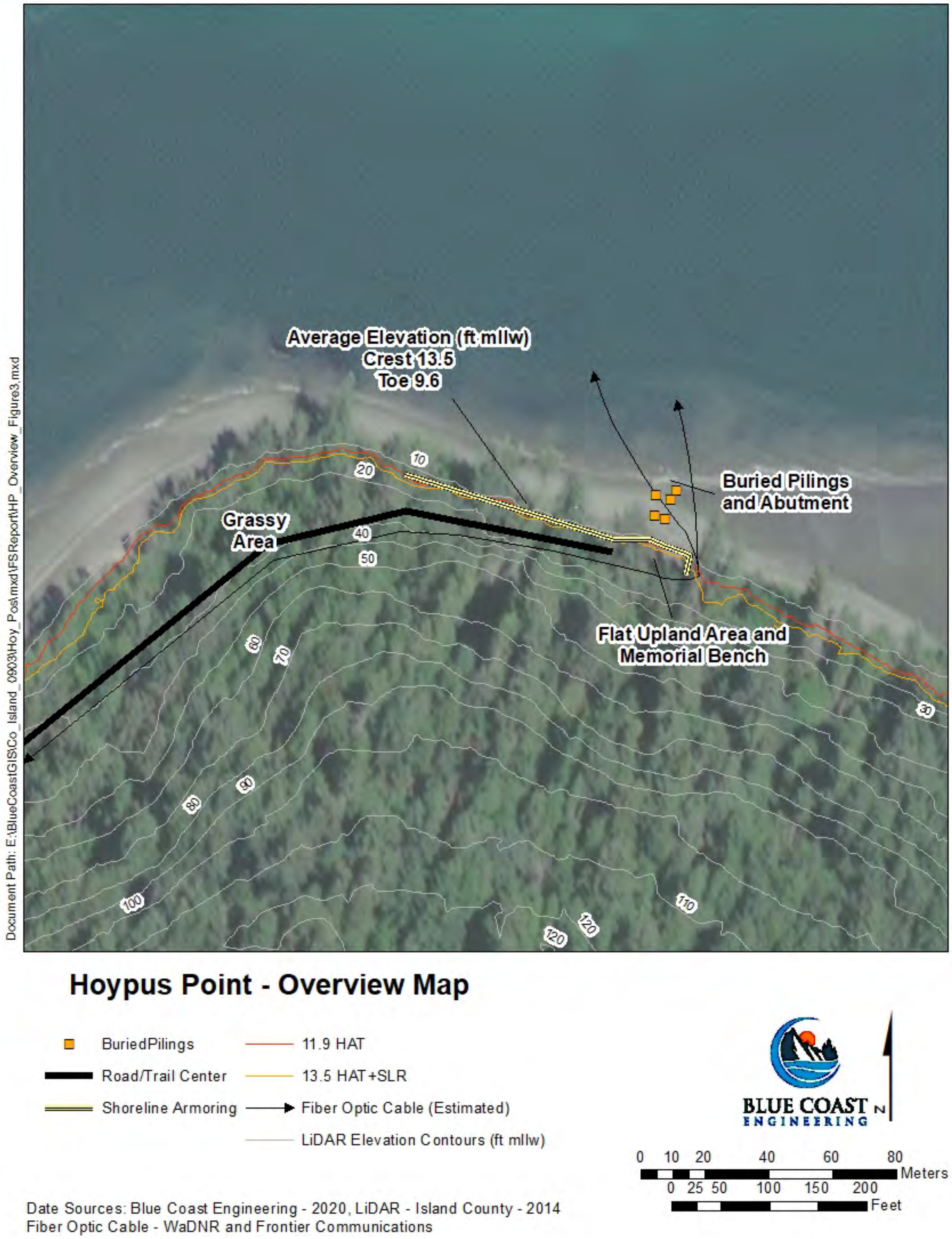


Figure B-2. Overview map of Hoypus Point project area.

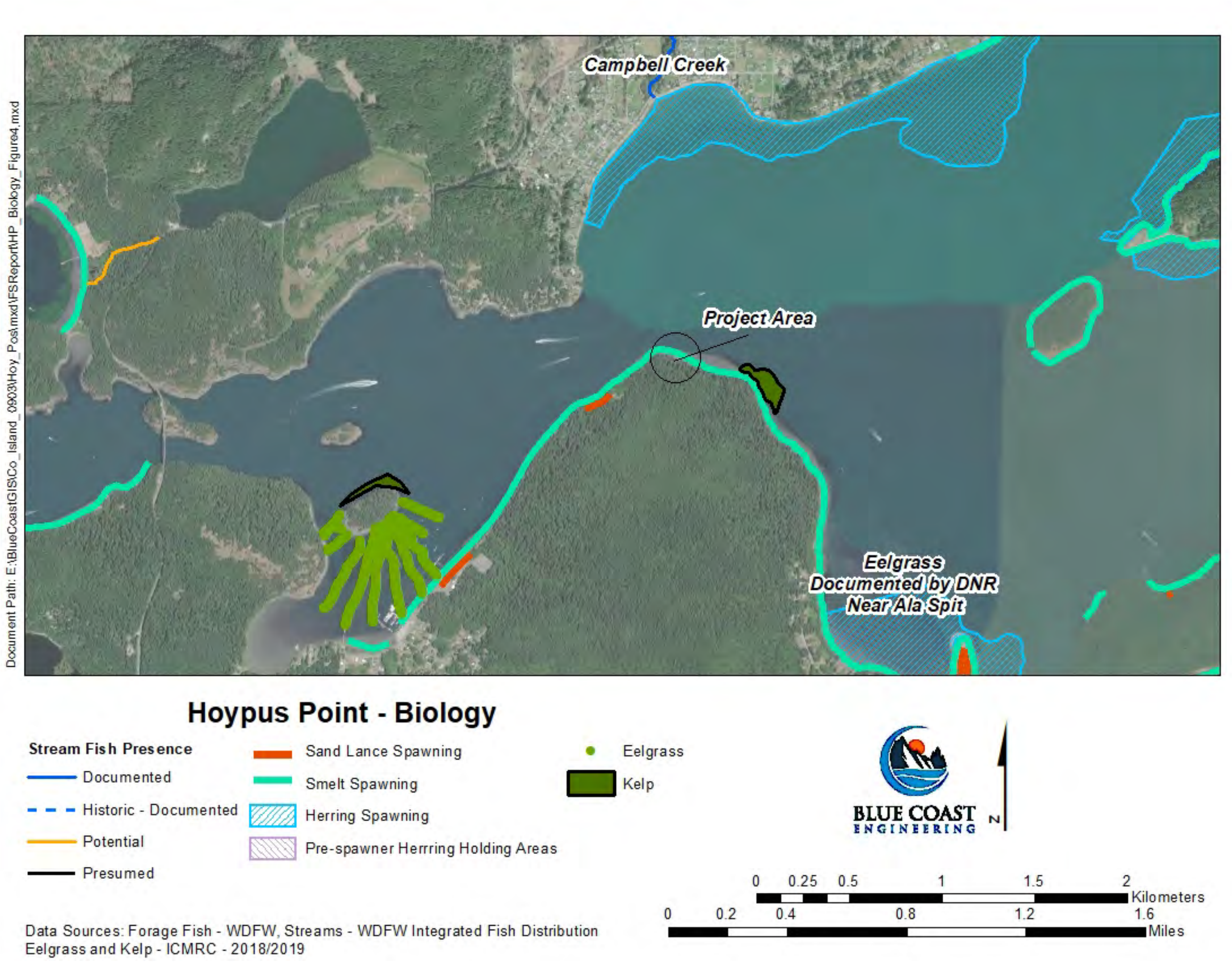


Figure B-3. Map of known biological resources in vicinity of Hoypus Point.

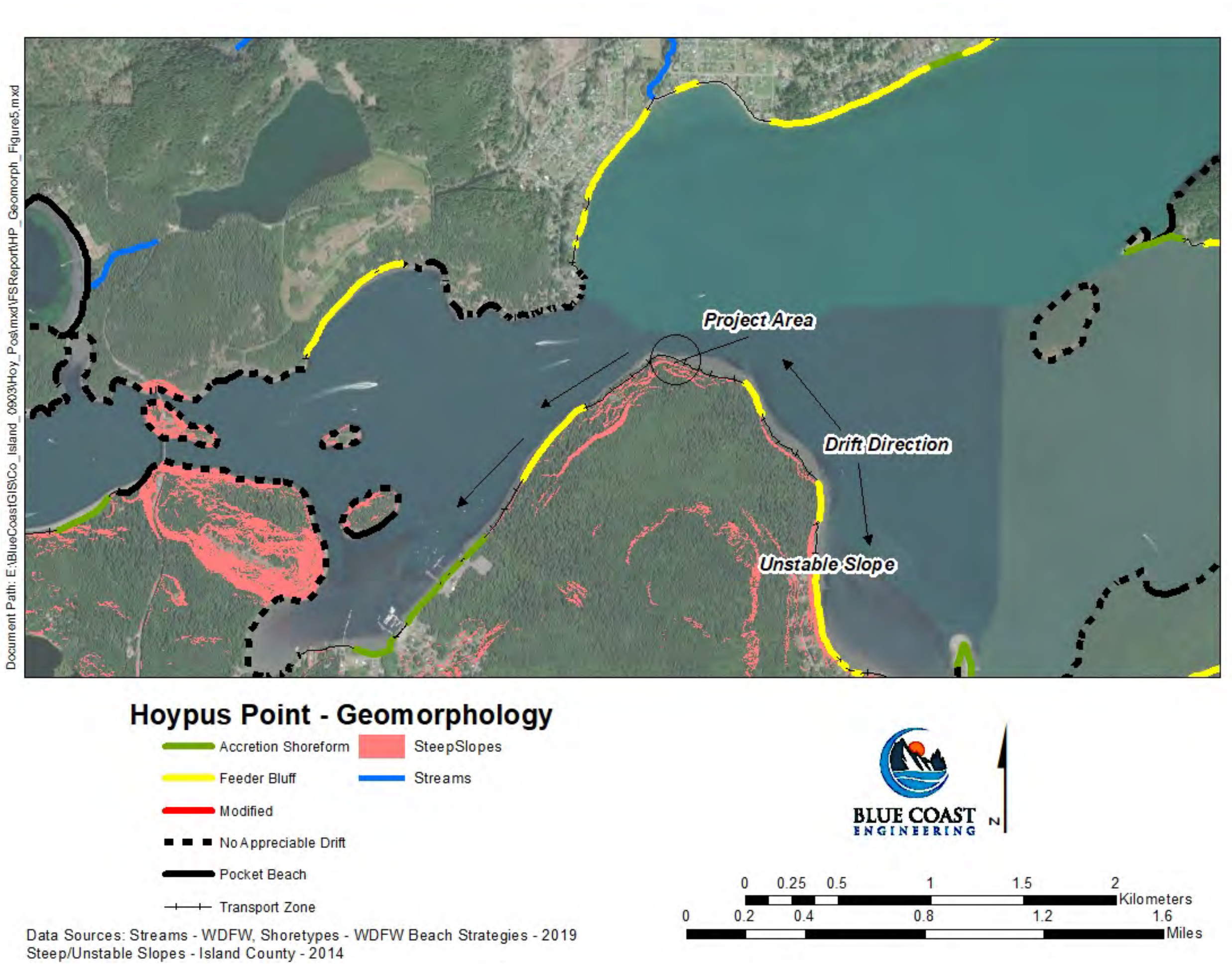


Figure B-4. Map of known geology in vicinity of Hoypus Point.

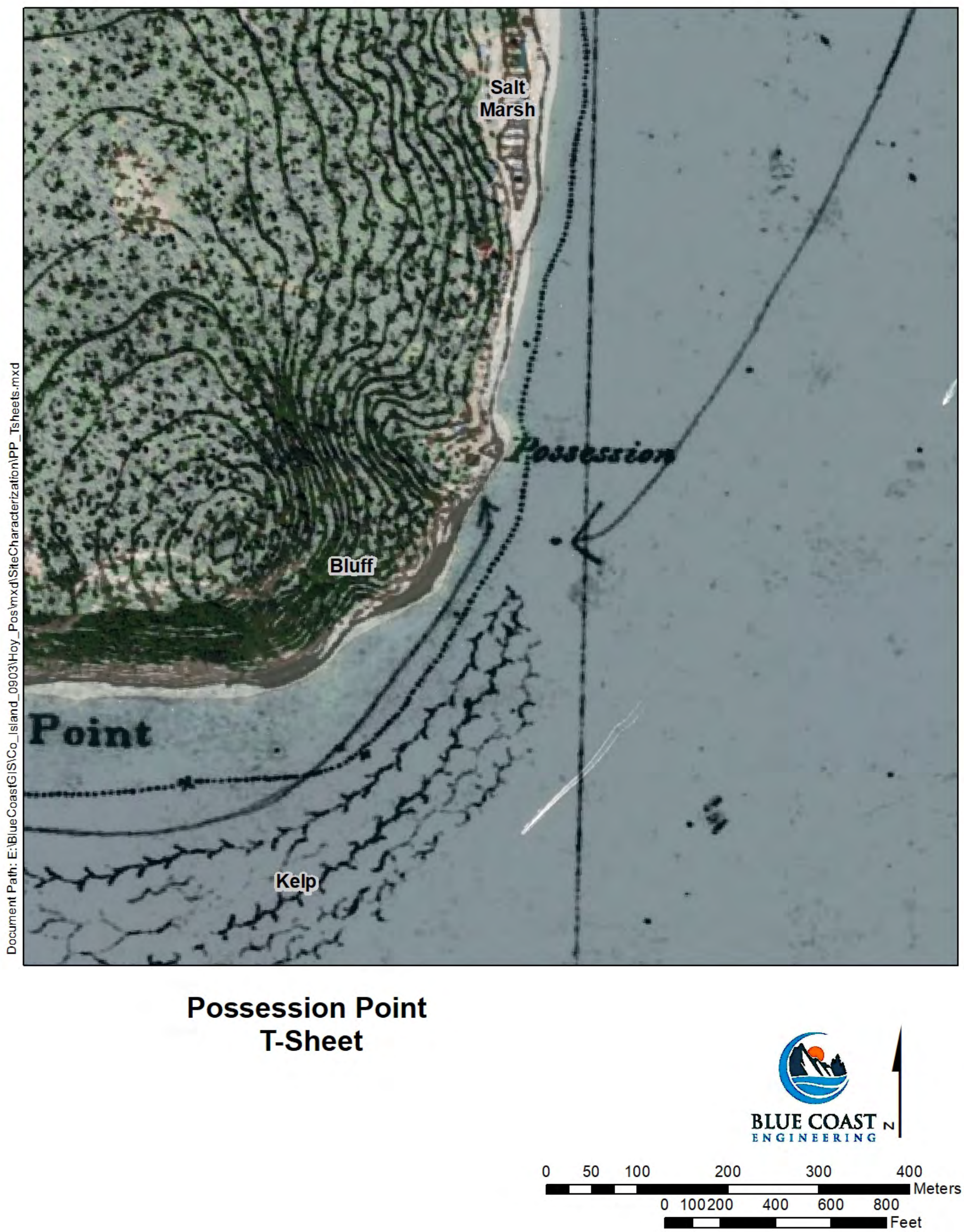


Figure B-5. Historic t-sheet for Possession Point.

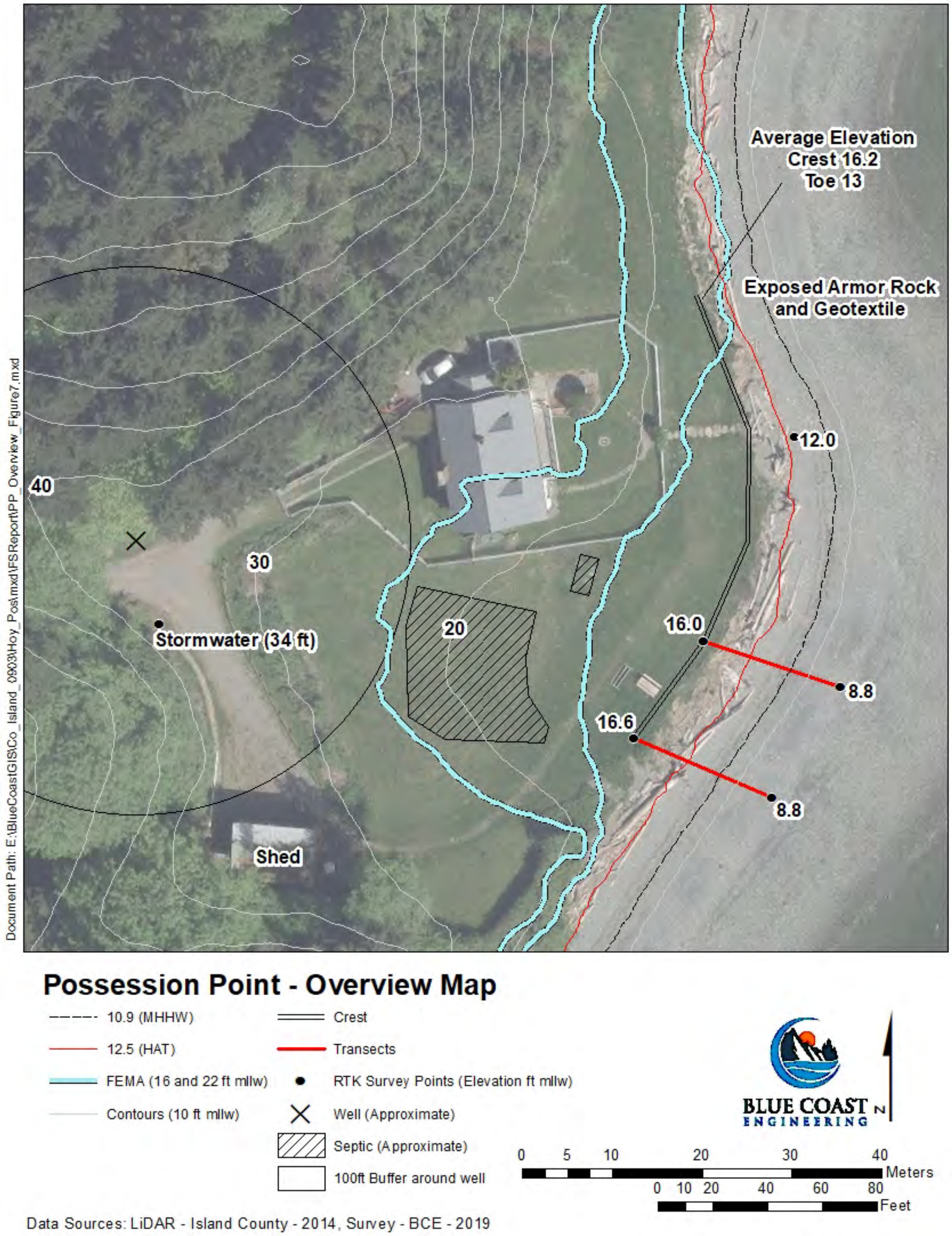


Figure B-6. Overview map of Possession Point project area.

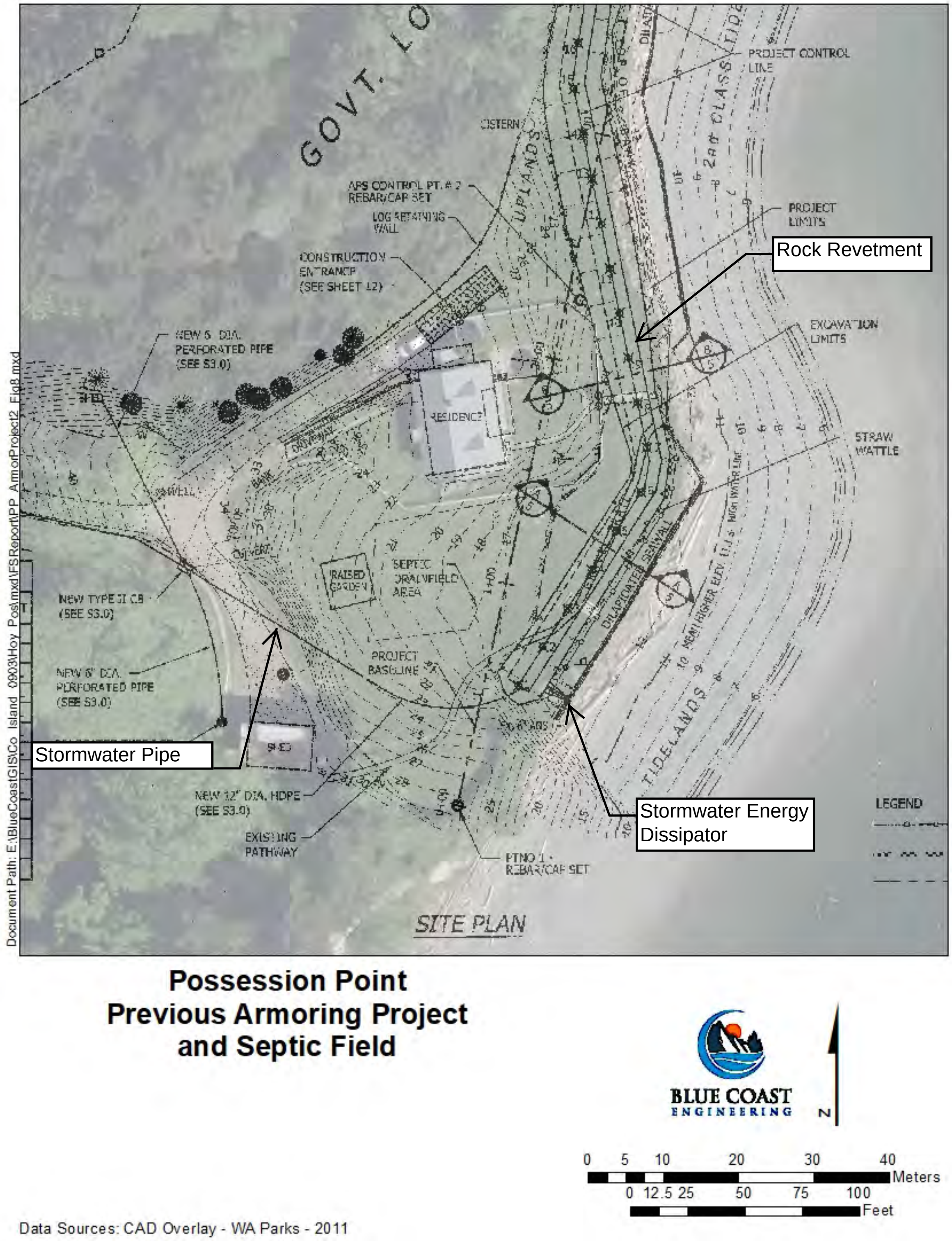


Figure B-7. Map from previous armor removal project at Possession Point.

Possession Point

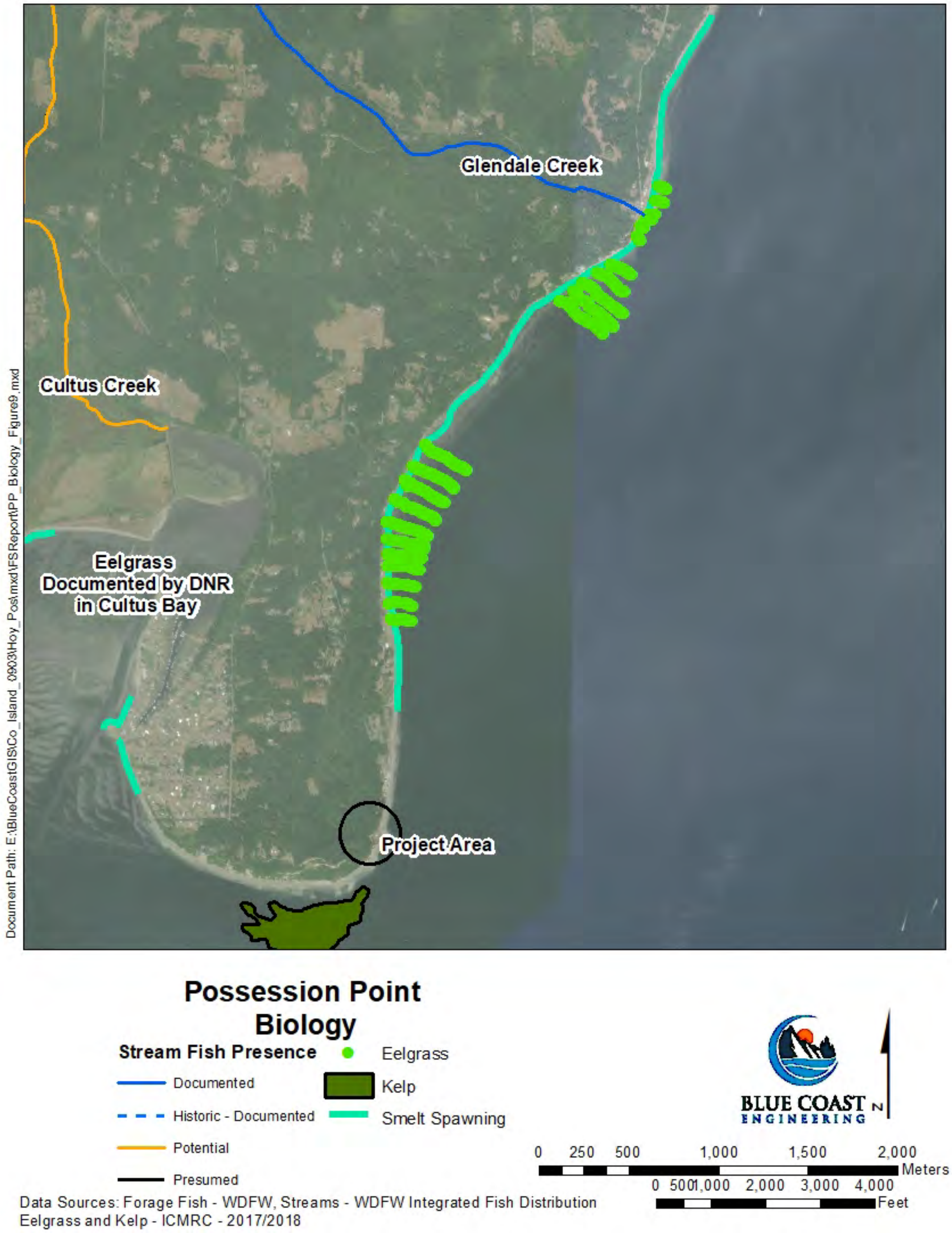


Figure B-8. Map of known biological resources in vicinity of Possession Point.

Possession Point

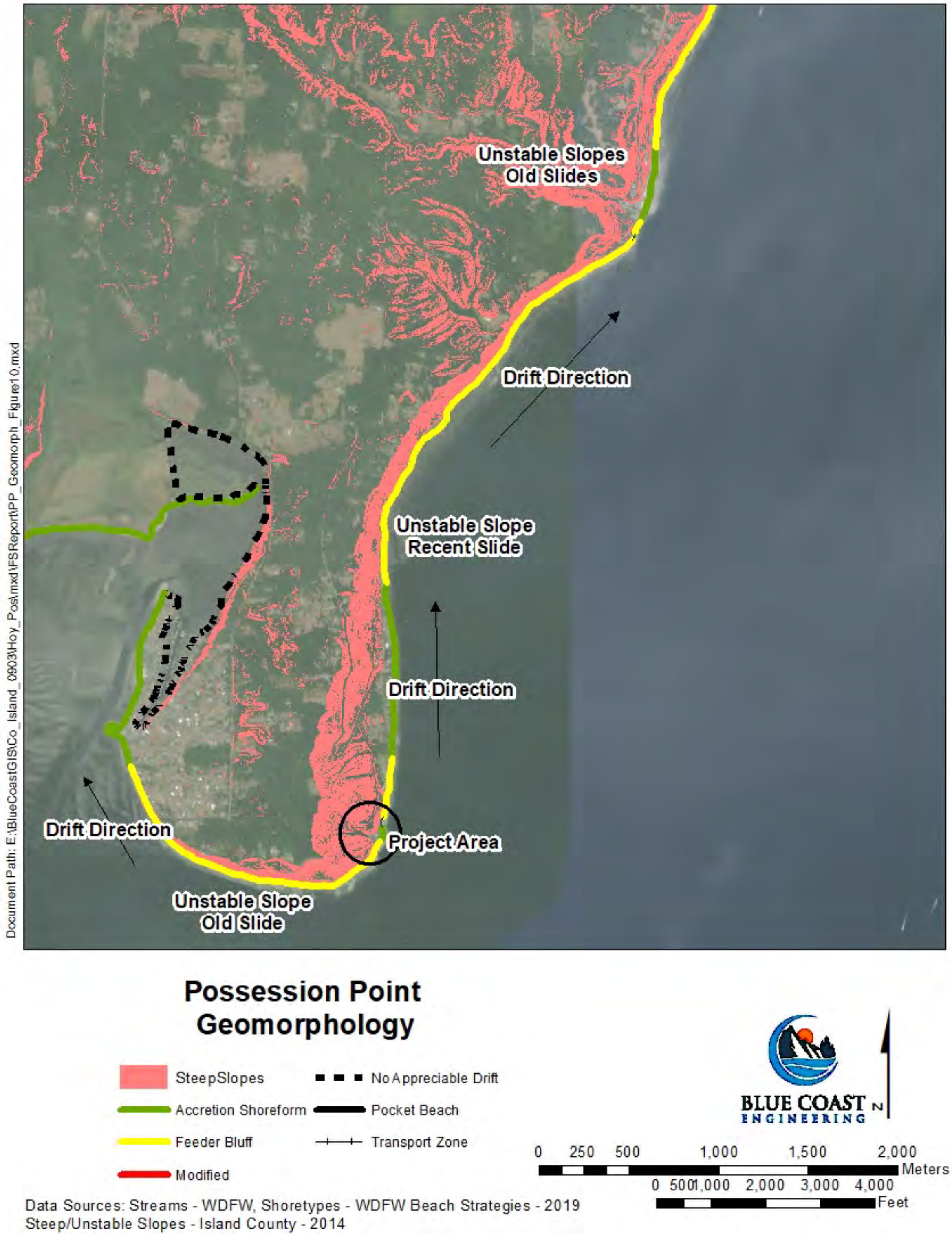


Figure B-9. Map of known goelogy in vicinity of Possession Point.

APPENDIX C

Coastal Processes Assessment

Appendix C: Coastal Processes Assessment

Hoypus Point and Possession Point Restoration Project Feasibility Study

Blue Coast Engineering

18320 47th Pl NE

Lake Forest Park, WA 98155

June 25, 2020

1 Purpose

This appendix describes the coastal processes and geomorphology of the project sites, Hoypus and Possession Points, to document existing conditions and provide baseline information to be used in the conceptual design.

2 Water levels

The project sites are located within the Puget Sound estuary where fluctuations in water level occur from several forcing mechanisms:

- Astronomical tidal influence (mixed semi-diurnal tide resulting in two highs and two lows per day).
- Localized, short-term fluctuations occur over several hours and days due to meteorological conditions (storm surge resulting from winds and differences in barometric pressure, wind set-up, wave set-up).
- Long-term changes in mean sea level due to climatic variation and vertical land motion.

The tidal datum elevations and extreme water levels and projections for sea level rise are provided in this section to understand the frequency and level of inundation along the shoreline at the project sites.

2.1 Tidal datums and extreme water levels

No site-specific water levels are available for the project site, however characteristic tidal datum elevations are available from the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) water level station #9447130, in Seattle, WA. A near continuous record of hourly water levels is available for the station from 1899 to 2019 (NOAA-NOS 2020). The tidal datum elevations are reproduced in Table 2-1 for the 1983 to 2001 tidal epoch at the Seattle station along with tidal datum elevations calculated for Hoypus Point and Possession Point using the NOAA Vdatum online tool. Water levels are provided in Table 2-1 relative to MLLW and NAVD88 based on the offset calculated using the NOAA Vdatum online tool. A frequency of occurrence and exceedance curve is provided in Figure 2-1 for the available hourly water level record the Seattle station. The most frequently occurring water levels are between 7 and 9 feet above MLLW.

A NOAA-NOS analysis of the water level record provides extreme water levels at the Seattle station 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 Hoypus Point and Possession Point (extrapolated from Seattle). The extreme water levels range from 11.6 feet MLLW for the 1-year return interval to 13.3 feet MLLW for the 100-year return interval. The water levels from the station record at Seattle (and estimates for the project site) include fluctuations due to astronomical tide, storm surge, wind, and wave setup, but do not include wave run-up. Water levels at the project site will be incorporated into the conceptual alternatives for restoration at the project site.

Table 2-1. Summary of water level elevations at the NOAA-NOS Seattle, WA tide station (#9447130), Hoypus Point, and Possession Point.

	Seattle, WA (station #9447130)		Hoypus Point[1]		Possession Point[1]	
	Elevation (feet MLLW)	Elevation (feet NAVD88)	Elevation (feet MLLW)	Elevation (feet NAVD88)	Elevation (feet MLLW)	Elevation (feet NAVD88)
Highest Observed Water Level (Date: 10 Dec 1993)	14.5	12.1	N/A	N/A	N/A	N/A
Highest Astronomical Tide (HAT)	13.3	10.0	11.9	10.3	12.5	10.6
Mean Higher High Water (MHHW)	11.4	9.0	10.5	8.9	10.9	8.9
Mean High Water (MHW)	10.5	8.2	9.6	8.0	10.0	8.0
Mean Tide Level (MTL)	6.7	4.3	6.1	4.5	6.4	4.4
Mean Low Water (MLW)	2.8	0.5	2.6	1.0	2.8	0.8
Mean Lower Low Water (MLLW)	0.0	-2.3	0.0	-1.6	0.0	-2.0
Lowest Observed Water Level (Date 12 Dec 1985)	-5.0	-7.4	N/A	N/A	N/A	N/A
Extreme water level elevations						
100-year water level (1% AEP)	14.7	12.4	13.3	11.7	14.0	12.0
10-year water level (10% AEP)	14.3	12.0	12.9	11.3	13.6	11.6
2-year water level (50% AEP)	13.8	11.5	12.4	10.8	13.1	11.1
1-year water level (99% AEP)	13.0	10.7	11.6	10	12.3	10.3

Notes: AEP = annual exceedance probability; N/A = not available

[1] Datums for project site are calculated based on NOAA Vdatum online tool; extreme water levels at Hoypus Point and Possession Point are an approximation based on an extrapolation of the Seattle values.

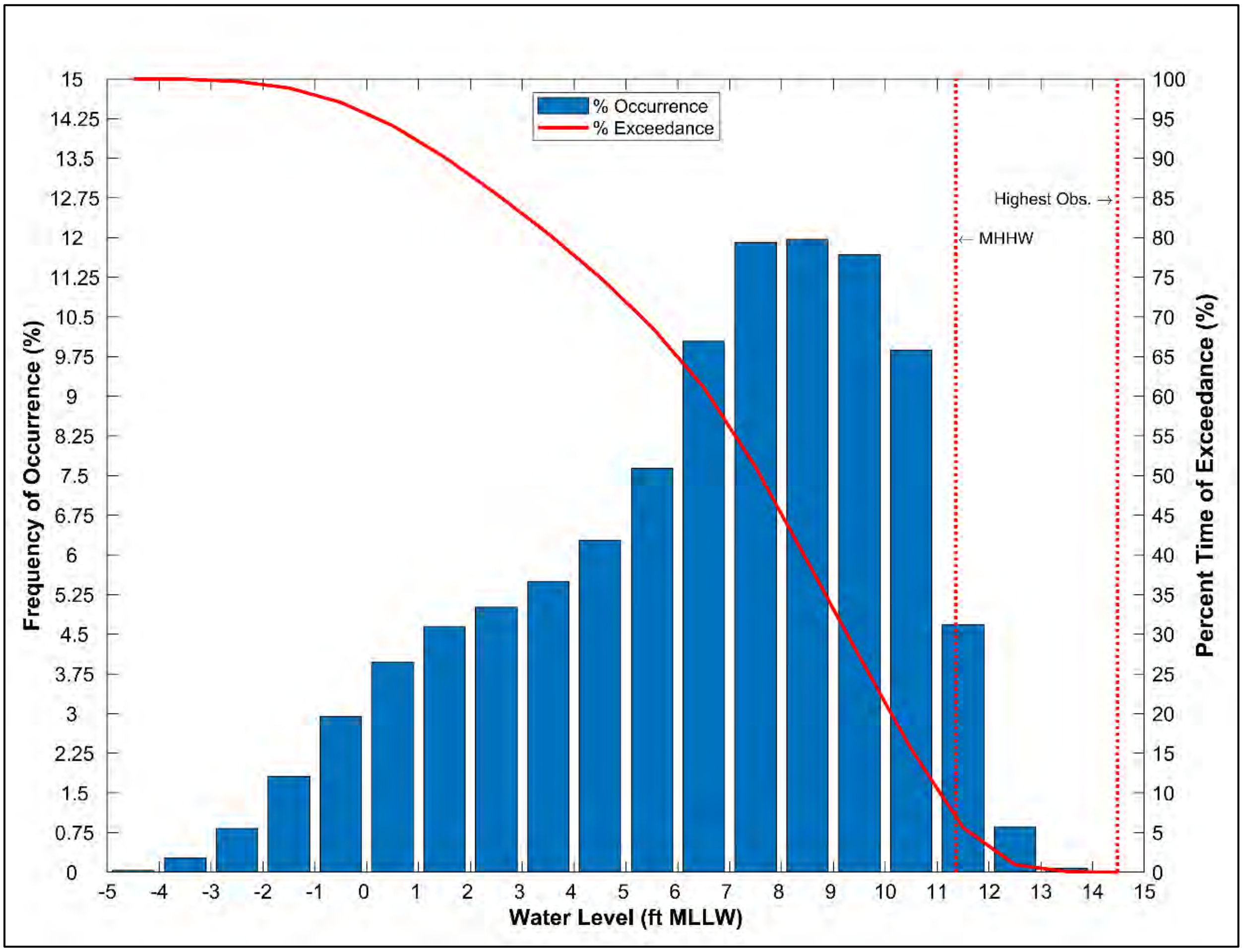


Figure 2-1. Frequency of occurrence and exceedance for hourly water levels measured at the Seattle (#9447130) tide station from 1899 to 2019. Mean Higher High Water (MHHW) and the highest observed water level on record are shown by red dashed lines.

The Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP) provides a Flood Insurance Rate Map (FIRM) for northern Whidbey Island which includes Hoypus Point and is based on the Flood Insurance Study (FIS) for Island County (FEMA FIS 2017c). The FIS gives a 1% annual chance still water elevation of 12.5 feet NAVD88 (14.1 feet MLLW) for the nearest transect to Hoypus Point located to the southeast on Skagit Bay. The still water elevation includes astronomical tides and storm surge). This elevation is slightly higher (0.8 feet) than the 100-year return interval water level reported in Table 2-1. The Base Flood Elevation (BFE) (subject to inundation by the 1% annual chance flood and includes wave run-up) is mapped as an elevation of 16 feet NAVD88 (17.6 feet MLLW) (FEMA FIRM 2017a).

A FIRM map is also available for southern Whidbey Island which includes Possession Point. The FIS gives a 1% annual chance still water elevation of 12.4 feet NAVD88 (14.4 feet MLLW) for the two nearest transects (#38 and #39) to Possession Point. The Base Flood Elevation (BFE) (subject to inundation by the 1% annual chance flood and includes wave run-up) is mapped as an elevation of 14 feet NAVD88 (16 feet MLLW) at Possession Point (FEMA FIRM 2017b).

2.2 Sea level rise

The historical mean sea level trend based on a NOAA-NOS analysis of the Seattle station is an increase in mean sea level of 2.06 millimeters per year (0.08 inches/year) with a 95% confidence interval of 0.03 inches/year. This is equivalent to an increase in water level of 0.7 feet over the last 100 years.

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 different greenhouse gas scenarios and local estimates of vertical land motion. Table 2-2 provides projections for year 2050, 2070, and 2100 planning horizons for the coastal location nearest Hoypus Point and Possession Point. These estimates should be incorporated into water levels in the design phase of restoration projects at the sites.

Table 2-2. Projected average sea level rise for different time periods and greenhouse gas scenarios for the coastal area near Hoypus and Possession Point.

Year	Greenhouse Gas Scenario	Sea level rise magnitude (feet) Central estimate (50% probability exceedance)	
		Hoypus Point	*Possession Point*
2050	Low (RCP 4.5)	0.7	0.7
2050	High (RCP 8.5)	0.7	0.8
2070	Low (RCP 4.5)	1.1	1.1
2070	High (RCP 8.5)	1.2	1.3
2100	Low (RCP 4.5)	1.7	1.7
2100	High (RCP 8.5)	2.1	2.2

3 Wind and Wind-Waves

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 the magnitude of the wind speed, the wind duration (i.e. time period of the windstorm) and fetch distance (i.e., distance over which wind is acting). Generally, the stronger the windspeed, the longer the windstorm lasts and/or the larger the fetch distance, the larger the height and period of the wave generated. For this reason, it is possible to have larger storm waves from a direction that does not have the largest fetch. In addition, the height of the storm waves and length of wave period can be reduced by shallow water and if the site is located within a confined body of water (not open coast).

In areas with little topographic influence, wave direction is generally aligned with the wind direction unless the waves are in shallow water and refract to align with localized bathymetric contours (underwater topography). In areas where topographic effects are significant, such as Puget Sound and surrounding area, the wind, and therefore the wave direction becomes aligned with the maximum fetch length. The wind and wind-wave climate at Hoypus Point and Possession Point were characterized to understand the potential for wave energy to transport sediment at the site.

3.1 Wind climate

The prevailing wind direction over the Whidbey sub-basin 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. Hoypus Point is sheltered from the southerly wind events and is only exposed to northerly fetches with the longest fetch from the northeast at a direction of 50° and a length of 3.5 miles. To the northwest and north, between 300° and 30° the site is exposed to shorter fetches, between 0.4 and 0.9 miles. Possession Point is exposed to both northeasterly and south-southeasterly fetches. The longest fetch is from the northeast at a direction of 30° and a length of 10.6 miles. To the south, the longest fetch is at a direction of 180° and a length of 5.6 miles.

The wind climate at both project sites was characterized using hourly wind records from two long-term meteorological stations: Whidbey Island Naval Air Station (NAS) (1945 to 2019) and West Point (1975 to 2019). Wind roses for the wind records at the two long-term stations are shown in Figure 3-1 superimposed on a topographic 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 at Whidbey Island (west to east) and along the axis (north to south) of Puget Sound at West Point. The strongest winds measured at both stations are from southerly exposures and are between 60 and 70 miles per hour (mph). The wind record at the West Point station was chosen as representative of both sites and for further analysis of wind-waves due to the overwater exposure to both northern and southern fetches.

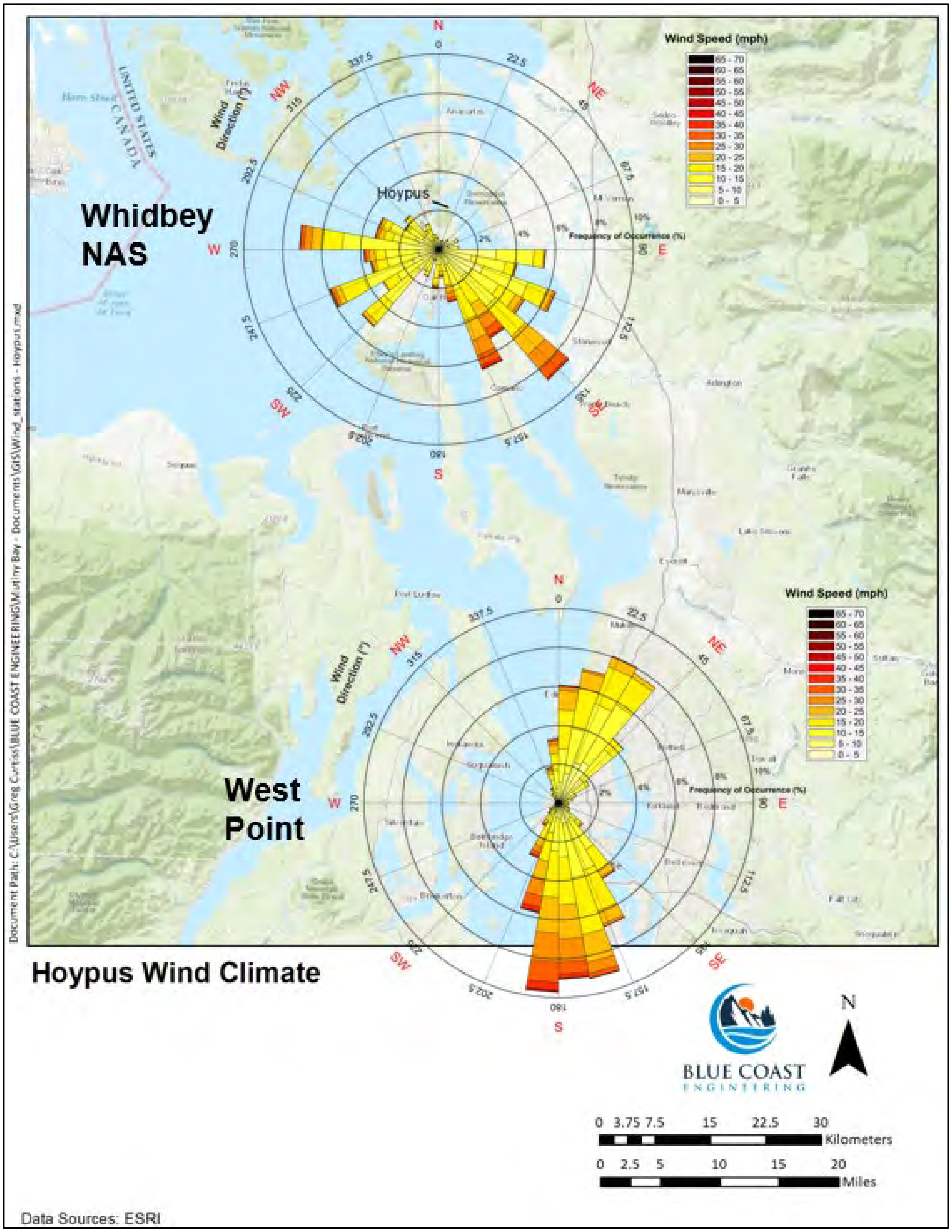


Figure 3-1. Wind rose for the Whidbey NAS meteorological station (top) and West Point (bottom). Direction is the direction from which wind is blowing.

A joint probability plot for wind direction and wind speed is shown in Figure 3-2 for the West Point wind data after filtering for suspect records (based on the quality code indicator for suspect or erroneous values) and 0 value wind speeds. The joint probability plot shows the frequency of occurrence of a combined wind speed and wind direction. The data are binned in 5 mph speed bins and 10° directional bins and shown as a heat map with warmer colors indicating a higher frequency of occurrence. The heat map shows that the most frequently occurring wind directions at the West Point station are southeasterly (160° to 170°; 12.5 mph bin center) and northeasterly (30° to 40°; 7.5 mph bin center). The strongest winds measured are from the south (160° to 240°), consistent with the broader regional wind patterns in western Washington.

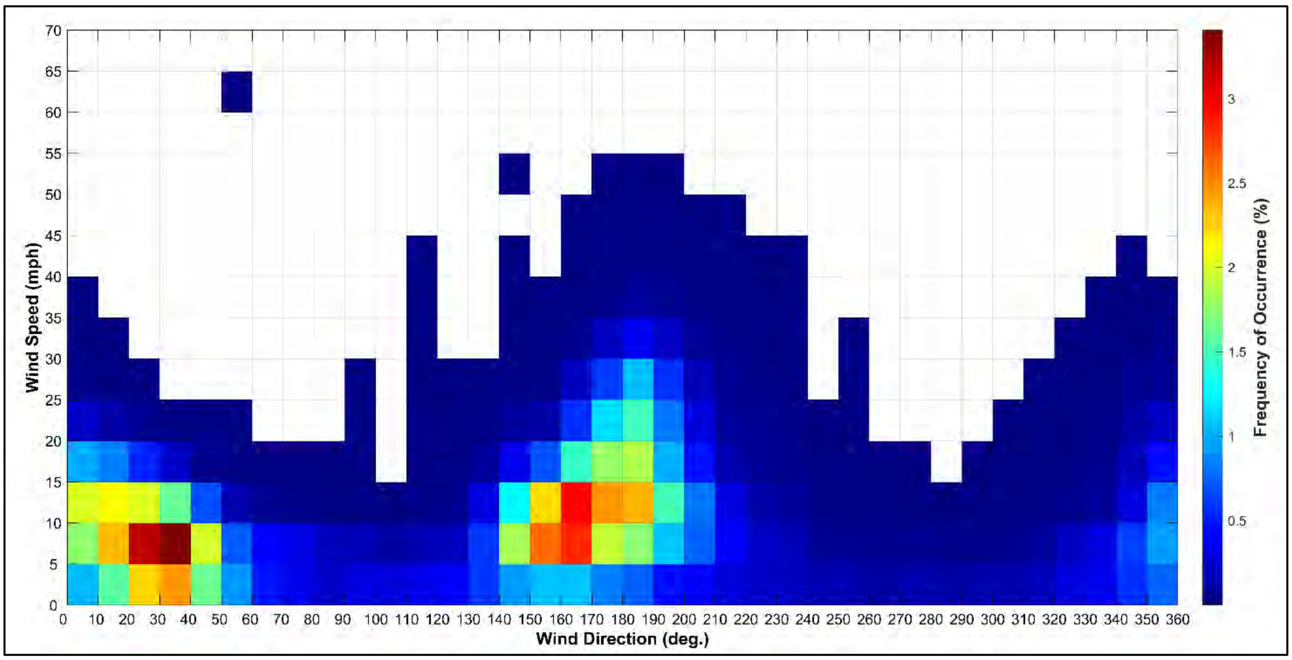


Figure 3-2. Joint probability plot of wind speed versus wind direction for the West Point meteorological station from 1975 to 2019.

An extreme value analysis of the wind record from the westerly sector was completed following the methods of Goda (1988) and Leenknecht et al. (1992). The analysis was completed for the northerly (300° to 30°) sector, northeasterly sector (30° to 90°), and southeasterly sector (130° to 180°) for the West Point wind record. Independent storm events were identified using a peaks over threshold (POT) analysis to identify a minimum of at least one storm per year (Goda 1988). Criteria were set to identify storms with consecutive wind records exceeding a given threshold for at least an hour.

The peak storm speeds were then fit to two extreme value probability distribution functions (pdfs), the Fisher Tippett Type 1 (FT-1) and Weibull distributions. Based on the best fit extreme value pdf, return value wind speeds were estimated for return intervals ranging from 1 year to 100 years. The return value wind speeds from the extreme value analysis are summarized in Table 3-1 and Table 3-2 along with the 95% confidence interval wind speeds for the directional sectors. The 100-year return interval wind speed is 43 mph for the northerly sector, 30 mph for the northeasterly sector, and 58 mph for the southeasterly sector, highlighting the difference in wind directionality.

Table 3-1. Extremal northerly wind speeds at the West Point meteorological station (relevant to Hoypus and Possession Points)

	West Point (northerly: 300° to 30°)				West Point (northeasterly: 30° to 90°)		
Return Period (years	Wind Speed (mph)	95% confidence interval, lower (mph)	95% confidence interval, upper (mph)	Return Period (years	Wind Speed (mph)	95% confidence interval, lower (mph)	95% confidence interval, upper (mph)
1	30	29	30	1	21	20	21
2	32	31	33	2	24	23	25
5	35	33	37	5	27	25	29
10	37	35	39	10	29	27	31
25	40	37	42	25	31	28	33
50	42	39	45	50	32	29	35
100	43	40	47	100	33	30	36

Table 3-2. Extremal southernly wind speeds at the West Point meteorological station (relevant to Possession Point)

West Point (southeasterly: 130° to 180°)			
Return Period (years	Wind Speed (mph)	95% confidence interval, lower (mph)	95% confidence interval, upper (mph)
1	37	36	38
2	41	40	43
5	46	43	48
10	49	45	52
25	53	48	57
50	55	50	60
100	58	52	64

3.2 Wind-waves

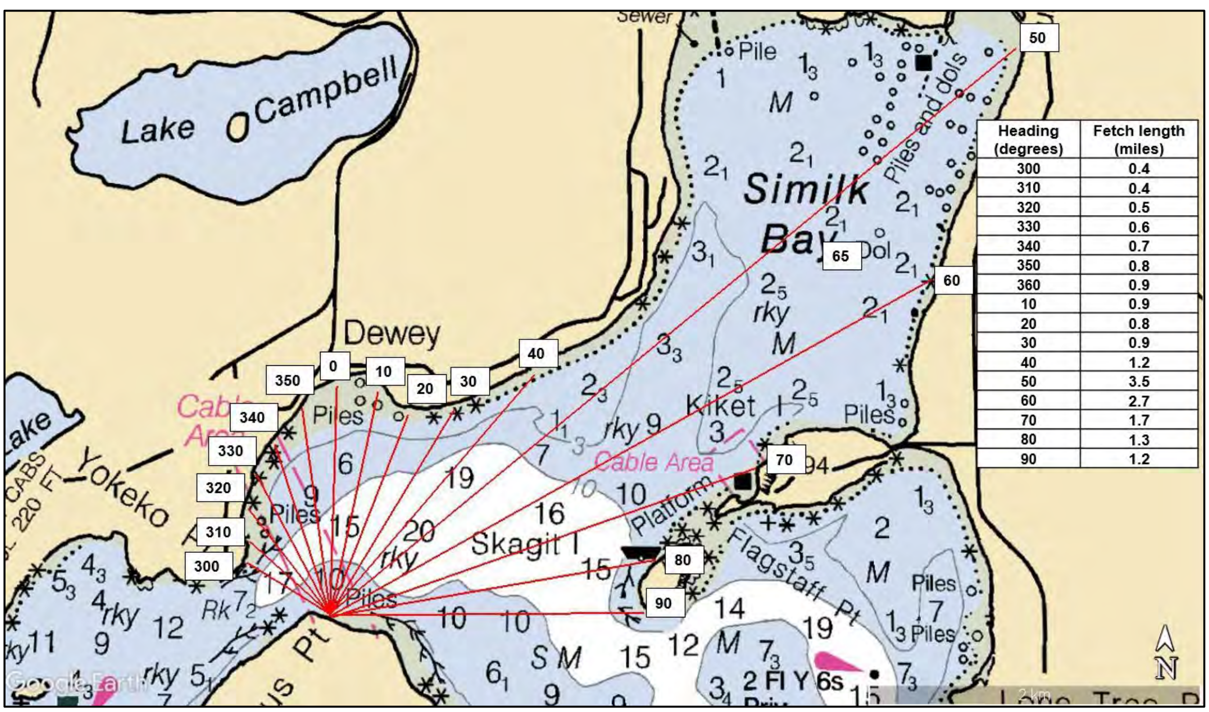
A wind-wave hindcast was completed to estimate extreme wave conditions at Hoypus Point and Possession Point to characterize the wave climate. Wind-wave parameters were calculated using the Automated Coastal Engineering System (ACES) software (Leenknecht et al. 1992) developed by the United States Army Corps of Engineers (USACE) to estimate wind-wave growth over a restricted fetch. The following assumptions were made in the calculations:

- 2-minute average wind speeds were input as 1-hour average wind speeds (a conservative assumption);
- Measurement height of 42 feet based on site elevation and anemometer height at the West Point meteorological station;
- The wind was applied along the direction of the maximum fetch to the north (0°) and northeast (50°) at Hoypus Point and northeast (30°) and southeast (180°) at Possession Point

Radial fetch lengths between 300° and 90° for which Hoypus Point is exposed were measured in 10° increments and are shown in Figure 3-3 on a nautical chart. The site is exposed to fetches to the north and northeast into Similk Bay. A similar chart is shown for Possession Point in Figure 3-4 for radial fetches between 10° and 180°.

Results of the wind-wave hindcast for Hoypus Point are presented in Table 3-3 for northerly and northeasterly wind events with return intervals between 1 and 100 years. The predicted significant wave heights (H_s) and peak wave period (T_p) are similar for the both directional sectors because of the combination of fetch and wind speed; longer fetch to the northeast but lighter wind speeds and shorter fetch to the north but higher winds speeds.

Results of the wind-wave hindcast for Possession Point are presented in Table 3-4 for the northeasterly and southeasterly wind events with return intervals between 1 and 100 years. The predicted significant wave height (H_s) at Possession Point is highest for the southeasterly events due to the higher wind speeds from this direction despite a longer fetch to the northeast.



Heading (degrees)	Fetch length (miles)
300	0.4
310	0.4
320	0.5
330	0.6
340	0.7
350	0.8
360	0.9
10	0.9
20	0.8
30	0.9
40	1.2
50	3.5
60	2.7
70	1.7
80	1.3
90	1.2

Figure 3-3. NOAA nautical chart in the vicinity of Hoypus Point with fetch measurements between 300° and 90° shown by the red lines.

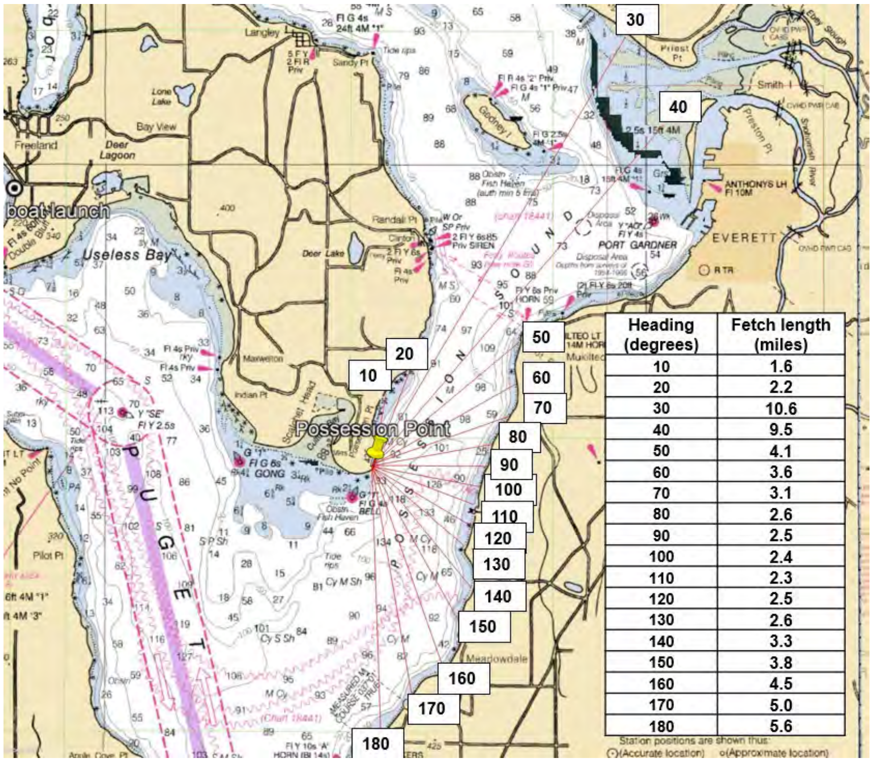


Figure 3-4. NOAA nautical chart in the vicinity of Possession Point with fetch measurements between 10° and 180° shown by the red lines.

Table 3-3 Wind-wave hindcast scenarios and results for Hoypus Point.

Wind Return Interval	Wind Direction (degrees)	Fetch (miles)	Wind Speed (mph)	Significant Wave Height, Hs (feet)	Peak Wave Period, Tp (seconds)
Northerly					
1	0	0.9	29.9	0.8	1.8
10	0	0.9	37.1	1.1	2.1
25	0	0.9	39.7	1.2	2.1
50	0	0.9	41.6	1.3	2.2
100	0	0.9	43.5	1.3	2.2
Northeasterly					
1	50	3.5	20.6	0.8	1.8
10	50	3.5	28.7	1.2	2.1
25	50	3.5	30.6	1.3	2.2
50	50	3.5	31.9	1.4	2.2
100	50	3.5	33.2	1.5	2.3

Table 3-4 Wind-wave hindcast scenarios and results for Possession Point.

Wind Return Interval	Wind Direction (degrees)	Fetch (miles)	Wind Speed (mph)	Significant Wave Height, Hs (feet)	Peak Wave Period, Tp (seconds)
Northeasterly					
1	30	10.6	21	1.8	3.2
10	30	10.6	29	2.6	3.7
25	30	10.6	31	2.9	3.8
50	30	10.6	32	3.0	3.9
100	30	10.6	33	3.1	3.9
South-Southeasterly					
1	180	5.6	37	2.3	3.2
10	180	5.6	49	3.4	3.6
25	180	5.6	53	3.8	3.7
50	180	5.6	55	4	3.8
100	180	5.6	58	4.3	3.9

3.3 Wave run-up

Wave run-up is the landward extent of wave uprush on a beach and when coinciding with king tides or storm surge can contribute to coastal flooding. Run-up consists of two parts: wave setup (mean water surface averaged over time) and swash (variation of the water –land interface about the mean) (Melby 2012). Wave run-up for engineering assessments is typically calculated as an R2% value which is the run-up exceeded by 2 percent of run-up crests (R2%).

Wave run-up was calculated for several scenarios for the 1-year and 100-year wind-wave event over a range of water levels on the beach face in front of the armor. The method of Stockdon (2006) as reported in Melby et al. (2013) was used for the calculation of R2%. At Hoypus Point, the calculation assumed a 12.5% (8:1 horizontal to vertical) beach slope below the armor based on survey transects collected in 2020. At Possession Point, the calculation assumed a 11% (9:1 horizontal to vertical) beach slope based on survey transects collected.

Results of the wave run-up analysis are presented in Table 3-5 for Hoypus Point and Table 3-6 for Possession Point. The results indicate total water levels at both sites are between 11 and 15 feet MLLW depending on scenario.

Table 3-5. Total water levels at the Hoypus Point project site

Scenario	Still water level	Wind-wave height (Hs, feet)	Wave run-up (feet)	Total water level (feet MLLW)
MHHW + 1-year wind-wave event	10.5	0.8	0.4	10.9
1-year water level + 1-year wind-wave event	11.6	0.8	0.4	12.0
10-year water level + 1-year wind-wave event	12.0	0.8	0.4	12.4
MHHW + 100-year wind-wave event	10.5	1.5	0.7	11.2
1-year water level + 2100 SLR + 1-year wind-wave event	13.5	0.8	0.4	13.9

Table 3-6. Total water levels at the Possession Point project site

Scenario	Still water level	Wind-wave height (Hs, feet)	Wave run-up (feet)	Total water level (feet MLLW)
MHHW + 1-year wind-wave event	10.9	2.3	1.1	12.0
1-year water level + 1-year wind-wave event	12.3	2.3	1.1	13.4
10-year water level + 1-year wind-wave event	13.6	2.3	1.1	14.7
MHHW + 100-year wind-wave event	10.9	4.3	1.8	12.7
1-year water level + 2100 SLR + 1-year wind-wave event	14.3	2.3	1.1	15.3

4 Sediment Transport

4.1 Hoypus Point

Hoypus Point is located at the northern end of Whidbey Island on the inside of Deception Pass where it connects to the Similk and Skagit Bay, part of the Whidbey sub-basin (Figure 4-2). The deposits along the immediate shoreline are mapped as beach deposits backed by advance outwash glacial deposits (Dragovich et al 2000).

Figure 4-1 shows key features of the Hoypus Point site on an oblique aerial photograph from the Washington Department of Ecology (Ecology 2020). The uplands in the vicinity of the project site are heavily forested and mapped as steep slopes by Ecology. Approximately 400 linear feet of armor exists along the upper portion of the beach from the old ferry landing at the end of Cornet Bay road to the northeast towards the point. Extensive wood is also located along the shoreline.

Sediment grain size distributions on the beach are medium to coarse sand with small amounts of gravel and cobble on the upper beach. To the southeast of the project site is a wide low-tide terrace consisting of fine-grained sediments.

The Hoypus Point littoral drift cell has been mapped as part of the 2017 Beach Strategies Phase 1 project (CGS 2017) and is shown in Figure 4-2 with the arrows pointing in the direction of net shore-drift from south to north. Hoypus Point is located within a low wave energy environment with exposure to wind-waves from the north and sheltered from stronger winds from the south. Southeast of the project site are approximately 600 feet of mapped feeder bluffs which provide sediment to the littoral system and is transported alongshore to the north (CGS 2017). The project site is mapped as transport zone.

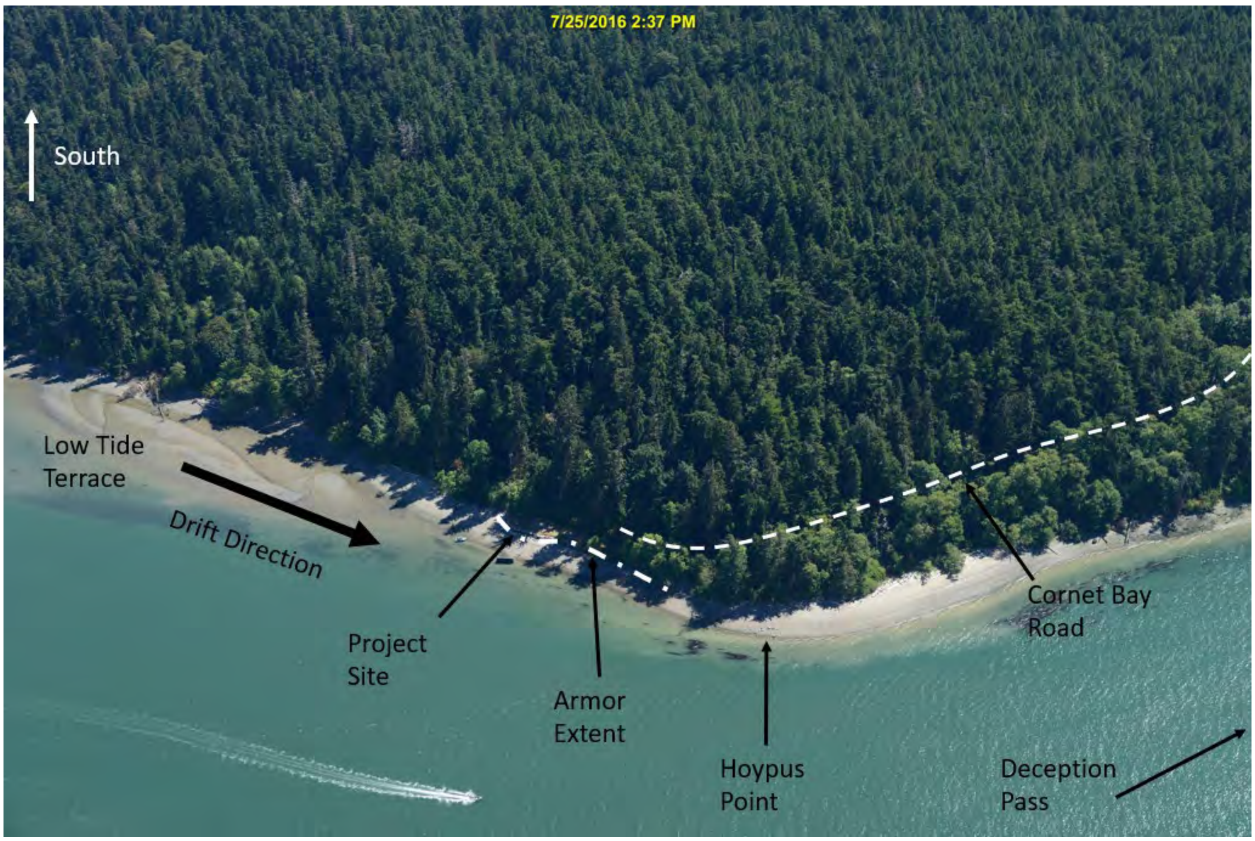


Figure 4-1. Washington State Department of Ecology oblique aerial photograph of Hoypus Point, taken on July 25, 2016.

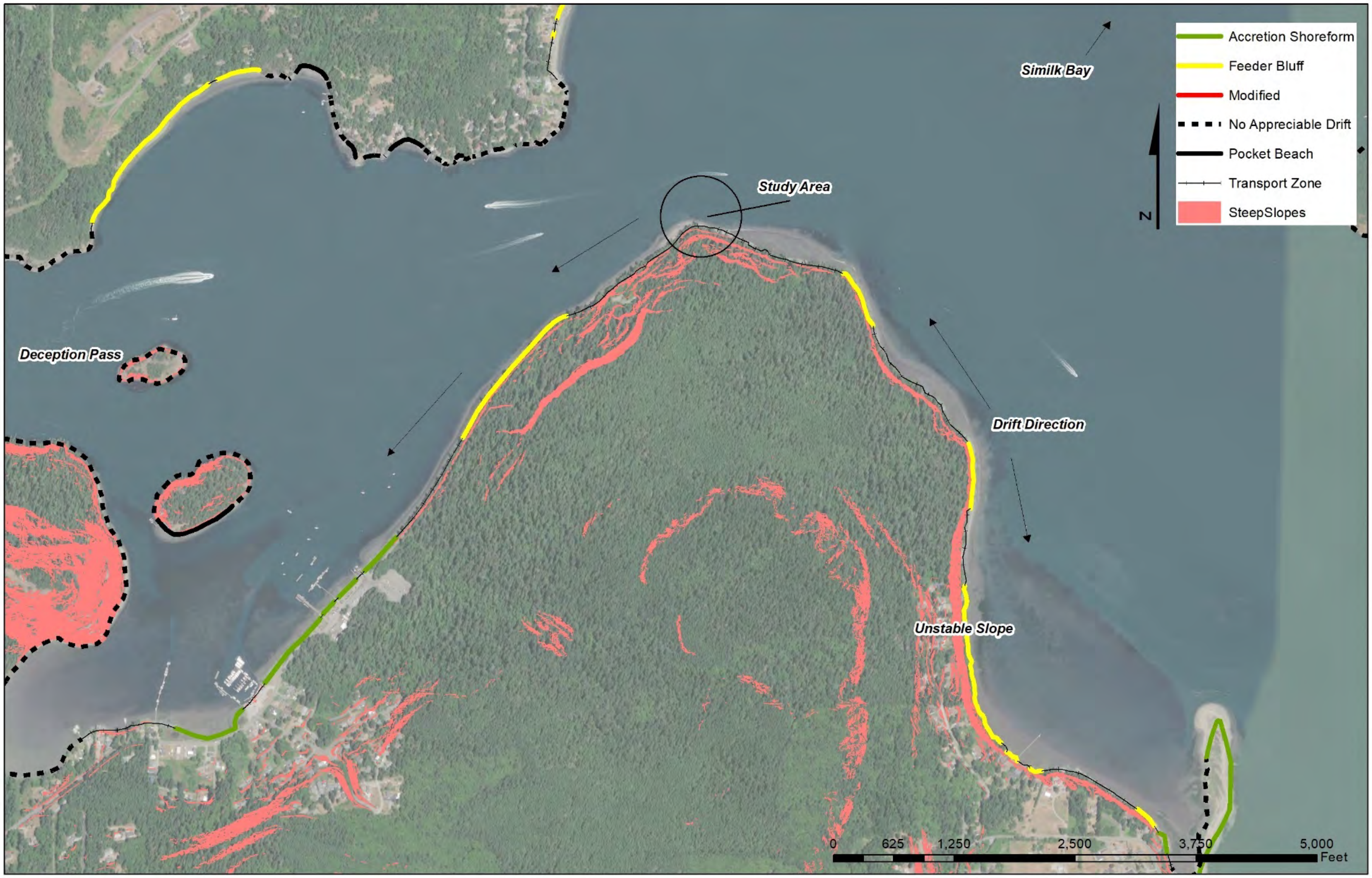


Figure 4-2. Map of littoral drift cells in the area of Hoypus Point. Arrows point towards the direction of net drift.

4.2 Possession Point

Possession Point is located at the southern end of Whidbey Island at the entrance to Possession Sound, part of the Whidbey sub-basin (Figure 4-4). To the south and west is the main channel of Puget Sound. The deposits along the immediate shoreline are mapped as landslide and beach deposits (Dethier et al 2000).

Figure 4-3 shows key features of the Possession Point site on an oblique aerial photograph from the Washington Department of Ecology (Ecology 2020). The uplands in the vicinity of the project site are heavily forested and mapped as steep slopes by Ecology. Approximately 250 linear feet of buried armor exists along the upper portion of the beach. A vertical scarp of the upper beach exposes the buried armor near the northern extent. Extensive wood is located along the shoreline. Sediment grain size distributions on the beach are medium to coarse sand with small amounts of gravel and cobble on the upper beach.

The Possession Point littoral drift cell has been mapped as part of the 2017 Beach Strategies Phase 1 project (CGS 2017) and is shown in Figure 4-4 with the arrows pointing in the direction of net shore-drift from south to north. Several hundred feet of shoreline to the south of the project site are mapped as exceptional feeder bluffs which are exposed to strong southerly wind-wave events and feed sediment to the drift cell at the project site. The shoreline immediately in front of the project site is mapped as an accretion shoreform resulting from the low-sloping curved shape of the shoreline at the site (Figure 4-3).

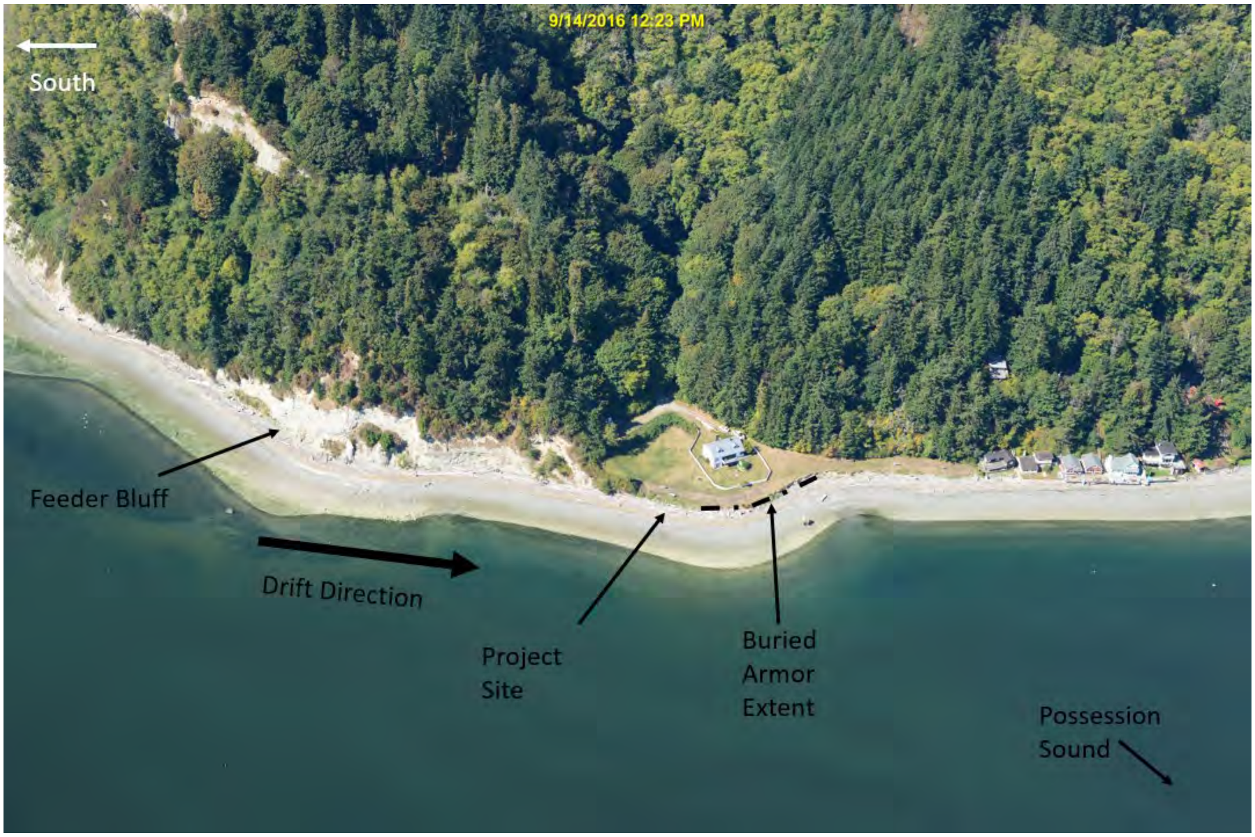


Figure 4-3. Washington State Department of Ecology oblique aerial photograph of Possession Point, taken on September 14, 2016.

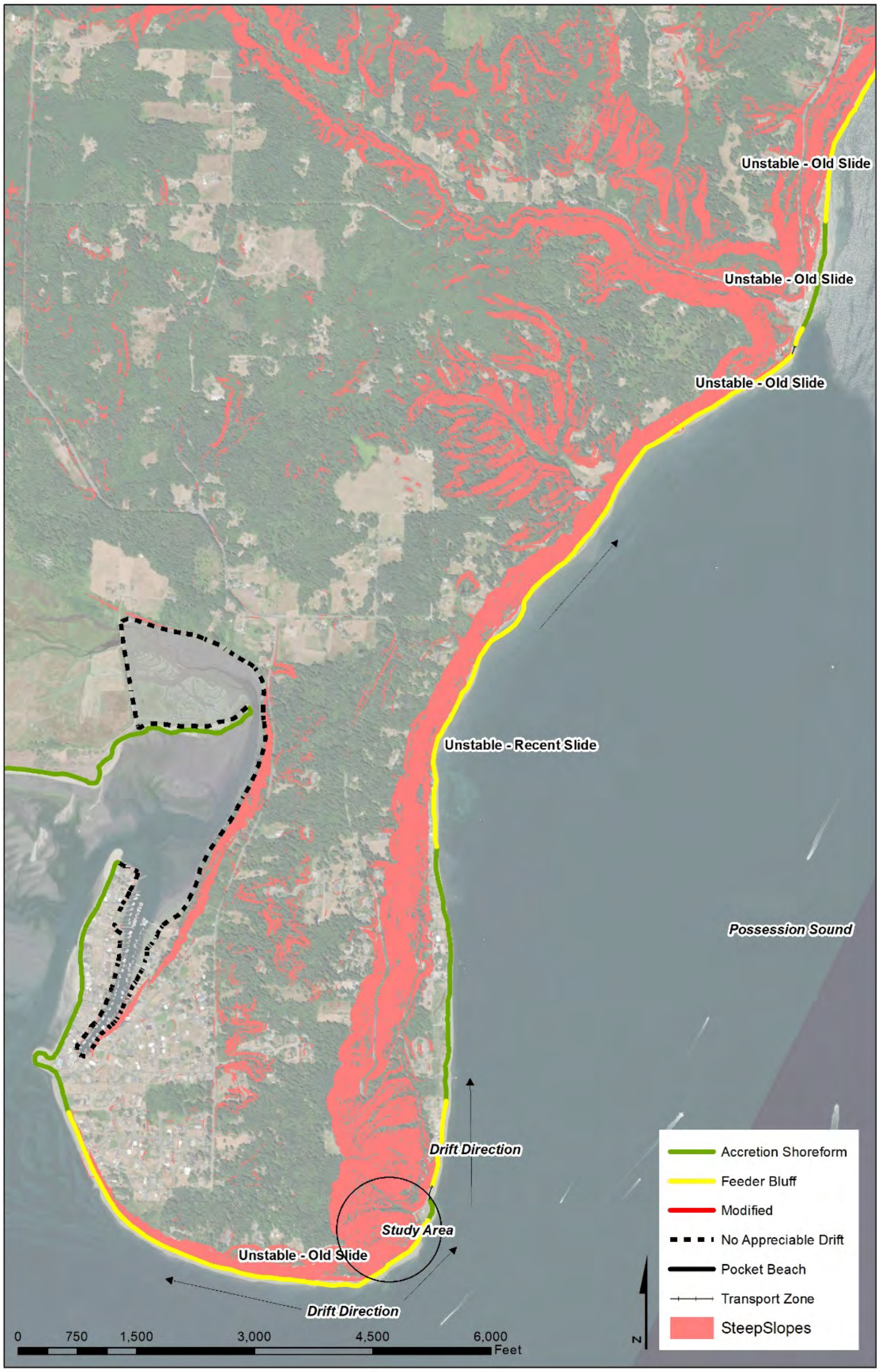


Figure 4-4. Map of littoral drift cells in the area of Possession Point. Arrows point towards the direction of net drift.

5 References

Coastal Geologic Services (CGS). 2017. Beach Strategies Phase 1 Summary Report: Identifying Target Beaches to Restore and Protect. Estuary and Salmon Restoration Program Learning Project #14-2308. October 25, 2017.

Dethier, D.P., Safioles, S.A., Minard, J.P. 1981. Preliminary Geologic Map of the Maxwelton Quadrangle, Island County, Washington. OFR 82-192.

Dragovich, J.D. Petro, Troost, M.L., Norman, D.K., Anderson, G., Cass, J., Gilbertson, L.A., McKay Jr., D.T. 2000. Geologic Map of the Anacortes South and La Conner, 7.5-minute Quadrangles, Skagit and Island Counties, Washington. WA Division of Geology and Earth Resources Geologic Map. OFR 2000-6.

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM). 2017a. Island County, Washington and Incorporated Areas, Panel 65 of 500, Map Number 53029C0065F, Effective Date March 7, 2017.

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map (FIRM). 2017b. Island County, Washington and Incorporated Areas, Panel 445 of 500, Map Number 53029C0445F, Effective Date March 7, 2017.

Federal Emergency Management Agency (FEMA), Flood Insurance Study (FIS). 2017c. Island County, Washington and Incorporated Areas, Washington, D.C., March 7.

Finlayson, D. 2006. The geomorphology of Puget Sound beaches. Puget Sound Nearshore Partnership Report No. 2006-02. Published by Washington Sea Grant Program, University of Washington, Seattle, Washington.

Goda, Y. 1988. "On the Methodology of Selecting Design Wave Height," Proceedings, Twenty-first Coastal Engineering Conference, American Society of Civil Engineers, Costa del Sol-Malaga, Spain, pp. 899-913.

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.

Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. Projected Sea Level Rise for Washington State – A 2018 Assess-ment. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, Oregon State University, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project.

Melby, J.A. 2012. Wave Runup Prediction for Flood Hazard Assessment. ERDC/CHL Technical Report TR-12-24: October 2012, US Army Engineer R&D Center, Vicksburg, MS.

Melby, J.A. Nadal, N. and Kobayashi, N. 2013. “Wave Runup Prediction for Flood Mapping,” Proceedings of 33rd Coastal Engineering Conference (ICCE2012), 141.

National Oceanic and Atmospheric Administration National Ocean Service (NOAA-NOS). 2020. Water level station data. Accessed September April 15, 2020: https://tidesandcurrents.noaa.gov/stationhome.html?id=9447130

Stockdon, H. F., Holman, R.A., Howd, P.A., and Sallenger, A.H. 2006. Empirical parameterization of setup, swash, and runup. Coastal Engineering. 53:573–588. Elsevier.

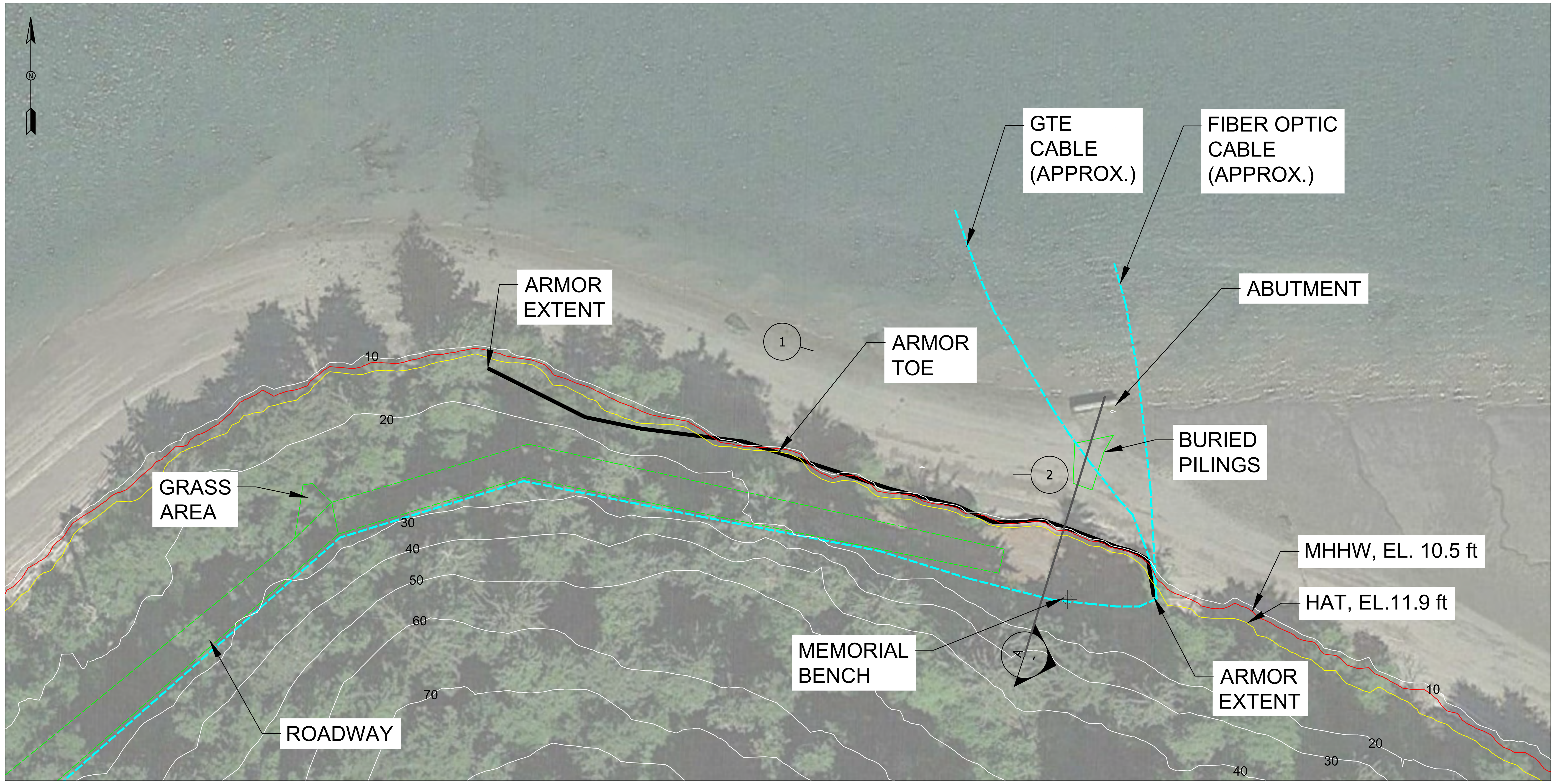
U.S. Army Corps of Engineers. 2006. Coastal Engineering Manual. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes).

Wallace, R.S. 1988. Quantification of net shore-drift in Puget Sound and the Strait of Juan de Fuca, Washington. J. Coast. Res. 4:395–403.

Washington Department of Ecology (Ecology). 2020. Coastal Atlas. Accessed on April 15, 2020. https://fortress.wa.gov/ecy/shorephotoviewer/Map/ShorelinePhotoViewer

APPENDIX D

Conceptual Design Figures



0 40' 80'

- EXISTING CONDITIONS SITE PLAN MAP

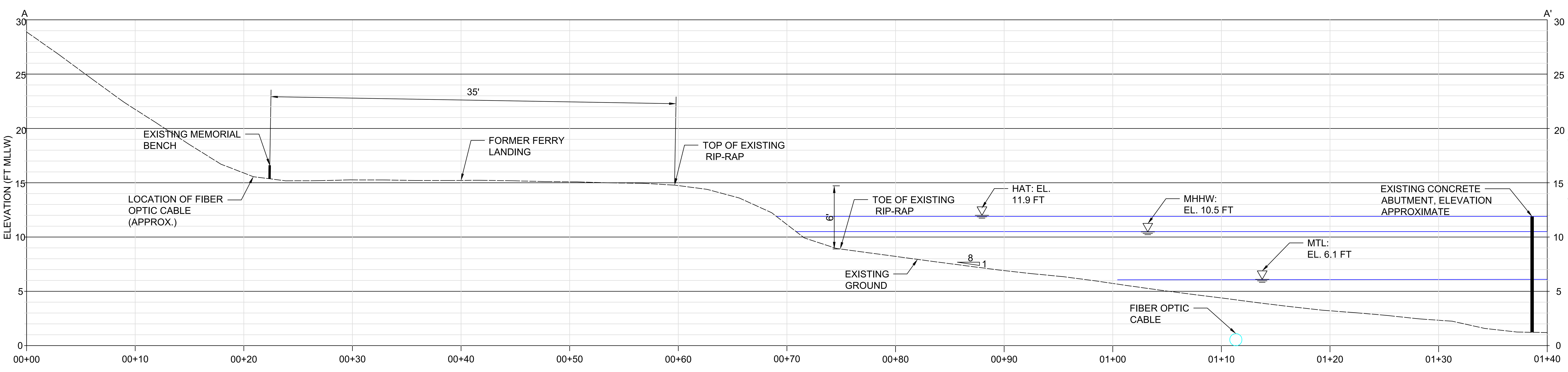
Scale: 1:40

1 ABUTMENT

VIEW SOUTH-EAST

2 INTER-TIDAL BEACH

VIEW NORTH-WEST



NOT FOR CONSTRUCTION

0 5' 10'

A EXISTING CONDITIONS - SECTION A

Scale: 1:5

Notes:

1.TOPOGRAPHY BASED PSLC LIDAR
2. JULY 2018 GOOGLE EARTH BACKGROUND AERIAL IMAGERY
3. ALL DIMENSIONS IN FEET.
4. ELEVATIONS PROVIDED RELATIVE TO MEAN LOWER LOW WATER (MLLW).
CONVERSION:
0 FT NORTH AMERICAN VERTICAL DATUM (NAVD88) = 2.0 FT MLLW (BASED ON VDATUM)
5. EXTENT OF ARMOR, ROAD LOCATION, GRASS AREA, AND BENCH LOCATIONS DETERMINED BY BLUE COAST ENGINEERING (RTK SURVEY) IN MARCH 2020

REV:	DESCRIPTION:	BY:	DATE:
A	CONCEPT FOR DISCUSSION ONLY.	GC	06/25/2020

STATUS: CONCEPTUAL DESIGN

BLUE COAST ENGINEERING

CLIENT: NORTHWEST STRAITS FOUNDATION
ISLAND COUNTY DNR

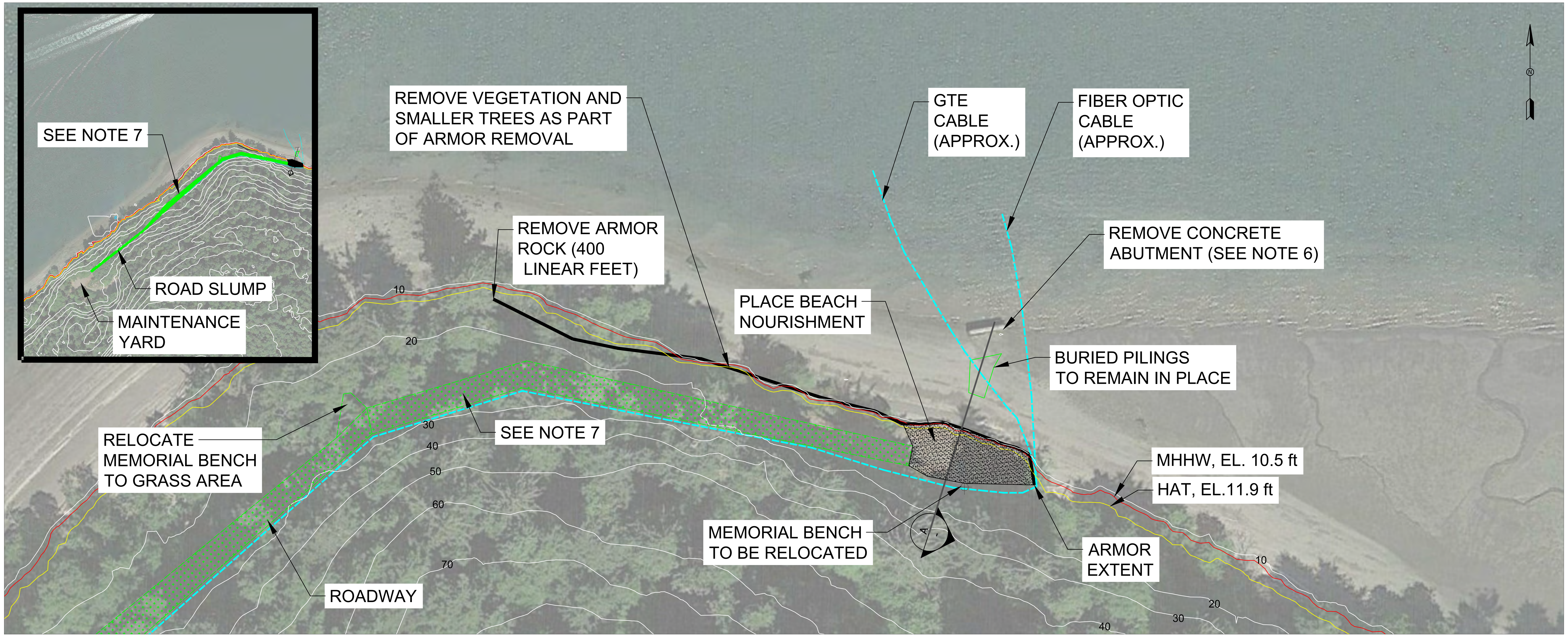
ENGINEER: BLUE COAST ENGINEERING
18320 47TH PL NE
LAKE FOREST PARK, WA
98155

SITE: ISLAND COUNTY
HOYPUS RESTORATION

TITLE: EXISTING CONDITIONS

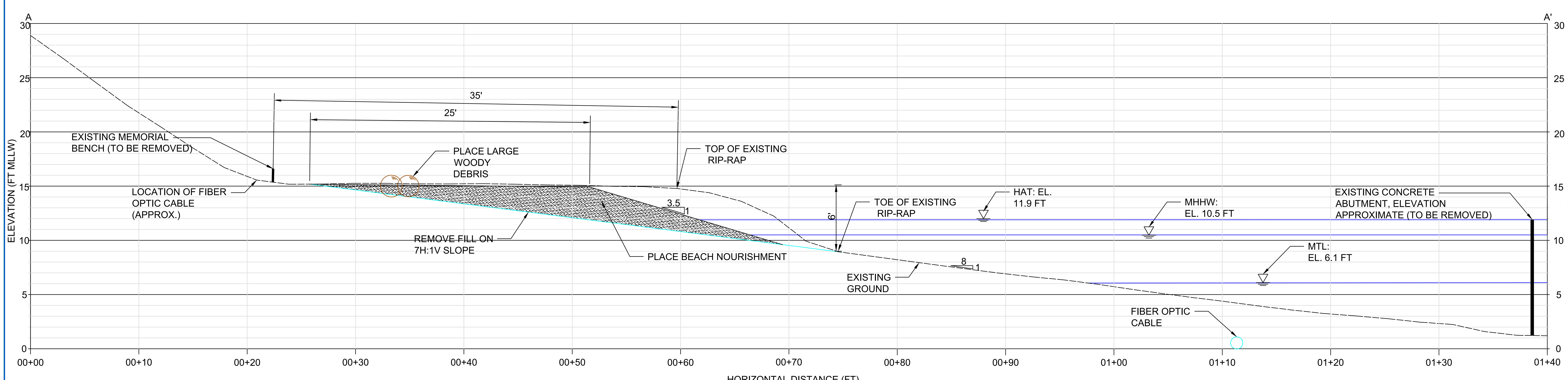
SCALE AT A1:	DATE:	DRAWN:	CHECKED:
1:5, 1:40	06/25/2020	GC	KK

PROJECT NO:	SHEET NO:	REVISION:
0903-2001	01	A



PROPOSED RESTORATION SITE PLAN MAP

Scale: 1:40



NOT FOR CONSTRUCTION

A SECTION A - CONCEPT 1

Scale: 1:5

Notes:

1.TOPOGRAPHY BASED PSLC LIDAR
2. JULY 2018 GOOGLE EARTH BACKGROUND AERIAL IMAGERY
3. ALL DIMENSIONS IN FEET.
4. ELEVATIONS PROVIDED RELATIVE TO MEAN LOWER LOW WATER (MLLW). CONVERSION:
0 FT NORTH AMERICAN VERTICAL DATUM (NAVD88) = 2.0 FT MLLW (BASED ON VDATUM)
5. EXTENT OF ARMOR, ROAD LOCATION, GRASS AREA, AND BENCH LOCATIONS DETERMINED BY BLUE COAST ENGINEERING (RTK SURVEY) IN MARCH 2020
6. EXISTING CONCRETE ABUTMENT DOES NOT SIGNIFICANTLY IMPACT COASTAL PROCESSES AT THE SITE. IT MAY BE LEFT IN PLACE IF RISK TO NEARBY FIBER OPTIC CABLE LINES IS DETERMINED TO BE HIGH.
7. REMOVE ASPHALT FROM ROADWAY AND PLACE ADA COMPLIANT GRAVEL

REV:	DESCRIPTION:	BY:	DATE:
A	CONCEPT FOR DISCUSSION ONLY.	GC	06/25/2020

STATUS: CONCEPTUAL DESIGN

BLUE COAST ENGINEERING

CLIENT: NORTHWEST STRAITS FOUNDATION
ISLAND COUNTY DNR

ENGINEER: BLUE COAST ENGINEERING
18320 47TH PL NE
LAKE FOREST PARK, WA
98155

SITE: ISLAND COUNTY
HOYPUS RESTORATION

TITLE: CONCEPTUAL DESIGN

SCALE AT A1:	DATE:	DRAWN:	CHECKED:
1:5, 1:40	06/25/2020	GC	KK

PROJECT NO:	SHEET NO:	REVISION:
0903-2001	02	A

APPENDIX E

Engineer’s Opinion of Construction Cost

Appendix E - Engineer's Estimate of Probable Construction Cost - Hoypus Point Restoration Project

Costs Associated with Concept Level (10%) Design

	Project Element	Qty	Unit	Unit Cost		Subtotal
1. Site Preparation						
a.	Improvements to road for site access	1	LS	$10,000.00	$	10,000
b.	Utility locate (including intertidal area)	1	LS	$2,000.00	$	2,000
c.	Protect fiber optic cable in place	1	LS	$5,000.00	$	5,000
d.	Temporary erosion control measures	1	LS	$5,000.00	$	5,000
b.	Remove memorial bench and reinstall in new location	1	LS	$1,000.00	$	1,000
Subtotal Mobilization and Site Prep					**$**	**23,000**
2. Shoreline Restoration						
a.	Clear and Grub Vegetation	0.05	Acre	$9,300.00	$	465
b.	Remove armor rock from shoreline and stockpile at maintenance yard	500	CY	$15.00	$	7,500
c.	Remove concrete debris from shoreline and recycle	220	CY	$20.00	$	4,400
d.	Excavate and dispose of fill (soils)	100	CY	$20.00	$	2,000
e.	Purchase and place beach substrate	50	CY	$120.00	$	6,000
f.	Purchae and place large woody material on backshore	8	EA	$1,000.00	$	8,000
g.	Riparian plantings, including mulch and topsoil	1	LS	$15,000.00	$	15,000
Subtotal Shoreline Restoration					**$**	**43,365**
3. Trail Improvements						
a.	Remove asphalt pavement within extent of armor removal and dispose of off site	450	SY	$20.00	$	9,000
b	Install ADA gravel between grassy area and project area	40	CY	$50.00	$	2,000
c.	Remove asphalt pavement from WA Parks maintence area to the start of armor removal	1800	SY	$20.00	$	36,000
d.	Install ADA gravel between WA Parks maintence area and start of armor removal	150	CY	$50.00	$	7,500
Subtotal Trail Improvements					**$**	**54,500**
4. Remove Abutment						
a.	Site preparation on beach	1	LS	$5,000.00	$	5,000
b.	Cut and removal of concrete structure	1	LS	$50,000.00	$	50,000
c.	Purchase and place beach substrate for backfill	20	CY	$120.00	$	2,400
d.	Additional temporary erosion control measures	1	LS	$5,000	$	5,000
Subtotal Remove Abutment					**$**	**62,400**
Subtotal for All Work Elements (#1 through #4 above)					**$**	**183,265**
				Mobilization (20%)	$	36,653
				Design & Construction Contingency (20%, inclusive of all work)	$	43,984
				Subtotal Const.+ Dredging Mob.+ Mob. + Conting.	$	263,902
				Sales Tax (8.7%)	$	23,487
				Subtotal Const. + Mob + Conting. + Tax	**$**	**287,389**
				Total Cost*	**$**	**288,000**

In providing opinions of probable construction cost, the Client (Island County) understands that Blue Coast 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.

All costs are in 2020 dollars.