SNOHOMISH COUNTY FISH AND WILDLIFE HABITAT CONSERVATION AREAS (FWHCA) ASSESSMENT

Hat Island Submarine Power Cable Replacement Project

October 23, 2024

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HAT ISLAND SUBMARINE POWER CABLE REPLACEMENT PROJECT

OCTOBER 23, 2024

Prepared for:

Snohomish County Public Utility District No. 1
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Abbreviations

BMPs	Best Management Practices
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FF	Forage Fish
FR	Federal Register
FWHCA	Fish and Wildlife Habitat Conservation Area
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drill

LUCAAR	Land Use, Critical Area and Archaeology Review
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
NFIP	National Flood Insurance Program
NMFS	National Marine Fisheries Service
NNL	No Net Loss
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
OHWM	Ordinary High-Water Mark
PHS	Priority Habitat Species
SAV	Submerged Aquatic Vegetation
SC	Snohomish County
SCC	Snohomish County Code
SnoPUD	Snohomish County Public Utilities District No. 1
SRKW	Southern Resident Killer Whale
TPN	Tax Parcel Number
TPZ	Tree Protection Zone
USACE	U. S. Army Corps of Engineers
USDA	U. S. Department of Agriculture
USGS	U. S. Geological Service
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WNHP	Washington Natural Heritage Program

1. General Information

Applicant: Snohomish County Public Utility District, No. 1
P.O. Box 1107
Everett, WA 98206

Contact: Kim Middleton, Jen-Jay Inc.

Office Phone: (360) 376-4664

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Physical location of proposed work:

Hat Island Community Association, Inc. Property
17D East Marine View Drive
Everett, WA 98201
Tax Property Number: 00466300003001
Section 08, Township 29, Range 04, Quarter NE, Neighborhood Code 2418000
Lat./Long: 48.01885° N; 122.32208° W
Water body: *Possession Sound*

1.1. No Net Loss Determination

Snohomish County Code (SCC) defines no net loss of shoreline ecological functions as “(1) All proposed land uses, modifications, development or new agricultural activities shall be designed and conducted to achieve no net loss of shoreline ecological functions as defined in WAC 173-26-201(3)(d)(i)(C); and (2) Project proponents shall make all reasonable efforts to avoid and minimize impacts to wetlands, fish and wildlife habitat conservation areas, and their buffers as required under SCC 30.62A.310(3)(a)” (SCC 30.67.320).

No net loss determinations are made by a qualified biologist. Snohomish Public Utility District No. 1 produced the project drawings dated March 17, 2023 (**Appendix 1**). Jen-Jay, Inc. performed both a Preliminary Eelgrass Macroalgae Habitat Survey and site visit on June 11, 2023 (**Appendix 2**). Haley & Aldrich, Inc. created a Geotechnical Report September 1, 2023 (**Appendix 3).** Tetra Tech, Inc. performed all necessary bathymetry to accurately locate appropriate placement of the proposed replacement submarine cable between Hat Island and the Port of Everett (**Appendix 4**). A vicinity map and site photos are included in **Figure 1**.

Figure 1. Aerial image showing Hat Island Community Association, Inc. property and proposed project site with location of HDD ingress and egress. Site photos include (**A**) the southern span of coastline taken from the shore in front of the proposed work site; (**B**) the northern span of coastline taken from the shore in front of the proposed work site showing the cable crossing sign.

2. Project Description

The project is the replacement and rerouting of a submarine power cable between Hat (Gedney) Island and the Port of Everett. Jen-Jay, Inc. has been hired by Snohomish Public Utility District (SnoPUD) Number (No.) 1 to evaluate critical areas and ecological functions and values present in the vicinity of the proposed replacement submarine power cable that serves Hat Island. This study is to fulfill all the requirements of the Critical Areas Study as described in Snohomish County Code (SCC) 30.62A.140.

Both proposed ends of the replacement submarine power cable are located within Snohomish County; however, the Port of Everett falls under the jurisdiction of the Town of Everett. As such, a separate Fish and Wildlife Habitat Conservation Areas Assessment has been composed for the Town of Everett to discuss the proposed submarine power cable replacement termination point on the mainland within the Port of Everett.

This Wildlife Habitat Conservation Areas Assessment for Snohomish County specifically addresses the proposed Hat Island site location immediately south of Hat Island Marina on Hat Island, Washington, where the replacement submarine power cable terminates on Hat Island under Snohomish County's jurisdiction.

Snohomish Public Utility District No. 1 (SnoPUD) is the twelfth largest public utility in the United States and the second largest in Washington state. SnoPUD serves the 875,000 residents of Snohomish County and Camano Island at over 373,000 homes and businesses. SnoPUD also supplies water service to over 23,000 homes. The public utility's territory covers more than 2,200 square miles (SnoPUD 2024).

Hat (or Gedney) Island is a small, 436-acre, private island located west of Everett, WA, and in between Whidbey and Camano Islands in *Possession Sound*. The island is the permanent or vacation home to approximately 260 families. The island is serviced by a passenger ferry and bus, and houses several community beaches, a fire station, a yacht and golf club, a 9-hole golf course, and a 127-slip marina. The island is small and without stores so vehicles on island are simply used to transport people from the ferry to their respective homes (HICA 2024).

Snohomish PUD No. 1 provides electrical service to Hat Island via an existing, near-50-year-old submarine power distribution cable. This 12kV electrical distribution cable extends from Mission Beach, west of Marysville, WA, on the Tulalip Reservation, to Hat Island, covering a distance of approximately 16,000 feet. SnoPUD serves Hat Island from the Tulalip substation, circuit 12-507. The electric service also powers the island's drinking water system. The existing, three-phase cable was installed in 1974. It is nearing the end of its serviceable life and is at risk of failure, with only two of the three conductors currently functioning. The lost phase, which occurred mid channel, indicates that the waterproof function of the cable is compromised. The compromised cable could lose another phase at any time, and the power cable is the only source of power to Hat Island and its residents. The new cable installation is proposed in order to avoid a potential emergency situation which would isolate the residents of Hat Island from electric service.

The proposed project is the installation of a new, 3.8-inch three-phase electric submarine cable from the mainland within the Port of Everett to service Hat Island. To continue reliable service to district customers, the existing cable will remain energized while the new cable is installed.

The existing mainland cable termination point currently runs beneath an occupied residence. A new cable route is proposed to be located south of the existing cable to ensure protection of the existing cable during installation activities and to facilitate the Port of Everett landfall location near the northern *Pigeon Creek* shoreline on the mainland side.

The proposed 3.8-inch three-phase submarine cable with fiber optics will be directly laid on the seafloor. At the two landfall sites, the cable will be installed through a high-density polyethylene (HDPE) conduit that has been previously installed using horizontal directional drilling (HDD) and connected to the submarine cable termination vault. The proposed HDPE conduit will have an outer diameter of 10 inches and will be drilled to an approximate depth of 50 feet before daylighting on the seafloor at approximately -30' MLLW, which is approximately 500 linear feet waterward from the HDD entry point on the Hat Island Community Association property and a minimum of 25 feet waterward of the eelgrass bed (project drawings, Appendix 1). HDD techniques were determined to be the best option to prevent the submarine cable from impacting hardshell clam areas and eelgrass habitat.

2.1. Project Site Description

The proposed submarine cable replacement project is located across *Possession Sound* and terminates in two locations: on the southwest end Port of Everett properties in Everett, WA, at TPN 29042500400200 and adjacent to the southern end of the Hat Island Marina on Hat Island Community Association, Inc. property at TPN 00466300003001 (SCOPI 2024). The shoreline description at the project location was determined using the Federal Emergency Management Agency (FEMA) Flood Hazard Zones (FEMA 2024); Washington Department of Fish and Wildlife (WDFW) Priority Habitat Lists (WDFW 2024 PHS); WDFW Forage Fish Spawning Maps (WDFW 2024 FF); Washington Department of Ecology (WDOE) Coastal Atlas (WDOE 2024 Atlas); Washington Department of Natural Resources (WDNR) Forest Practices Map (WDNR 2024 FPAMT); WDNR Natural Heritage Program (WNHP) (WDNR 2024 WNHP); WDNR Natural Hazards (WDNR 2024 Hazards); Snohomish County Assessor (SCOPI 2024); as well as a Preliminary Eelgrass and Macroalgae Habitat Survey (Appendix 2) and a site visit, both conducted on June 11, 2023, by Jen-Jay, Inc.

2.1.1. Parcel Description

Snohomish County zones the Hat Island Community Association, Inc. parcel as Rural Business (RB). The parcel is accessible from the dirt road, East Marine View Drive. The parcel is developed with utilities, an outdoor picnicking shelter, a small outbuilding, and recreational facilities. The property is primarily dirt and sand with large quantities of beach-accrued woody material stacked along the upper beach. There is a driftwood-cleared area for beach access for smaller recreational watercraft such as kayaks, paddleboards, and small shore-launched sailboats. There is native and non-native vegetation including grass, shrubs, and a smaller tree.

The upper tidal zone is heavily lined with large woody debris. Shoreline ecological functions present at the proposed project site include attenuation of wave and tidal energy; recruitment and redistribution of large woody debris and other organic matter; storage of water and sediment; vegetation support; provision of habitat for native aquatic and shoreline-dependent fish and wildlife through space and conditions for reproduction, resting, hiding, and migration, as well as food production and delivery.

2.1.2. Vegetation Habitats

Coastal Atlas indicates that patchy fringe eelgrass (*Zostera marina*) exists along the shoreline at the project site, and that the nearest documented patchy fringe kelp is located on the southwest tip of Hat Island approximately 1.5 miles southeast of the project site. A site visit and a Preliminary Eelgrass and Macroalgae Habitat Survey were both conducted by Jen-Jay, Inc. on June 11, 2023 (Appendix 2). The submerged aquatic vegetation (SAV) pertinent to the Hat Island landfall is detailed below as per each nearshore marine habitat region.

- **Upland:** a flat, modified slope developed with recreational facilities, dirt road access, and driftwood-cleared beach access. Minimal native and non-native vegetation lines the accrued driftwood tidal line on sand and dirt bare soils.
- **Upper Shore Zone (+5’ MLLW to HAT):** substrate is sandy mud and is devoid of vegetation.
- **Lower Shore Zone (-10’ MLLW to +5’ MLLW):** substrate is sandy mud with 0-6” rocks; 5% cover of filamentous green algae in the +3’ to +5’ MLLW; eelgrass (*Zostera marina*) present from approximately +3’ MLLW to -8’ MLLW along the proposed submarine power cable route.
- **Deep Shore Zone (deeper than -10’ MLLW):** substrate is sand with no detected submerged aquatic vegetation.

Eelgrass habitats will be discussed further in the Critical Areas section 3.1.1 Coastal Vegetation.

2.1.3. Presence of Forage Fish and Shellfish Areas

Hardshell clam presence is documented in the nearshore habitat of the northeast coast of Hat Island and Pacific sand lance spawning habitat is documented on the shoreline of the project site (Figure 2). The nearest pre-spawner herring holding area is documented approximately one mile northeast of the project site in the passage between Camano Island and *Tulalip Bay* on the mainland. The nearest herring spawning area is approximately three miles northeast of the project site inside *Tulalip Bay*. Forage fish and shellfish areas of concern will be discussed further in the Critical Areas Section 3.1.2 Forage Fish and Shellfish Areas.

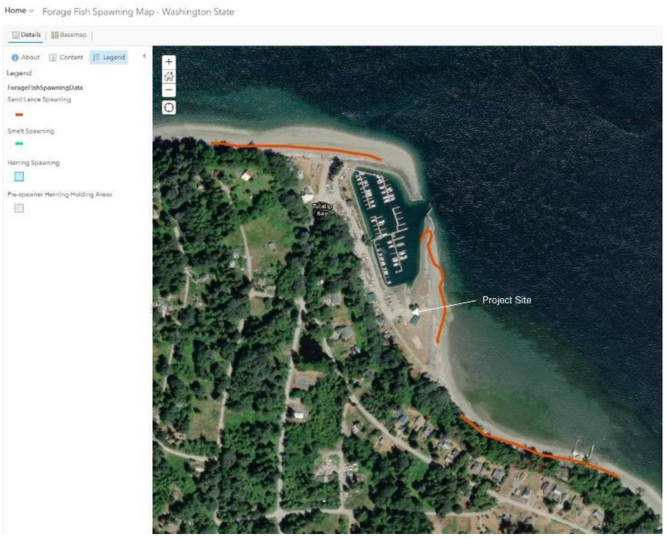

Figure 2. WDFW Forage Fish Spawning Map showing Pacific sand lance spawn along the beach at the project site.

2.1.4. Flood Plain

The shoreline at the project site is located within a Special Flood Hazard Area designated as AE with base flood elevation of +14' MLLW. The project site occurs within a FEMA flood hazard area zoned “AE” meaning that floodwaters are likely to be low velocity and without significant breaking waves. The HDD project site is approximately +20' MLLW and is not anticipated to be affected by flood inundation during drilling. The cable will be in the HDD drilled conduit or lying on the seafloor and will be protected from flooding.

2.1.5. Coastal Landform Characteristics

The Coastal Atlas documents the shoreline at the proposed project site as modified. The shoreline can be characterized as an accretion shoreform with littoral drift moving from north to south. The next parcel to the south contains a transport zone, with a feeder bluff documented approximately 600 feet south of the proposed work site (Figure 3).

Figure 3. DOE Coastal Atlas showing the various coastal landforms at the project site.

2.1.6. Inland Water

Freshwater is found in the atmosphere, on the Earth's surface, and underground. Surface freshwater ecosystems consist of rivers, streams, lakes, reservoirs, ponds, and wetlands (USGS 2018). These ecosystems are crucial for life and provide drinking water, water for agriculture, energy production, habitats for aquatic life, recreational opportunities, water purification and storm and flood relief. Freshwater is considered a renewable resource.

The project site will be on a developed dirt access road and the Washington DNR Forest Practices Map does not document any freshwater features on or near the project site.

2.1.7. Geologically Hazardous Areas

The immediate shoreline at the project site is classified as Pleistocene continental glacial drift. The geotechnical report conducted by Haley and Aldrich (Appendix 3) describes the project site at Hat Island as having an approximately 35 feet beach and bluff deposits over a dense layer of glacially overridden soils.

The project site shoreline is documented on Coastal Atlas as modified and has very low and gradual slopes upwards to an approximate elevation of +20' MLLW at the power cable landfall site. The cliff upland to the project site is classified as unstable. The entire marine coastline of Washington State is susceptible to tsunamis inundation. The areas bordering Puget Sound that are most prone to inundation flooding occur in lowland areas. The project parcel has documented seismic hazards with high liquefaction susceptibility.

Haley & Aldrich, Inc. composed a soil conditions memorandum for subsurface traits at the proposed relocation site of the submarine cable at both the Hat Island and the Port of Everett sites. The conclusions of these geotechnical observations are detailed in their report dated September 1, 2023 (Appendix 3).

2.1.8. Presence of Species of Concern

Some species of concern may occur at or near the project site. For waterfront property, some salmon and rockfish species have the potential to be present in the nearshore habitat of the project site. Salmon and rockfish will be discussed further in the Species of Concern Section 3.2.1 Salmonids and Section 3.2.2 Rockfish.

Endangered Species Act (ESA) listed marine mammals, such as humpback, gray, and Southern Resident Killer Whales (SRKW), may be found throughout Puget Sound. The project site is located within quadrate 384 with 54 SRKW sighting days documented from 1999-2022 within the work window for tidal reference area #7 of July 15th to February 15th. There is a moderate probability of these whales occurring in the vicinity of the project site. Whales will be discussed further in the Species of Concern Section 3.2.3 Marine Mammals.

Pacific sand lance, hardshell clam, and Dungeness crab all have the potential to be in the project area and will be discussed further in the Species of Concern Section 3.2.

2.2. Construction Techniques and Sequencing

The proposed submarine power cable installation between the Port of Everett and Hat Island will be conducted in compliance with all requirements set forth by county, state, and federal agencies. HDPE conduit will be installed using HDD at both landfalls to avoid sensitive habitats, potentially contaminated soils, and interference with other easements. The new submarine cable will be installed into the conduit from the waterward end and threaded through the conduit. The cable will be directly laid on the seafloor from reels on a construction barge and installed into the conduit on the other side. The cable will be connected to the submarine cable junction vault at each of the landfall project sites. Installation is expected to take place in two steps: HDPE conduit installation via HDD on both landfalls and cable installation via a construction barge from the Port of Everett to Hat Island. The following construction techniques and sequencing have been provided by the project managers at Snohomish Public Utility District No. 1, Jessica Spahr and Eric Schneider.

Horizontal Directional Drilling (HDD) is a trenchless pipeline installation technique during which a horizontal directional drill rig is used to install the pipeline beneath the substrate. An HDD pilot bore is advanced along a pre-determined alignment beneath the seabed to the exit point where the bore will emerge to the surface of the seafloor. Clean bentonite clay drilling fluid is used to help facilitate the drilling of the bore and keep the bore hole open during the multiple steps of the drilling operation. It is anticipated that small amounts of bentonite clay will disperse to the unvegetated seabed at the exit point.

To avoid disturbances of potentially contaminated substrate and other utilities above the HDD route, the bore will be located up to 50 feet below the surface of the seabed to prevent what is known as “frack-out.” Frack-out occurs when a shallow HDD operation forces excess drilling fluid (clay) upward through the interstitial spaces in the seafloor substrate, depositing clay in an undesired location. For sensitive SAV like eelgrass, which is found on the Hat Island side of the proposed cable route, this fine clay can cause shading of the vegetative species that might diminish the health of the eelgrass bed. Locating the bore approximately 50 feet below the eelgrass bed and locating the bore exit-point a minimum of 25 feet beyond the waterward edge of eelgrass habitat, minimizes the likelihood of disturbing this important vegetation.

At the completion of the borehole preparation, the conduit is connected to the pull-head for simultaneous installation as the drill rod and reamer are retracted from the borehole for the final time. The two ends of the conduit will be capped until the cable is ready to be installed.

The cable will be direct-laid along the unvegetated substrate in the deeper portions of *Possession Sound* from a barge-mounted spool using support vessels and divers. At the Hat Island landfall site, the cable will be spooled out and floated on the surface. A diver and support vessels will position the cable end down to the waterward end of the HDD preinstalled conduit. A diver will assist the cable being fed through the conduit where it will be trenched to the existing infrastructure. The method employed on the Hat Island side of the cable route will be similar on the Port of Everett termination point. The total length of the submarine cable is approximately 30,000 feet from termination vault to termination vault.

2.2.1. Pre-fabrication

The new submarine power cable, HDPE conduct, power vault, and fiber splice vault will be prefabricated. Materials and equipment will be brought to the Hat Island project site by trucks transported on a barge or landing craft.

2.2.2. Site Preparation

Construction crew will examine the tidelands surrounding the project site to ensure a safe access corridor for the barge to reach all project components without risk of hull or substrate damage.

2.2.3. Construction Access

HDD construction equipment will access the landward project site from a ferry, barge, or landing craft. Construction access to the waterward site to install the cable will be from a construction barge.

2.2.4. On-site Construction

Horizontal directional drilling (HDD) will be used to install a HDPE conduit to traverse the upland termination point with a predetermined offshore exit point (see Appendix 1). Best management practices (BMPs) will be implemented to prevent construction-related pollution from entering the nearshore or offshore habitats. These BMPs will include, but are not limited to, on-site materials (straw wattles, silt fencing, etc.) for erosion control and a frac-out contingency plan to prevent silt-laden water from entering the nearshore during HDD.

The submarine power cable will be fed into the preinstalled conduit and then laid directly on the seafloor using a construction barge. On the upland landfall site on Hat Island, the cable will exit the conduit and be connected to the newly installed power vault and fiber splice vault, then attached to the existing infrastructure via trenched in conduit.

2.2.5. Equipment Used

Ferries, barges, or landing craft will be used to transport equipment, materials, tools, and personnel to the Hat Island landward construction site. An excavator, drill rig, and associated equipment will be used during HDD and conduit installation. Whenever possible, hand tools will be used during construction to assemble new components for the submarine power cable terminal structure.

Barge stern-mounted spools of cable will be used to install the new submarine power cable. Power tools and hand tools will be used to trench in conduit from the HDD upland exit point to the disassemble and reattach the submarine cable components to the electrical transformer on Hat Island.

2.2.6. Materials Used

Approximately 30,000 feet of three-phase submarine cable and approximately 1500 feet 10-inch HDPE conduit.

2.2.7. Work Corridor

Vehicles, equipment, and personnel will operate along the dirt driveway and parking area at the landward cable access point near the Hat Island Marina, as well as on the water via the construction barge. Work will be isolated to the locations where the landward HDD conduit installation is taking place and the marine regions covered by the construction barge to unreel the new submarine cable along the seabed. The work corridor will include areas wide enough for necessary equipment to access the sites.

2.2.8. Staging Area and Equipment Washouts

Staging for upland activities for the HDD will occur on the existing driveway and parking area adjacent to the upland cable access point. When finished, all construction equipment will be loaded onto work trucks and transported to an approved, contained area for washouts. All waterward staging activities will occur on the construction barge. Equipment wash outs will not occur at the project location in the marine setting. Any necessary wash outs will occur at an approved facility.

2.2.9. Stockpiling Areas

The barge and upland cable termination areas will hold all construction materials during the project. All construction debris will be stored for later disposal at an approved upland facility upon completion of the project.

2.2.10. Running of Equipment During Construction

Equipment will be running off and on throughout the on-site construction phase. All equipment will be kept in good running order, free of leaks or debris, and will be running only when required.

2.2.11. Clean-Up and Re-vegetation

All barge-related construction debris will be stored on the barge for later disposal at an approved upland location. Upland construction areas will be cleaned of all construction debris. All construction equipment and debris will be removed to an approved upland facility for storage or disposal upon completion of the project. Disturbed soil will be returned to the existing condition prior to the commencement of project activities.

2.2.12. Project Timing and Work Window

All proposed construction and barge access will take place during WDFW and Army Corps of Engineers (ACOE) approved in-water work windows for the protection of fish in Tidal Reference Area 7. Due to the use of HDD to avoid sensitive habitats, the proposed work window for this project is July 15th – February 15th, at appropriate tides during daylight hours. This work window is proposed to protect sensitive salmonid and forage fish species which may use the waters near the project area.

2.2.13. Duration of Construction

On-site construction timing is to be determined by the contractor, but it is anticipated to take no more than two weeks.

3. Critical Areas and Species Impact Assessment

The installation of an approximately 6-mile replacement submarine power cable between Hat Island's existing power vault and the Port of Everett's access site has a variety of possible effects to critical areas and species within those regions.

The potential effects from the proposed project include the following:

1. Grounding the barge during cable installation.
2. Deleterious materials enter the water during construction.
3. Impacts to wildlife due to increased noise, particularly noise associated with horizontal directional drilling (HDD).
4. Impacts due to barge and HDD activities, such as oil discharge, drilling fluid, or other hazardous substances.
5. Temporary, increased turbidity in the water column due to horizontal directional drilling and cable installation.

6. Increased benthic hard substrate in the form of a submarine power cable.
7. Disturbance to spawning forage fish and other sensitive fish species.

Construction activities will be done in a manner that will minimize the overall potential effects on critical areas caused by the proposed actions. These activities will be conducted during approved work windows and appropriate hours and tides and with the implementation of best management practices laid out in WDOE Storm Water Management Manual for Western Washington Volume II (WDOE 2024). to prevent potential negative effects to identified sensitive species and critical habitats located within 300 feet of the proposed development. Impacts will also be reduced by using appropriate construction design, techniques, and best management practices (BPMs), and are outlined in Section 5.1 Conservation Measures.

3.1. Critical Areas

Critical areas are important habitats for the protection of valuable ecosystems and the ecological services they provide. The critical areas and buffers that are located within 300 feet of the proposed project site and may be affected by project activities are identified in Table 1. Site data is based on information provided by the Federal Emergency Management Agency (FEMA) Flood Hazard Zones (FEMA 2024); Washington Department of Fish and Wildlife (WDFW) Priority Habitat Lists (WDFW 2024 PHS); WDFW Forage Fish Spawning Maps (WDFW 2024 FF); Washington Department of Ecology (WDOE) Coastal Atlas (WDOE 2024 Atlas); Washington Department of Natural Resources (WDNR) Forest Practices Map (WDNR 2024 FPAMT); WDNR Natural Heritage Program (WNHP) (WDNR 2024 WNHP); WFDNR Natural Hazards (WDNR 2023 Hazards); Snohomish County Planning and Development Services (SC 2022 PDS Map Portal); as well as a Preliminary Eelgrass Macroalgae Habitat Survey (Appendix 2) and site visit on June 11, 2023, by Jen-Jay, Inc.

Table 1: Critical areas and buffers that are located within 300 feet of the proposed project site and may be affected by project activities.

Critical Areas	Mapped at Site	Occurrence	Impact
Coastal Vegetation	Fringe patchy eelgrass	Occurs	NNL
Forage fish, shellfish	Pacific sand lance; hardshell clams	Occurs	NNL
FEMA Flooded Areas	AE (EL +14’)	Occurs	NNL
Coastal Landforms	None	Does not occur	NNL
Inland Water	None	Does not occur	NNL
Terrestrial Habitats	None	Does not occur	NNL
Geologically Hazardous Areas	Tsunami; flood; seismic hazard	Occurs	NNL

EL = Elevation Level in feet MLLW; **NNL** = No-net loss

3.1.1. Coastal Vegetation

Sensitive and important submerged aquatic vegetation (SAV) is common in the nearshore environment within *Possession Sound*. Eelgrass and kelp are known to be valuable habitats for forage fish, as well as a nursery ground for numerous other valuable and protected fish species such as rockfish and salmon. Loss of eelgrass and kelp habitat can play a significant role in the degradation of the nearshore marine food web and lead to population declines in numerous sensitive species.

Submerged Aquatic Vegetation

Patchy fringe eelgrass (*Zostera marina*) has been documented at the project location. A Preliminary Eelgrass and Macroalgae Habitat Survey was conducted by Jen-Jay, Inc. on June 11, 2023 (Appendix 2). Kelp was not documented at the site, but eelgrass was observed throughout the survey area between +3’ MLLW and -8 MLLW.

The use of horizontal directional drilling (HDD) will entirely avoid placement of the cable within the demarcated eelgrass habitat in the nearshore of Hat Island. The landward HDD access entry point is located at an approximate 20’ elevation and well clear of any eelgrass habitat. Similarly, the waterward HDD cable exit point is proposed at approximately -30’ MLLW and at least 25 feet waterward of eelgrass habitat. The construction barge will have sufficient depth to prevent grounding during construction activities. With these measures in place, along with using best management practices, no long-term adverse impacts to SAV habitats are expected based on the project proposal.

No net loss of eelgrass or kelp habitat is anticipated.

3.1.2. Forage Fish and Shellfish Areas

Forage Fish Spawning and Holding Areas

In marine ecosystems, forage fish frequently serve as crucial trophic connectors, bridging the gap between zooplankton and the wide array of fish-eating species that populate the *Salish Sea* (Seldon and Baker 2023). Forage fishes are small schooling species that are prey for sea birds, marine mammals, and other fishes including Pacific salmonids. Surf smelt (*Hypomesus pretiosus*) ranges from *Prince William Sound*, Alaska to Long Beach, California, and spawns on many beaches in *Puget Sound*. Surf smelt spawn on beaches with a sand and gravel mix, with a grain size about 1-7 mm, at approximately +7' MLLW to the extreme high water (EHW). Pacific sand lance (*Ammodytes personatus*) is found from the Aleutian Islands of Alaska to Southern California and spawn on appropriate beaches scattered throughout *Puget Sound*. The Pacific sand lance spawning beach preference can overlap with surf smelt with a wider range between +5' MLLW to EHW. Pacific sand lance spawn on a beach composed of finer sand and gravel with most of the grain size ranging from 0.2-0.4 mm in diameter. The Pacific herring (*Clupea pallasii*) are a pelagic species found throughout the northern *Pacific Ocean*. Within Puget Sound, Pacific herring move into nearshore areas and congregate into specific holding areas before spawning. Pacific herring spawn in shallow waters by depositing their sticky eggs on submerged aquatic vegetation or rocky substrate mainly between late January to early April (Penttila 2007 and Froese and Pauly 2024). Adults and juveniles of forage fish species, including Pacific sand lance, surf smelt, and Pacific herring, are typically found occupying or transiting through nearshore habitat throughout northern *Puget Sound* (Allen and Smith 1988; Paul et al. 1997; Yang and Nelson 2000; Mecklenburg et al. 2002). Forage fish could forage, rest, or move within marine areas adjacent to the project site as this is a nearshore area within the *Puget Sound*.

The shoreline at the Hat Island Comm, Inc. parcel has been documented by WDFW as Pacific sand lance spawning habitat. Pacific sand lance (*Ammodytes hexapterus*), also known as Arctic sand lance, is an iridescent silvery blue, grey, and green forage fish which flashes red when spawning. The maximum length of a sand lance fish is 11 inches. The species has a pointed snout, elongated dorsal and anal fins, and a forked tail fin. The species forms schools in both nearshore and offshore environments. Individuals also bury themselves in sandy and pebbly seafloor substrate habitat to depths of up to over 540 feet. Offshore schools tend to stay closer to the water’s surface. Spawning (breeding) grounds of the species occur at high tidal levels on sand-gravel beaches. The species serves as a pivotal prey species for many ecosystems and directly feeds many bird, fish, and marine mammal species. Due to their ecological importance, damage to their spawning habitat can be quite detrimental to local populations (Fretwell, K. and Starzomski, B. 2014).

The nearest pre-spawner herring holding area is documented approximately one mile northeast of the project site in the passage between Camano Island and *Tulalip Bay* on the mainland. The nearest herring spawning area is approximately three miles northeast of the project site inside *Tulalip Bay*. The shoreline at the proposed project site is a sandy mud combination and may serve as potential forage fish spawning habitat. For this reason, it is possible that other forage fish species may use the parcel's shoreline for spawning.

The waterward HDD daylighting of the drill bit through the seafloor substrate at approximately -30' MLLW depth is proposed beyond the eelgrass habitat and potential forage fish spawning habitat. If required by WDFW, a forage fish spawning survey will be conducted prior to the commencement of any beach-related activity following WDFW forage fish survey protocol.

Shellfish Areas

Puget Sound shorelines provide relatively isolated patches of habitat for shellfish. Native littleneck clam (*Prothothaca staminea*), butter clam (*Sexidomus giganteus*), pacific geoduck (*Panopea generosa*), and Olympia oyster (*Ostrea lurida*), as well as non-native Pacific oyster (*Crassostrea gigas*) are listed as WDFW Priority Habitats and Species (PHS). Hardshell clam habitat presence is demarked on the WDFW map of the northern and northeastern coastlines of Hat Island, including that of the proposed project site at the Hat Island Comm, Inc. parcel. The WDOE Coast Atlas shows a prohibited commercial shellfish area including that of the proposed project's nearshore habitat.

Utilizing HDD techniques for installing a conduit that will house the submarine cable as it reaches the landfall site on Hat Island, will minimize impacts to the nearshore habitat. The HDD entry point is proposed to be upland in a driveway with the exit point at approximately -30' MLLW. Best management practices will be implemented throughout the HDD and cable lay procedures. The submarine power cable will lay atop the seabed substrate at depths between -30' MLLW and -450' MLLW. Construction activities are not anticipated to have any long-term effects on shellfish habitat in the nearshore environment.

No net loss of Pacific sand lance or forage fish habitat is anticipated.

3.2. Species of Concern

The significance of a species of concern and their associated habitats can vary between federal, state, and local jurisdictions. National Marine Fisheries Service (NMFS) and Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (WDFW 2024 PHS) species of concern are listed in Table 2.

Table 2: Species of concern that may be near the project site.

Species	Significance	Occurrence	Impact
Rockfish	ESA listed	Yes	NNL
Salmonids	ESA listed, Local importance	Yes	NNL
Dungeness Crab	Vulnerable Aggregations	Yes	NNL
Cetaceans	ESA listed	Yes	NNL

3.2.1. Salmonids

Multiple species of salmonid fish are presumed to use waters surrounding Puget Sound including the waters of San Juan, Skagit, and Whatcom Counties during various life cycle stages. These species include Puget Sound DPS steelhead (*Oncorhynchus mykiss*) listed as threatened under the ESA, updated April 14th, 2014 (79 FR 20802); Puget Sound bull trout (*Salvelinus confluentus*) listed as threatened under the ESA, updated November 11th, 1999 (64 FR 58910); Hood Canal summer-run chum salmon (*Oncorhynchus keta*) listed as threatened under the ESA, updated April 14th, 2014 (79 FR 20802); and Puget Sound ESU Chinook salmon (*Oncorhynchus tshawytscha*) listed as endangered under the ESA, updated April 14th, 2014 (79 FR 20802). Endangered Chinook salmon are of particular conservation concern in the San Juan Islands as they use the archipelago for growth and maturation during their outmigration from their natal freshwater streams.

It is presumed that juvenile salmon, including endangered juvenile Chinook salmon, may use the nearshore areas as important migratory habitat that includes finding prey, such as forage fish and insects. Juvenile salmon use nearshore aquatic vegetation such as kelp and eelgrass for foraging and cover during their migration to the open ocean (Herrera and the Watershed Company, 2011). The documented patchy fringe eelgrass bed could provide prey habitat and thus, foraging opportunities for juvenile salmon.

Sound-producing project elements are proposed and include horizontal directional drilling (HDD). These sounds are anticipated to be extremely low and non-injurious at close range but may result in minimal and temporary behavioral disturbance to individual salmon present at the project location. Temporary disturbance of submerged aquatic vegetation is not proposed as the HDD will allow for the cable to avoid eelgrass habitats as the installed conduit extends approximately 500 feet from shore and at least 25 feet from the waterward portion of the eelgrass bed.

No net loss of salmon is anticipated.

3.2.2. Rockfish

There are 36 species of rockfish (*Sebastes sp*.) found in the *Puget Sound* and *Georgia Basin* areas. Populations in the *Puget Sound* have decreased significantly in the last century due to overfishing and loss of habitat quality (Palsson et al. 2009, Williams et al. 2010). *Puget Sound/Georgia Basin* Distinct Population Segments (DPS) of yelloweye rockfish (*Sebastes ruberrimus*) are listed as threatened, and bocaccio (*Sebastes paucispinis*) as endangered under the ESA, which was made effective on July 27, 2010 (75 FR 22276).

Rockfish are viviparous, giving live birth to larval young. Larvae can inhabit the full water column but mostly occur in the upper 262 feet (Love et al. 2002, Weis 2004). Juvenile yelloweye rockfish typically settle in areas with steep rough terrain with rocky boulders or bedrock and at depths greater than 98 feet and they do not typically occur in shallow nearshore waters (Richards 1986, Yamanaka et al. 2006, Love et al. 2002, Palsson et al. 2009). Juvenile bocaccio rockfish move from open waters to settle onto nearshore benthic habitats. Juvenile yelloweye and bocaccio rockfish have rarely been documented in Puget Sound (Palsson et al. 2009, Obaza et al. 2021).

Adult yelloweye and bocaccio rockfish generally live at depths from approximately 100 to 1,400 feet (Orr et al. 2000, Love et al. 2002). Adults are often found in steep and rough habitats with features such as rocky outcroppings, kelp, bedrock, and areas dominated by cobble-boulder fields. (Yoklavich et al. 2000, Love et al. 2002, Anderson and Yoklavich 2007, Haldorson and Richards 1987, Matthews 1989). Yelloweye rockfish remain near the bottom and have relatively small home ranges, while some bocaccio rockfish have larger home ranges, move long distances, and spend time suspended in the water column (Demott 1983, Love et al. 2002, Friedwald 2009).

Much of the waters of Possession Sound are designated as nearshore critical habitat for bocaccio rockfish (50 CFR 226.224), excluding the Snohomish River outfall into Puget Sound around the City of Everett. Juvenile bocaccio rockfish have not been documented within the Georgia Basin in recent years (Drake et. al 2010), and suitable habitat may not occur near the project site due to a lack of rocks and kelp in the area. Adult listed rockfish are unlikely to be in the nearshore shallow waters around the proposed submarine cable route and landfalls of *Possession Sound* due to the lack of appropriate habitat needs.

Impacts from the submarine conduit and cable installation will be temporary at both the Hat Island and Port of Everett project sites. In the vicinity where the HDD will daylight onto the seabed, there will be temporary disturbance of the substrate and may be an increase in local turbidity. Increased turbidity is anticipated to dissipate within a couple of tidal cycles. There may also be a temporary increase in noise pressure. Noise impacts are not anticipated to be injurious, even at close range, and the cable installation activities will be done in such a way that any rockfish in the area will be able to move away from the project site if disturbed.

No net loss of rockfish is anticipated.

3.2.3. Marine Mammals

Marine mammals found in Washington state include whales, dolphins, porpoise, seals, sea lions, and sea otters. All marine mammals are protected by the Marine Mammal Protection Act (MMPA), and some have protection under the Endangered Species Act (ESA). Gray whales, humpback whales, southern resident killer whales, and sea otters are federally or state ESA-listed marine mammals. Sea otters are found in the western section of the Strait of Juan de Fuca and the northern section of the Washington outer coast. The listed whales are frequently sighted in and around the San Juan Islands and surrounding waters of *Puget Sound*.

Gray whales (*Eschrichtius robustus*) are a medium-sized baleen whale that can weigh up to 45 tons and grow up to 50 feet in length. There are two regional populations in the Pacific Ocean, the endangered Western North Pacific Stock and the delisted Eastern North Pacific Stock (WDFW 2023 GW). A small group of the Eastern stock of gray whales, known as the Sounders, migrate into the Puget Sound in the spring to forage on ghost shrimp in shallow muddy bays mostly near Whidbey Island, Camano Island, and Everett (Cascadia Research Collective 2023). Gray whales may be seen within the proposed cable route in *Possession Sound* during the winter and spring. The proposed project and HDD daylighting offshore is not anticipated to impact gray whales in the area. If directed by the agencies, the HDD drilling could be completed before December when gray whales tend to start congregating and foraging in the area.

Humpback whales (*Megaptera novaeangliae*) are large baleen whales that can weigh up to 40 tons and grow up to 60 feet in length. There are three distinct population segments (DPSs) of humpbacks within Washington, and their habitat geographical range encompasses the entirety of the Salish Sea and outer coast of Washington (WDFW 2023 HW). Due to their size and method of foraging, humpback whales tend to prefer deeper, open waters. According to the Orca Network, there have been more than four humpback whale sightings in *Possession Sound* in the past two years (Orca Network 2024). Humpback whales may be seen within the deeper parts of the proposed cable route in *Possession Sound* but unlikely in the shallower waters near HDD exit points.

The killer whale *(Orcinus orca)* is a medium-sized toothed whale that can weigh up to 11 tons and grow up to 32 feet in length. Killer whales in the Eastern North Pacific region are classed as: offshore, transients (mammal-eating or Bigg's), and resident (fish-eating) (NOAA 2023 KW). Killer whales are geographically distributed throughout the world and can be found within the marine waters of Washington State (WDFW 2023 KW). The Salish Sea resident killer whales are divided into two subgroups: northern and southern. The northern resident killer whales occur in the northern section of the Salish Sea and into Southeast Alaska. The southern residents (SRKW) reside mostly within Puget Sound and nearby coastal waters. These two distinct populations are structured around matrilines and individuals have not been documented to reside within the other's matriline. Over the past few decades, the northern resident population has grown to approximately 300 whales, whereas, the SRKW population has remained precariously low. Recent research has found that the two populations hunt prey differently (Tennessen 2023).

The historical minimum population size of southern resident killer whales was estimated at approximately 140 animals. The population has declined to the current population of approximately 75 individuals due to live capture for use in marine mammal parks; a lack of food, namely Chinook salmon; environmental contaminants; vessel traffic; and under-water noise (NOAA 2023 KW). SRKW were federally listed as endangered under the Endangered Species Act (ESA) in 2006 (70 FR 69903). The transient and offshore populations are stable or increasing, although the species is broadly listed as endangered in Washington state due to the status of the imperiled Southern Residents (WDFW 2023 KW).

Table 3. Southern resident killer whale sightings during the proposed work window (NOAA and TWM 2024).

Month	Sightings in Quadrate 384, northwest *Possession Sound*
July	1
August	2
September	5
October	7
November	18
December	13
January	4
February	4
Total	**54**

Table 3 uses The Whale Museum's (TWM) Orca Master dataset and shows the total sighting days from 1999 to 2022 of southern resident killer whales (SRKW) within the quadrate affected by the project's underwater sound for the Hat Island cable landfall. The number of sighting days in quadrate 384 during the proposed work window months of July 15th to February 15th totals 54.

Activities of an in-water project that may pose potential impacts to SRKW and their critical habitats are underwater noise greater than the assumed background noise for Puget Sound of 120 dB, often associated with pile driving and rock drilling. No pile driving or rock drilling is proposed for this project. The HDD sound is not expected to produce any consequential noise because the drilling occurs beneath the seafloor substrate. No long-term changes to aquatic habitats are proposed. Furthermore, the proposed project is designed to avoid or minimize impacts to nearby fish and wildlife critical habitats with HDD and by utilizing BPMs outlined in Section 5.1 Conservation Measures.

No net loss of ESA-listed marine mammals is anticipated.

3.2.4. Dungeness Crab

Many species of crab can be found in the waters around Hat Island with the most economically valuable being the Dungeness crab (*Cancer magister*). Dungeness crabs are found from California to Alaska. Washington's commercial crab grounds extend from the Columbia River to

Cape Flattery near Neah Bay and include the estuary of the Columbia River, Grays Harbor, and Willapa Bay and within Puget Sound from Everett north to the Canadian border (WDFW 2023 DC). A decline in Dungeness crab since 2013 necessitated the first full seasonal "personal use" harvest closures in 2018, and since 2015 the number of closures has increased in South-Central Puget Sound and Hood Canal (Velasquez 2022). Due to the population decline in Puget Sound, WDFW has identified Dungeness crab as a priority species under WDFW priority habitat and species program.

Dungeness crabs move inshore during the molting and mating season (Diamond and Hankin 1985). Males mate with recently molted females in the late spring and summer. Eggs are not immediately fertilized, and females can store sperm until eggs are fully developed or up to 2.5 years (Hankin et al. 1989). After hatching, larvae are planktonic for about three to four months and metamorphose through six stages until settlement. Juveniles prefer nearshore shallow estuarine areas with protective structures such as pilings or woody debris and primarily feed on fish, shrimp, mollusks, and crustaceans (Fisheries and Ocean Canada 2013). Adults prefer sandy or muddy substrate, eelgrass beds, and feed primarily on bivalves, crustaceans, and fish (Garth and Abbott 1980, Stevens et al. 1982). Along the Pacific coast, Dungeness crab live in the intertidal zone out to a depth of 750 feet, most frequently occurring deeper than 164 feet. The maximum life expectancy of Dungeness crab is 8-13 years (Kashef 2015). Threats to Dungeness crab include low dissolved oxygen levels, fluctuations in temperature and salinity, fisheries, loss or alteration to habitat, and pollutants. Early life stages are most likely to be influenced by human activities due to their reliance on estuarine habitats and high sensitivity to toxins (Dethier 2006).

Utilization of horizontal directional drilling (HDD) and the subsequent submarine power cable installation is anticipated to temporarily disturb the seabed in the vicinity of the Hat Island Comm, Inc. parcel. These disturbances may temporarily increase turbidity and noise pressures at the project site during installation. Noise impacts from HDD are not anticipated to be injurious, even at close range, and the submarine cable installation activities will be done in such a way that crabs in the area will be able to move away from the project site, if disturbed. Increased turbidity is anticipated to dissipate within a couple of tidal cycles.

No net loss of Dungeness crab is anticipated.

4. Cumulative Impacts Assessment

The following are potential impacts associated with proposed project activities, followed by conservation measures and best management practices (BMPs) designed to minimize or eliminate such impacts.

4.1. Direct Impacts

1. Potential of deleterious materials entering the water during construction activities.

2. Noise disturbances to listed species during submarine cable installation activities, including sounds during the HDD procedures from shore and into the nearshore habitat.
3. Increased turbidity due to the HDD installation of the subterranean conduit should disperse or settle with a few tidal cycles.
4. Potential direct physical contact of animals or habitats with, or indirect exposure to, oil discharge or other hazardous substances.
5. Addition of hard substrate to the seabed.

5. Mitigation Procedures for Critical Areas

Shoreline development, land uses, structures and activities must meet the no net loss requirement of WAC 173-26-186(8)(b). If project proposals do not comply with the critical area protections in Snohomish County Code, applicants must submit a mitigation sequence analysis to the County. Mitigation measures must be applied in the following sequence. The applicant must demonstrate that each mitigation action is not feasible or applicable before proceeding to the next option or action:

5.1. Conservation Measures

The potential direct and indirect impacts of the proposed project can be minimized by the following best management practices (BMPs):

1) Access to construction sites will be from existing roads, ferries, landing craft, or the construction barge.
2) Situating the barge such that it does not ground out during installation.
3) Prefabricated project components will be used to reduce the duration of noise and barge activity required for submarine cable installation.
4) The avoidance of the eelgrass habitat with the use of HDD methods will minimize impacts to nearshore habitats.
5) No deleterious material will enter state waters.
6) Equipment will be kept in good running order and engines will be run only while needed to help reduce noise and the possibility of deleterious materials entering the water column or the shoreline jurisdiction.
7) Disposal of all waste material will be done appropriately at a permitted upland disposal site.
8) Installation activities will take place at compatible tides during daylight hours to ensure that equipment does not ground out and installations are efficient.
9) Approved in-water work windows will be implemented and work is expected to take up to a month.
10) Spill prevention and clean-up plans will be in place for this activity as a safeguard against unexpected, accidental contamination. If a spill does occur that causes fish or other wildlife

to be in obvious distress, project activity will immediately be halted and a WDFW Habitat biologist will be notified.

11) Construction activities will include the implementation of best management practices designed to limit or eliminate excess stormwater runoff during construction activities.
12) Erosion control and runoff treatment and prevention measures will include the minimum requirements as outlined in the Snohomish County Storm Drainage Standards (SCC 30.63A Drainage).
13) All construction will be done in accordance with Snohomish County Department of Health and Community Development building permits.

It is expected that the conservation measures and best management practices established for this project will limit potential disturbance to shoreline and other wetland areas caused by construction activities. This will minimize the impact on all habitat and conservation areas in both the project site and nearby habitats.

5.2. Avoid Impacts

Avoiding all impact during project activities is not possible, however, installing the proposed submarine cable into a conduit at the landfall on Hat Island that has been installed using HDD methods will allow for avoidance of Pacific sand lance spawning, eelgrass and other nearshore habitats in the project site vicinity and will contribute to the reduction of impacts.

5.3. Minimize Impacts

Access to the terrestrial project site will occur through the existing access road to the proposed site at the Port of Everett lot. Access to the nearshore habitat and marine setting will primarily occur from the construction barge.

Temporary increased sediment disturbance may occur during HDD installation of the conduit and subsequent laying of the submarine cable. Although turbidity may increase locally, it is expected to dissipate within the next couple of tidal cycles and potential impacts to critical areas are expected to be minimal or non-existent with best management practices in place. In-water work windows will be observed for the protection of sensitive salmonids and forage fish that may be utilizing the waters near the project site.

5.4. Mitigate Impacts

Mitigation measures are used to repair, rehabilitate, or restore the affected environment to the conditions existing at the time of the initiation of the project or activity.

Based on the project design and scope, it is expected that any long-term impacts from the cable installation will be negligible. No mitigation is proposed.

5.5. Reduce or Eliminate Impacts Over Time

Due to the large scope of this project and in its efforts to support an entire island community with electrical power, it is imperative that all environmental impacts are reduced or eliminated completely to support the long-lasting positive impacts of this new infrastructure being put into place. Impacts over time from project actions are anticipated to be minimal and well monitored with best management practices in mind.

6. Conclusion

The above narrative contains information with regards to critical area habitats and species of concern potentially impacted by project activities. These include water quality/quantity and fish and wildlife habitat. Due to the project design, and provided that all recommendations described in this report are followed, **no net loss** of Snohomish County Fish and Wildlife Habitat and Conservation Areas is expected.

This document hereby certifies that the information provided in this form is complete, true, and correct to the best of our knowledge based on the site visit on June 11, 2023, and documents given and accessed. The findings in this report were based on observations of conditions at the time of the site visit and are provided for the use of the named recipient only and are not intended for use by other parties for any purpose. This report does not guarantee agency concurrence or permit approval.

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8. Jen-Jay, Inc. Qualifications

Jen-Jay, Inc. was established in 1989 as a biological consulting firm focused on biological assessments, environmental permitting, conducting underwater and inter-tidal surveys, and commercial diving. The following staff conducted this assessment. A summary of their qualifications is provided.

Chris Betcher, Principal Biologist

Chris Betcher is a biologist with 38 years of experience conducting intertidal and underwater biological surveys and studies within Puget Sound. Chris conducts Eelgrass/Macroalgae Habitat, forage fish, and geoduck surveys; conducts studies for salinity near desalination plants; vegetation monitoring for mitigation and restoration sites; provides consultation for overwater structures, barge landings, and restoration projects; and provides management recommendations to support permit compliance and performance standards.

Credentials:

- BS, Marine Biology, Western Washington University, 1978
- WDFW certified for conducting forage fish surveys, 2002
- WDFW certified for conducting geoduck surveys, 1999

Kim Middleton, Lead Biologist and Permitting Specialist

Kim Middleton is a scientist with 38 years of research experience. Her biology background is grounded in ornithology. Kim possesses a thorough working knowledge of local, state, and federal permitting and plan requirements, including Washington state's SEPA and State Hydraulic Code and federal JARPA and NEPA processes. Kim conducts terrestrial and marine avian point count and behavioral surveys, critical area assessments, water quality sampling, vegetation monitoring of mitigation and restoration sites; prepares critical areas reports; and provides consulting for environmental compliance of overwater structures.

Credentials:

- BS, Biology and Chemistry, Western Washington University, 1980
- WDOE Certified Erosion and Sediment Control Lead (CESCL) 2023

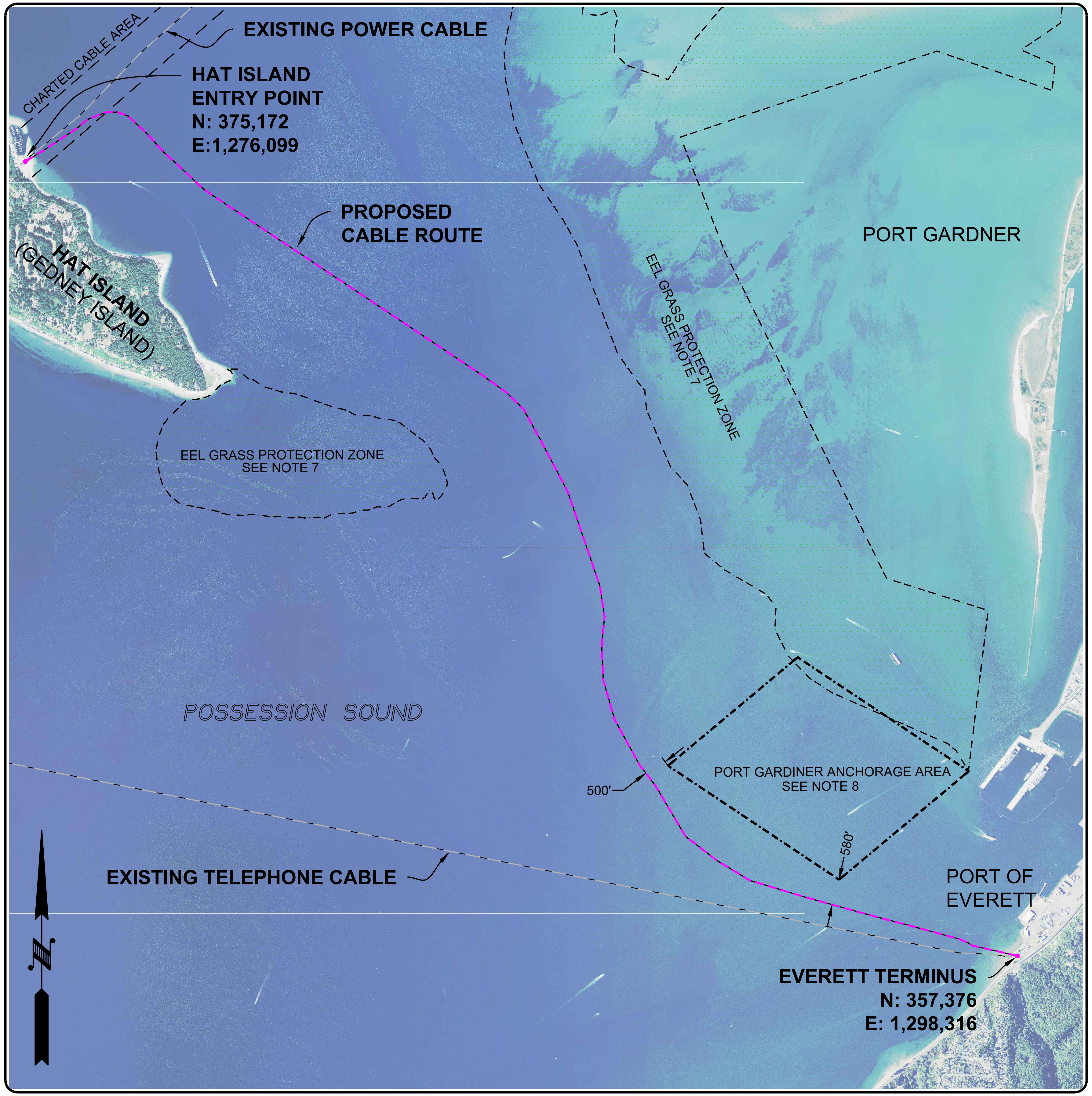
Alise Newman, Biologist and Permitting Specialist

Alise Newman is a biologist with a background in terrestrial mammalogy and evolutionary development. Within the marine science field, Alise has experience working with federal agencies conducting intertidal eelgrass surveys, European green crab monitoring, forage fish surveys, water quality and amphibian monitoring, and larval fish identification.

Credentials:

- BS, Biology, University of Washington 2022
- WDFW certified for conducting forage fish surveys, 2022

Appendix 1



GENERAL PROJECT AREA

SCALE: 1"=2500'

GENERAL PROJECT DESCRIPTION

SNOHOMISH COUNTY PUBLIC UTILITY DISTRICT NO. 1 PROPOSES INSTALLATION OF A NEW SUB-SEA POWER CABLE . THE CABLE SPANS FROM UPLAND OF PORT OF EVERETT OWNERSHIP ACROSS POSSESSION SOUND APPROXIMATELY 6.3 MILES TO AN EXISTING POWER CONNECTION NEAR THE MARINA AT HAT ISLAND. BOTH LANDWARD ENTRY/EXIT POINTS WILL EMPLOY HORIZONTAL DIRECTIONAL DRILLING (HDD) AS SHOWN ON ATTACHED PROFILE SHEETS.

DATUM AND TIDAL INFORMATION

1. BASIS OF BEARINGS FOR THIS PROJECT IS GRID NORTH, WASHINGTON COORDINATE SYSTEM NORTH ZONE NAD 83 (2011): BASED ON GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) OBSERVATIONS.

2. VERTICAL DATUM IS MEAN LOWER LOW WATER (MLLW), NOAA STATION 9447659 EVERETT, WA EPOCH 1983-2001. TIDAL DATUMS AND SUBSEQUENT CONVERSIONS ARE AS FOLLOWS:

DATUM	ELEVATION
MEAN LOWER LOW WATER (MLLW)	0.00
NAVD88	2.03
MEAN LOW WATER (MLW)	2.80
MEAN HIGH WATER (MHW)	10.21
MEAN HIGHER HIGH WATER (MHHW)	11.09

3. EXTREME LOW TIDE (ELT) AS SHOWN HEREON, AND AS DEFINED BY PUBLISHED DNR GUIDANCE MEANS THE LINE AS ESTIMATED BY THE FEDERAL GOVERNMENT BELOW WHICH IT MIGHT REASONABLY BE EXPECTED THAT THE TIDE WOULD NOT EBB. IN THE PUGET SOUND AREA OF WASHINGTON STATE, THIS LINE IS ESTIMATED BY THE FEDERAL GOVERNMENT TO BE A POINT IN ELEVATION 4.50 FEET (PLUS OR MINUS 0.5 FEET) BELOW THE DATUM PLANE OF MEAN LOWER LOW WATER, (0.0).

4. ALL DISTANCES AND ELEVATIONS SHOWN HEREON ARE IN FEET AND DECIMALS THEREOF.

5. TERRESTRIAL AREAS OF HAT ISLAND WERE SURVEYED AND MAPPED BY HARMSEN LLC IN DECEMBER AND JANUARY OF 2019.

6. BATHYMETRIC DATA IS TETRATECH BATHYMETRIC SURVEY DATED XXXXX.

7. SNOHOMISH WATERSHED KELP AND EEL GRASS PROTECTION ZONE SHOWN AS DESCRIBED ON COMMISSIONER'S ORDER NUMBER 202201, SIGNED MARCH 16, 2022.

8. ANCHOR AREA IS COORDINATE PROVIDE BY CFR 110.230 (5) PORT GARDNER GENERAL ANCHORAGE.

SHEET INDEX

SHEET	TITLE
P1	COVER SHEET
P2	HAT ISLAND PLAN AND PROFILE
P3	PORT OF EVERETT PLAN AND PROFILE
P4	SUB-SEA CABLE PLAN AND PROFILE
P5	SUB-SEA CABLE PLAN AND PROFILE
P6	PORT OF EVERETT DETAIL AREA
P7	HAT ISLAND DETAIL AREA
P8	LEGEND AND ABBREVIATIONS

DRAFT
FOR REVIEW

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

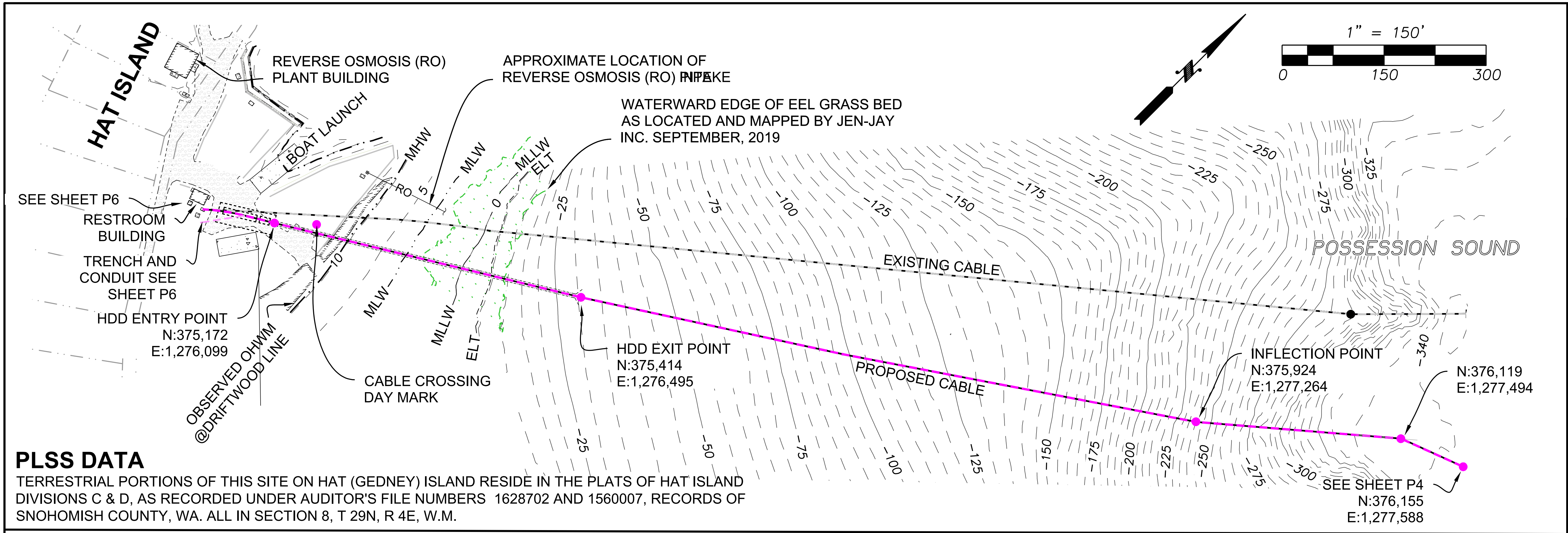
WO	100045299
TASK	
SCALE	1"=2000'
DFTR	JTF
CHKR	
ENGR	
APVD	
DATE	3/17/2023

REVISIONS

No	DATE	BY	

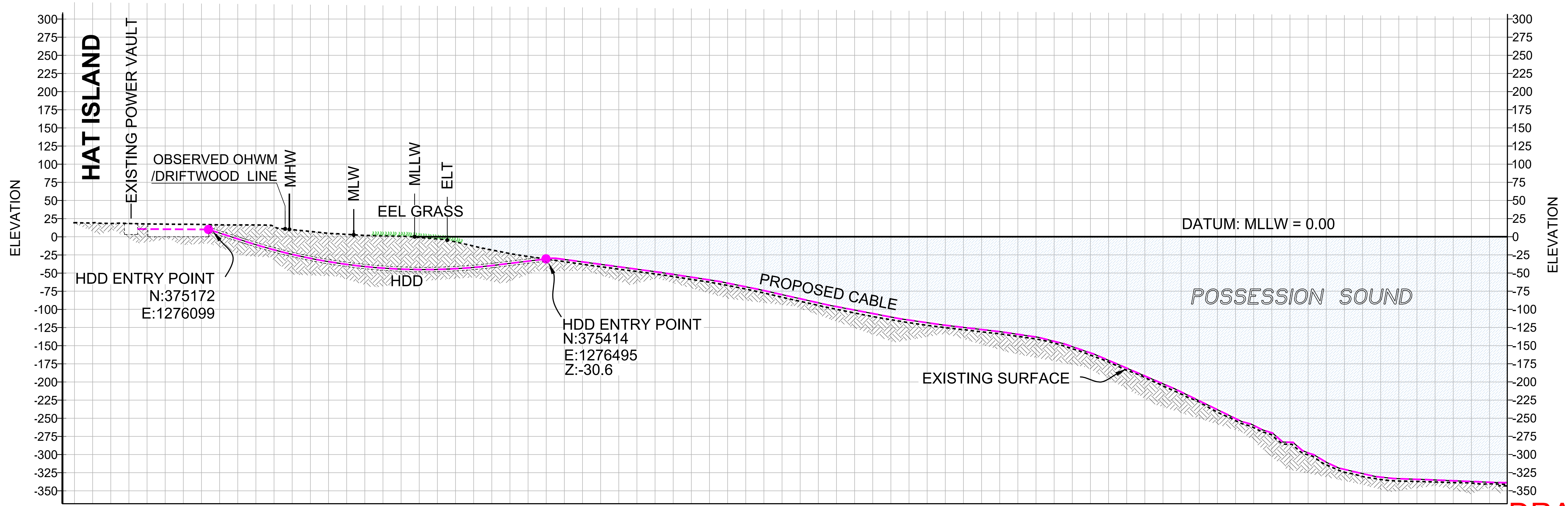
HAT ISLAND TO PORT OF EVERETT
CABLE CROSSING
PERMIT SET
COVER SHEET

REV	DRAWING
0	P1



PLSS DATA

TERRESTRIAL PORTIONS OF THIS SITE ON HAT (GEDNEY) ISLAND RESIDE IN THE PLATS OF HAT ISLAND DIVISIONS C & D, AS RECORDED UNDER AUDITOR'S FILE NUMBERS 1628702 AND 1560007, RECORDS OF SNOHOMISH COUNTY, WA. ALL IN SECTION 8, T 29N, R 4E, W.M.



CABLE PROFILE

SCALE 1"=150 HORIZONTAL/VERTICAL

DRAFT
FOR REVIEW

SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

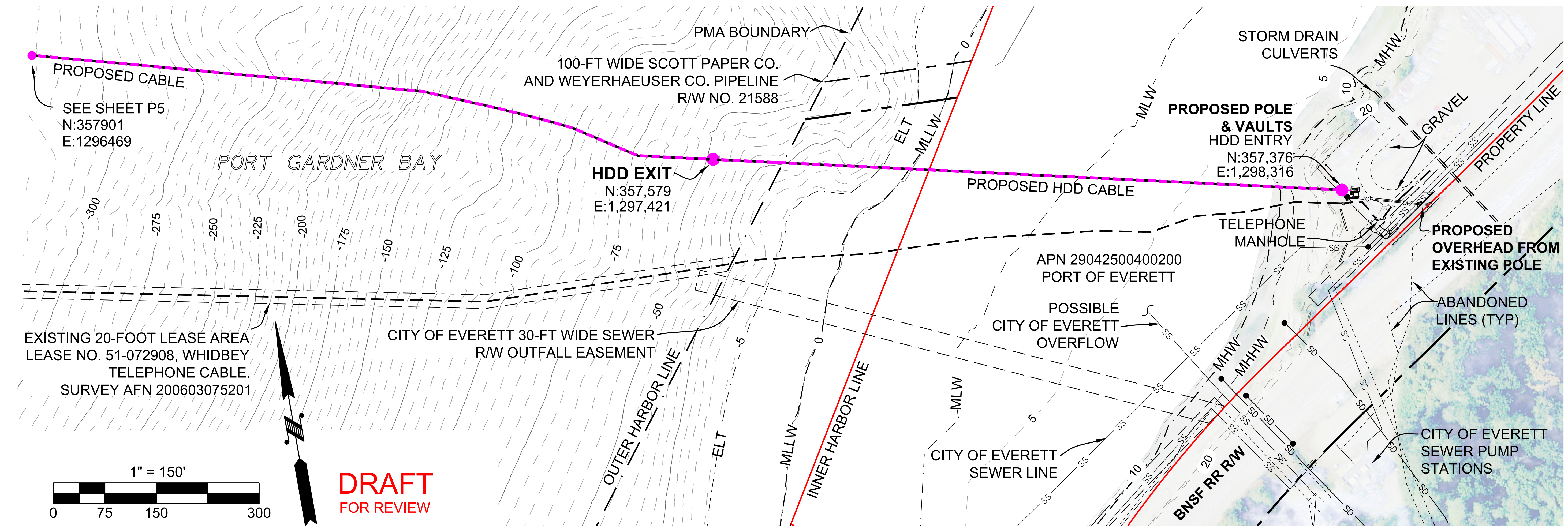
WO	100045299
TASK	
SCALE	1"=150'
DFTR	JTF
CHKR	
ENGR	
APVD	
DATE	3/17/2023

REVISIONS

No	DATE	BY

HAT ISLAND TO PORT OF EVERETT
CABLE CROSSING
PERMIT SET
HAT ISLAND PLAN & PROFILE

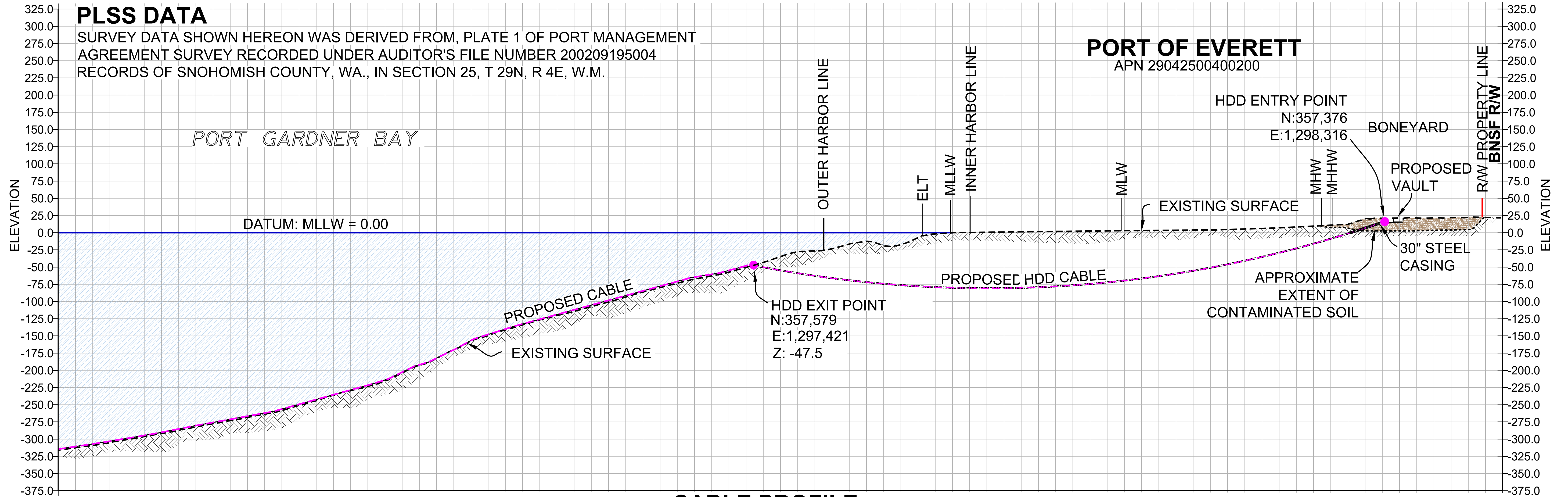
REV	DRAWING
0	P2



DRAFT
FOR REVIEW

PLSS DATA

SURVEY DATA SHOWN HEREON WAS DERIVED FROM, PLATE 1 OF PORT MANAGEMENT AGREEMENT SURVEY RECORDED UNDER AUDITOR'S FILE NUMBER 200209195004 RECORDS OF SNOHOMISH COUNTY, WA., IN SECTION 25, T 29N, R 4E, W.M.



CABLE PROFILE

SCALE 1"=150 HORIZONTAL/VERTICAL

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

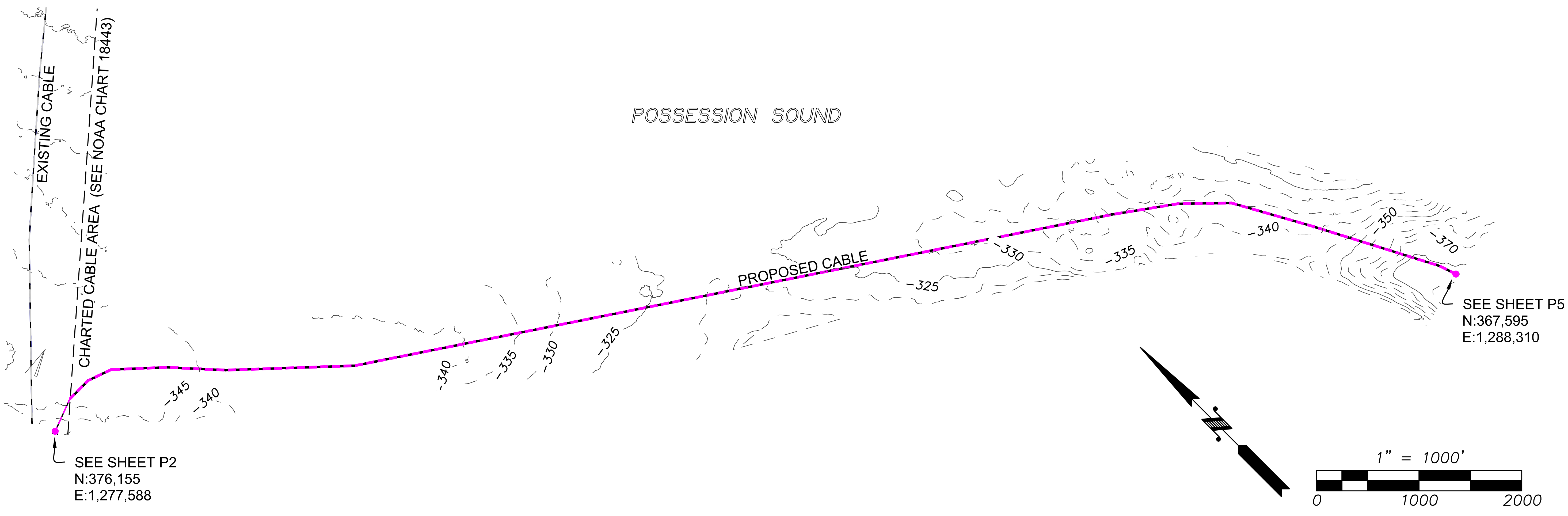
WO	100045299
TASK	
SCALE	1"=150'
DFTR	JTF
CHKR	
ENGR	
APVD	
DATE	3/17/2023

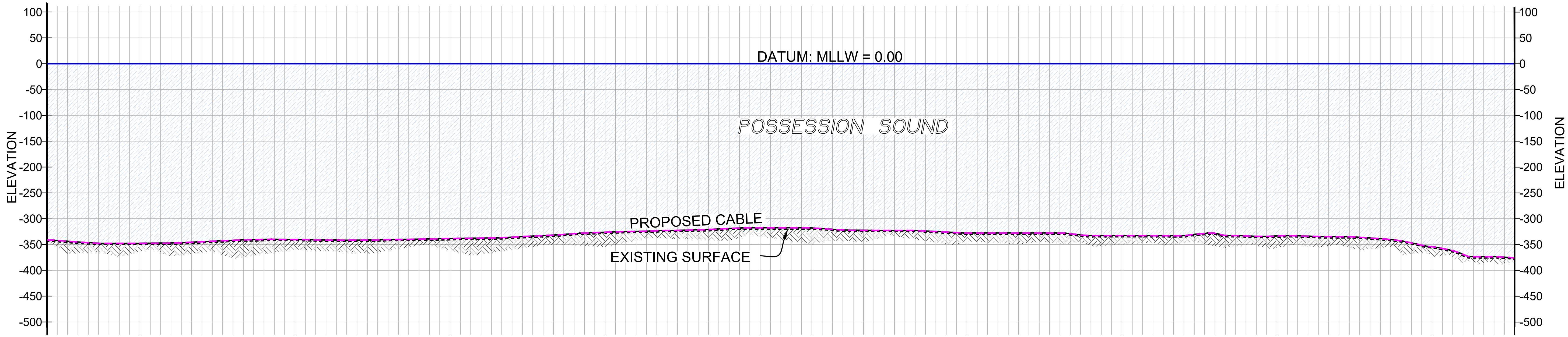
REVISIONS

No	DATE	BY

HAT ISLAND TO PORT OF EVERETT
CABLE CROSSING
PERMIT SET
PORT OF EVERETT PLAN & PROFILE

REV	DRAWING
0	P3





SUB-SEA CABLE PROFILE

SCALE 1"=1000' HORIZONTAL/ 1"=200' VERTICAL

DRAFT
FOR REVIEW

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

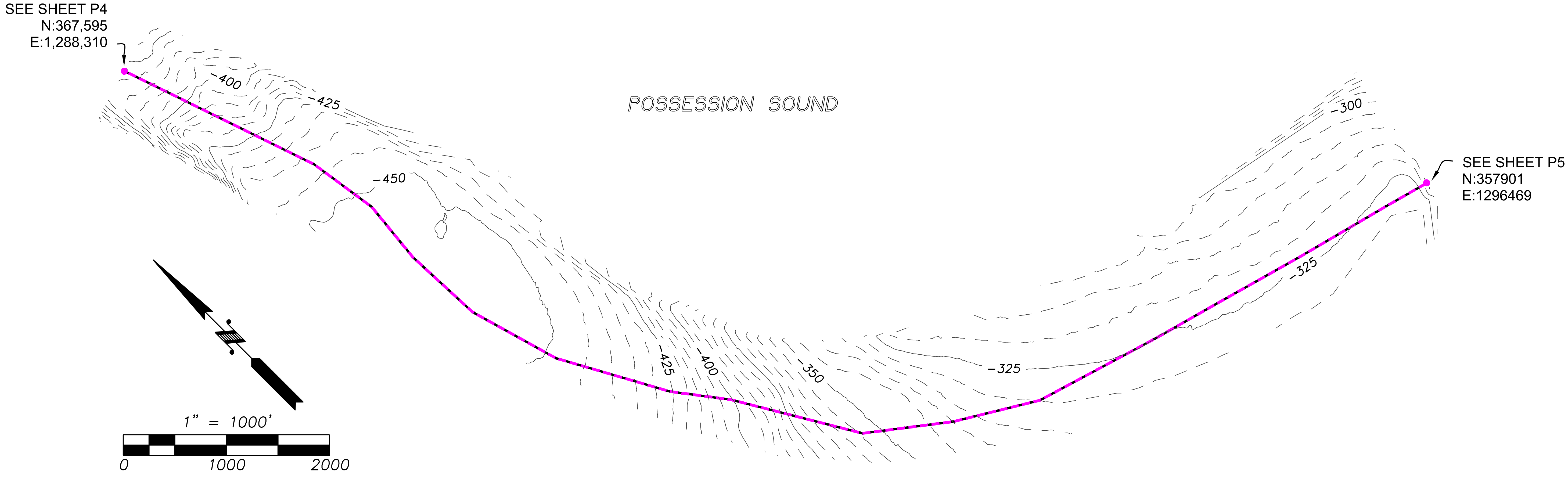
WO	100045299
TASK	
SCALE	1"=150'
DFTR	JTF
CHKR	
ENGR	
APVD	
DATE	3/17/2023

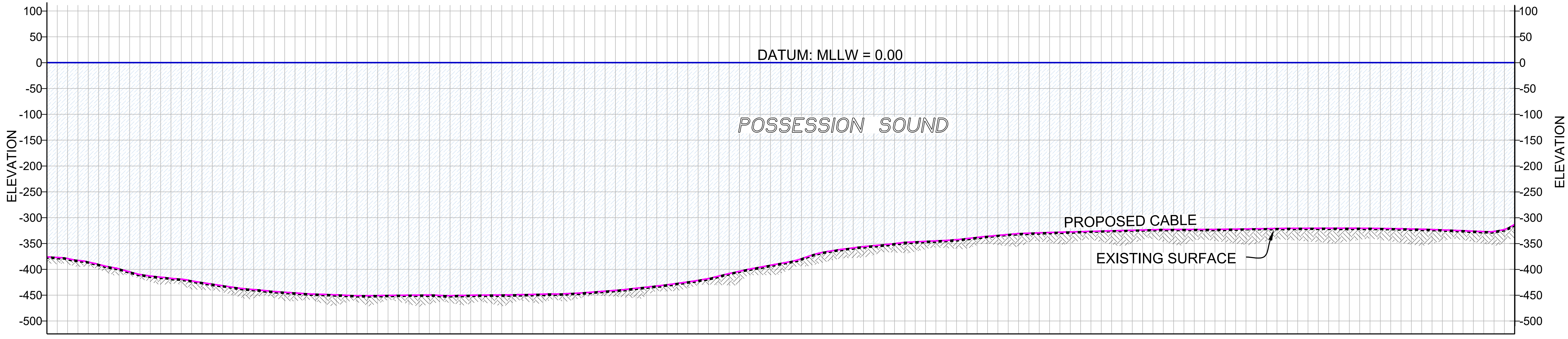
REVISIONS

No	DATE	BY

HAT ISLAND TO PORT OF EVERETT
CABLE CROSSING
PERMIT SET
SUB-SEA CABLE PLAN & PROFILE

REV	DRAWING
0	**P4**





SUB-SEA CABLE PROFILE

SCALE 1"=1000' HORIZONTAL/ 1"=200' VERTICAL

DRAFT
FOR REVIEW

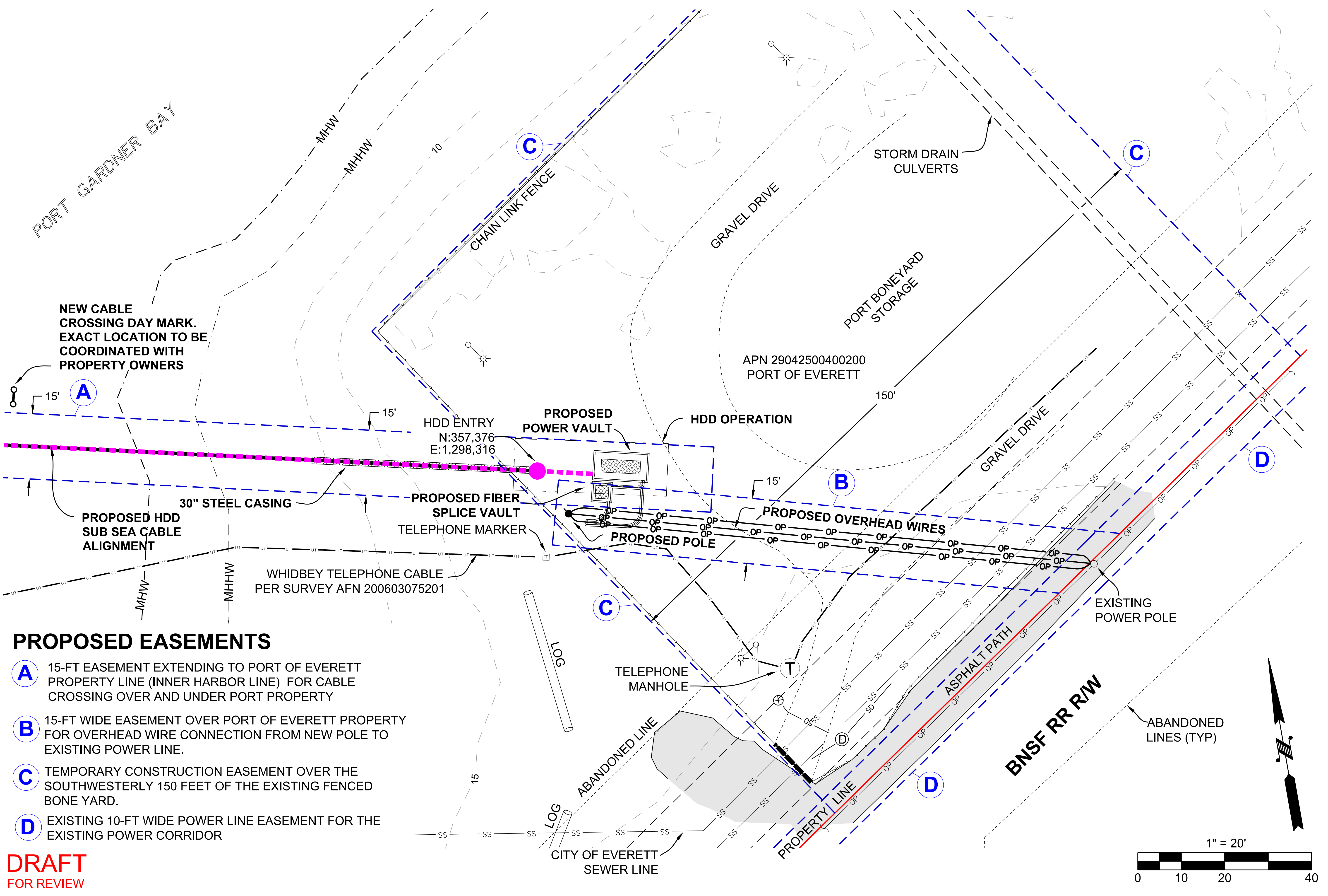
SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

WO	100045299
TASK	
SCALE	1"=150'
DFTR	JTF
CHKR	
ENGR	
APVD	
DATE	3/17/2023

No	DATE	BY	REVISIONS

HAT ISLAND TO PORT OF EVERETT
CABLE CROSSING
PERMIT SET
SUB-SEA CABLE PLAN & PROFILE

REV	DRAWING
0	P5



PROPOSED EASEMENTS

A	15-FT EASEMENT EXTENDING TO PORT OF EVERETT PROPERTY LINE (INNER HARBOR LINE) FOR CABLE CROSSING OVER AND UNDER PORT PROPERTY
B	15-FT WIDE EASEMENT OVER PORT OF EVERETT PROPERTY FOR OVERHEAD WIRE CONNECTION FROM NEW POLE TO EXISTING POWER LINE.
C	TEMPORARY CONSTRUCTION EASEMENT OVER THE SOUTHWESTERLY 150 FEET OF THE EXISTING FENCED BONE YARD.
D	EXISTING 10-FT WIDE POWER LINE EASEMENT FOR THE EXISTING POWER CORRIDOR

DRAFT
FOR REVIEW

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1

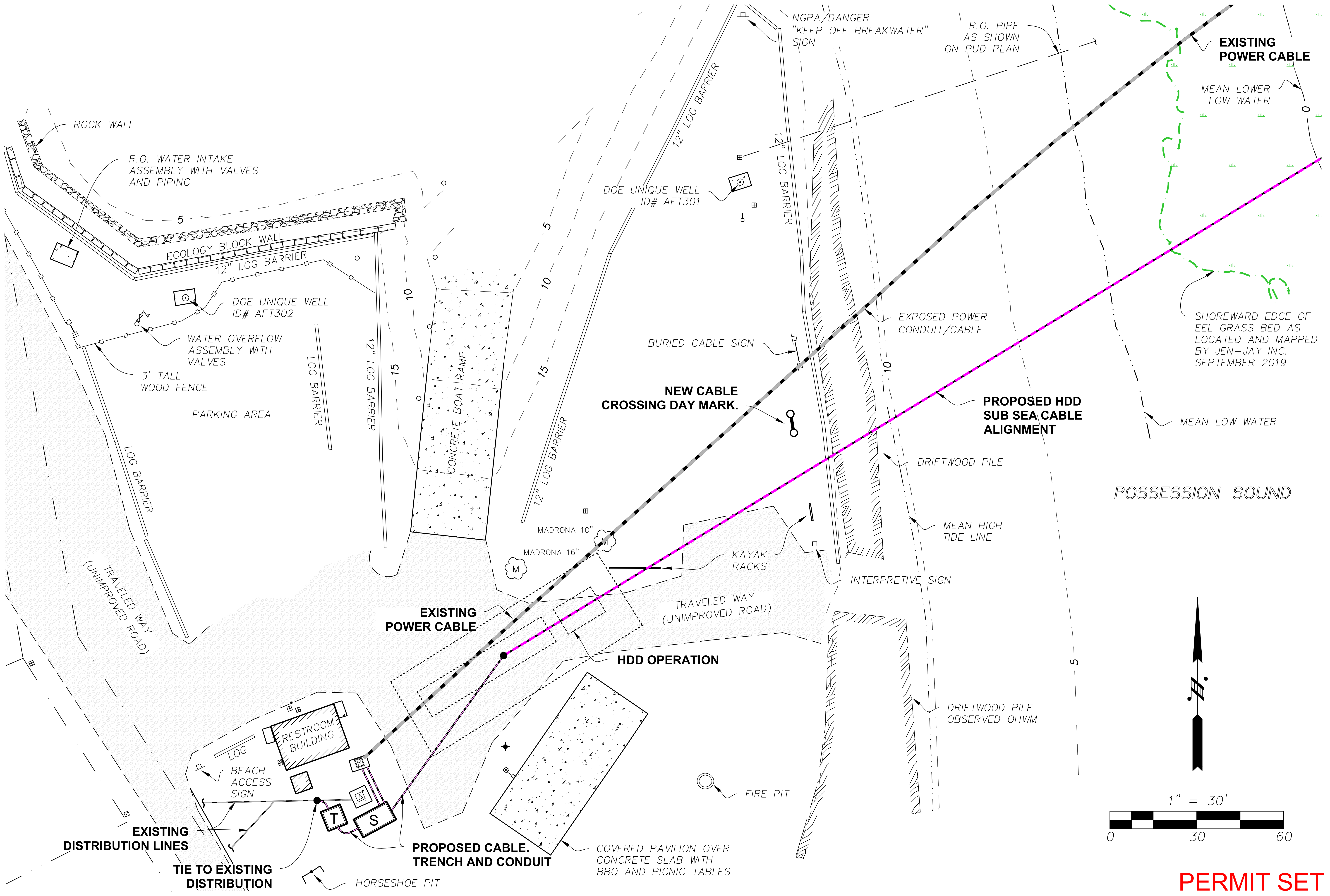
WO	100045299
TASK	
SCALE	1"=20'
DFTR	JTF
CHKR	
ENGR	
APVD	
DATE	3/17/2023

REVISIONS

No	DATE	BY

HAT ISLAND TO PORT OF EVERETT
CABLE CROSSING
PERMIT SET
PORT OF EVERETT DETAIL AREA

REV	DRAWING
0	P6



PERMIT SET

WO	100045299
TASK	
SCALE	1"=30'
DFTR	JTF
CHKR	
ENGR	RKS
APVD	
DATE	3/17/2023

No	DATE	BY	REVISIONS

HAT ISLAND TO MISSION BEACH
CABLE CROSSING
PERMIT SET
HAT ISLAND DETAIL AREA

REV	DRAWING
0	P7

LEGEND

EXISTING

- UTILITY POLE ANCHOR
- UTILITY POLE
- TRANSFORMER
- LIGHT POST
- P POWER VAULT
- • BOLLARD
- POWER METER
- JUNCTION BOX
- ○ PILING
- STORM DRAIN CATCH BASIN
- Ⓓ STORM DRAIN MANHOLE
- AREA DRAIN
- Ⓢ SANITARY SEWER MANHOLE
- ⊞ WATER METER
- ⋈ WATER VALVE
- FIRE HYDRANT
- FAUCET
- IRRIGATION VALVE
- ⊙ WELL HEAD
- ▭ MAIL BOX
- Ⓣ TELEPHONE MANHOLE
- T TELEPHONE PEDESTAL/MARKER
- A ALDER TREE
- C CEDAR TREE
- P PINE TREE
- DECIDUOUS TREE
- M MADRONA TREE
- FLAG POLE
- SIGN
- CULVERT
- G GAS LINE
- DITCH CENTERLINE
- SD STORM DRAIN
- SS SEWER LINE
- OP OVERHEAD POWER
- OT OVERHEAD TELEPHONE
- UP UNDERGROUND POWER
- UT UNDERGROUND TELEPHONE
- CHAIN LINK FENCE
- WOOD FENCE
- EXISTING SUB SEA CABLE

PROPOSED

- NEW HDD CABLE / SUB SEA CABLE
- CABLE AND CONDUIT IN TRENCH
- T ELECTRIC TRANSFORMER
- J JUNCTION BOX
- S ELECTRIC SWITCH GEAR
- CABLE CROSSING DAY MARK
- ● POWER POLE

ABBREVIATIONS

AFN - AUDITOR'S FILE NUMBER
APN - ASSESSOR'S PARCEL NUMBER
CONC - CONCRETE
CB - CATCH BASIN
CL - CENTERLINE
CMP - CORRUGATED METAL PIPE
CPP - CORRUGATED PLASTIC PIPE
CONC - CONCRETE
DIA - DIAMETER
ELT - EXTREME LOW TIDE
ESMT - EASEMENT
FDC - FIRE DEPARTMENT CONNECTION
FT - U.S. SURVEY FEET
G.E. - GRATE ELEVATION
HDD - HORIZONTAL DIRECTIONAL DRILLING
I.E. - INVERT ELEVATION
LS - LAND SURVEYOR
MHW - MEAN HIGH WATER
MHHW - MEAN HIGHER HIGH WATER
MLLW - MEAN LOWER LOW WATER
MLW - MEAN LOW WATER
OHWM - ORDINARY HIGH WATER MARK
PVC - POLYVINYL CHLORIDE
R.O.- REVERSE OSMOSIS
SD - STORM DRAIN
SS - SANITARY SEWER
SSMH - SANITARY SEWER MANHOLE
STA - STATION
TYP - TYPICAL
YD - YARD DRAIN

PERMIT SET

WO	100045299
TASK	
SCALE	NTS
DFTR	JTF
CHKR	
ENGR	RKS
APVD	
DATE	3/17/2023

No	DATE	BY	REVISIONS

HAT ISLAND TO MISSION BEACH
CABLE CROSSING
PERMIT SET
LEGEND & ABBREVIATIONS

REV	DRAWING
0	P8

Appendix 2

JEN–JAY, INC.

Preliminary Eelgrass Macro Algae Habitat Survey

Snohomish Public Utilities District – Hat (Gedney) Island Power Cable
11 June 2023

LOCATION: Between the northeastern shore of Hat Island and Pigeon Creek Beach area of Everett, WA.

PURPOSE: To survey the area for replacement of a failing submarine power cable.

TIME: 9:30 AM

VISIBILITY: 15′ ±

DEPTH CALCULATIONS: Depth contours (Bathymetric Survey) were provided by others.

BOTTOM TYPE: The channel is entirely mud/sand with 0-12″ rock nearshore on both landing sites.

VEGETATION: Eelgrass (*Zostera marina*) was observed on the Hat Island landing of the proposed cable location starting approximately 50 feet above MLLW and extending offshore for a total of 150 feet, approximately. On the Everett landing there was no observed eelgrass or macroalgae. On the Hat Island landing there is generally no macroalgae, with the exception of small amounts of filamentous green algae growing on small rocks in the nearshore. The accompanying drawings indicate where vegetation was observed.

SURVEY PATTERN: A single transect was swam by a diver along the proposed route. The Hat Island landing was surveyed for 300' to a depth of approximately -30'. The Everett landing was surveyed for 800' to a depth of approximately -30'. Observations were made every twenty feet, with the diver noting any observed vegetation within their visible range to either side. Additionally, a TOPCON HiPer VR GNSS rover receiver was used to map the boundaries of the eelgrass on the Hat Island landing of the proposed route.

Survey methods for this project are in accordance with the WDFW Eelgrass/Eelgrass Habitat Interim Survey Guidelines revised in June 2008 and WAC 220-660-35, and follow the Preliminary Survey and Tier 1 survey methods outlined in Components of a Complete Eelgrass Delineation Report developed by the Army Corps of Engineers (ACOE) dated January 9, 2018. Eelgrass Delineation Method B was employed to determine the location of the edge of the eelgrass bed. A single linear transect was used to assess vegetation at the project site, as the power cable has a narrow, linear impact zone. The deviation from the survey guidelines was approved by the WDFW Area Habitat Biologist prior to conducting the eelgrass/macroalgae survey.

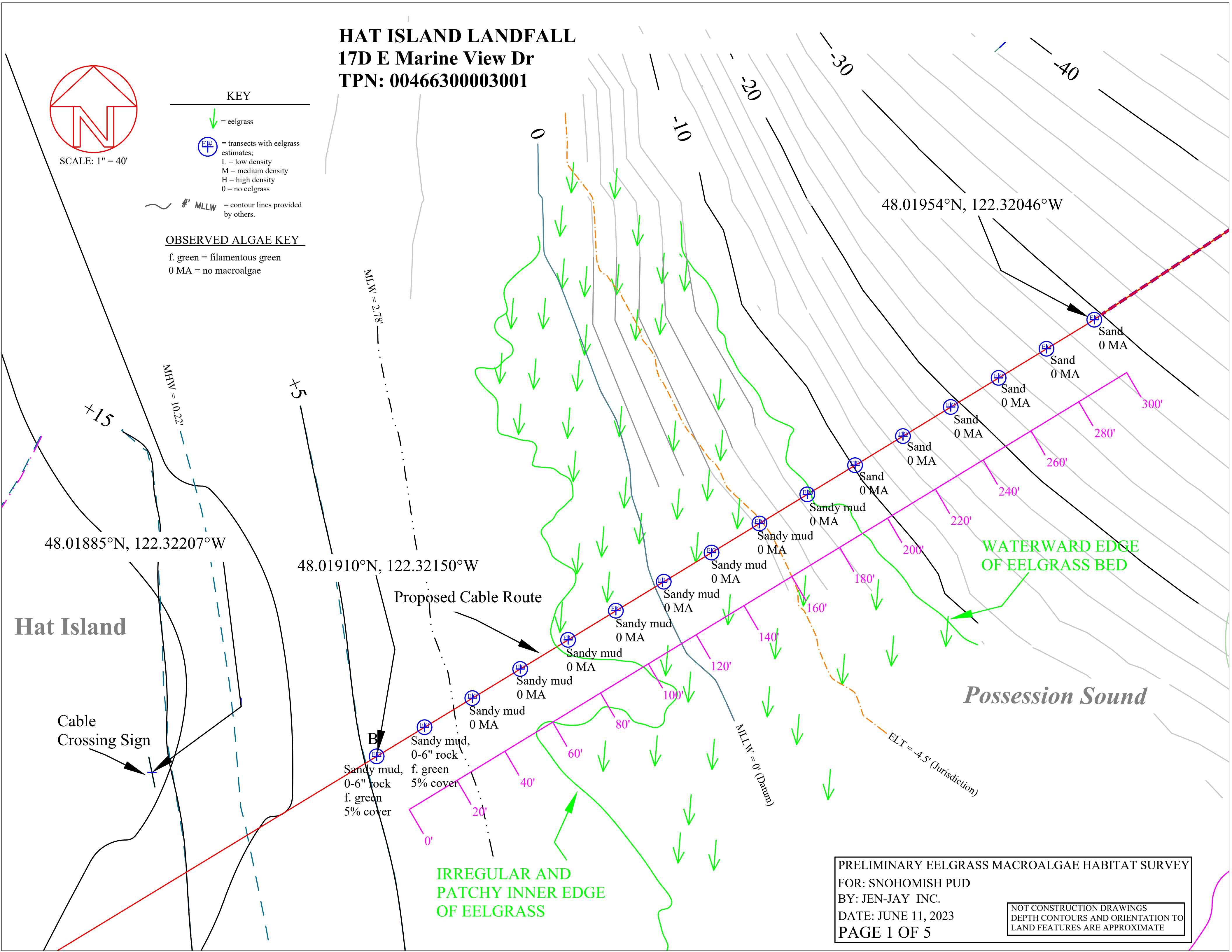
VERTEBRATE and INVERTEBRATE SPECIES: None noted.

FORAGE FISH HABITAT: There is WDFW documented sand lance spawning habitat located on the beach at the proposed Hat Island cable landfall. No documented forage fish spawning habitat is present at the Everett landfall, however, there are sand lance and surf smelt spawning habitats documented approximately 3500' to the southwest.

Any questions regarding this survey should be addressed to:

JEN-JAY DIVING, INC.

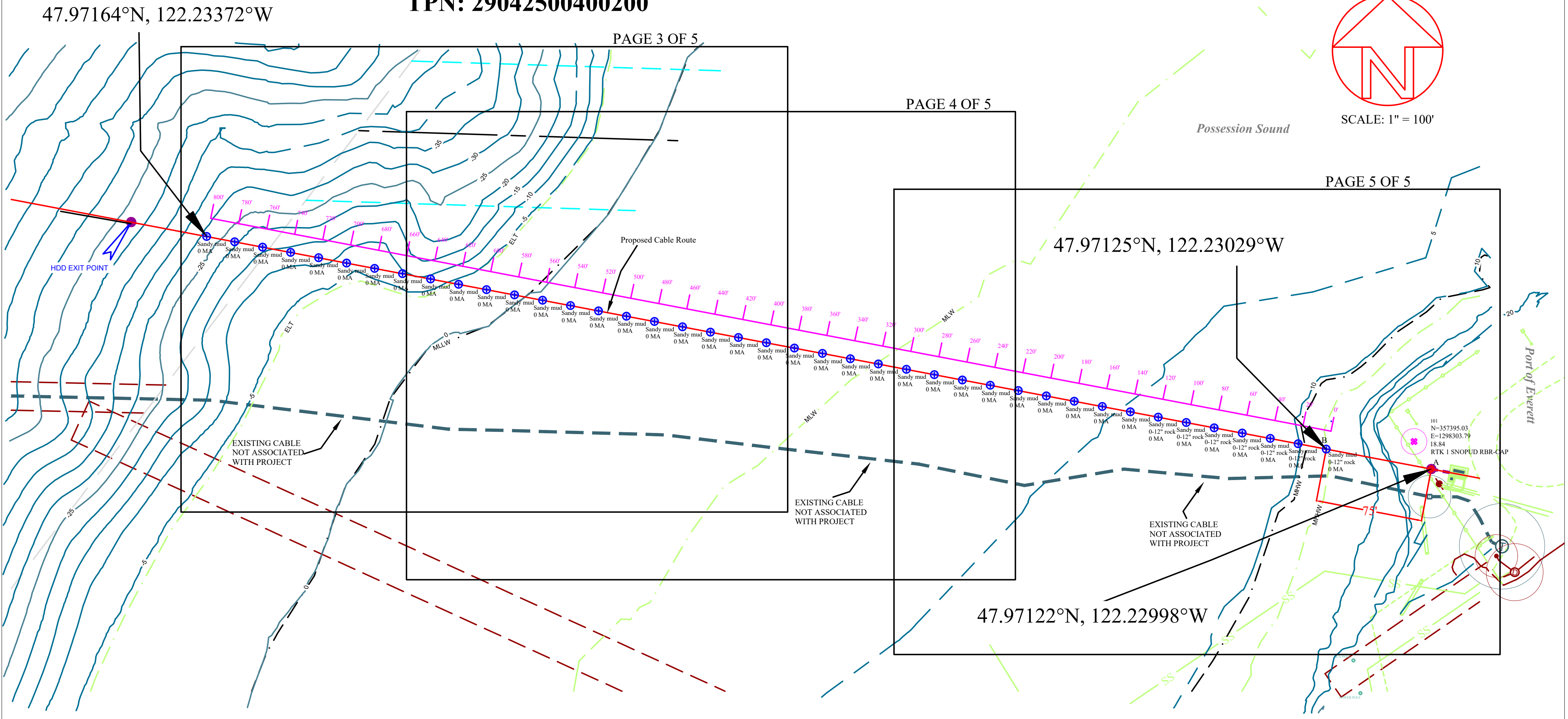
HAT ISLAND LANDFALL
17D E Marine View Dr
TPN: 00466300003001



PRELIMINARY EELGRASS MACROALGAE HABITAT SURVEY
FOR: SNOHOMISH PUD
BY: JEN-JAY INC.
DATE: JUNE 11, 2023
PAGE 1 OF 5

NOT CONSTRUCTION DRAWINGS
DEPTH CONTOURS AND ORIENTATION TO
LAND FEATURES ARE APPROXIMATE

EVERETT LANDFALL OVERVIEW
2890 Terminal Ave
TPN: 29042500400200



KEY

= eelgrass

E# = transects with eelgrass estimates;
L = low density
M = medium density
H = high density
0 = no eelgrass

#' MLLW = contour lines provided by others

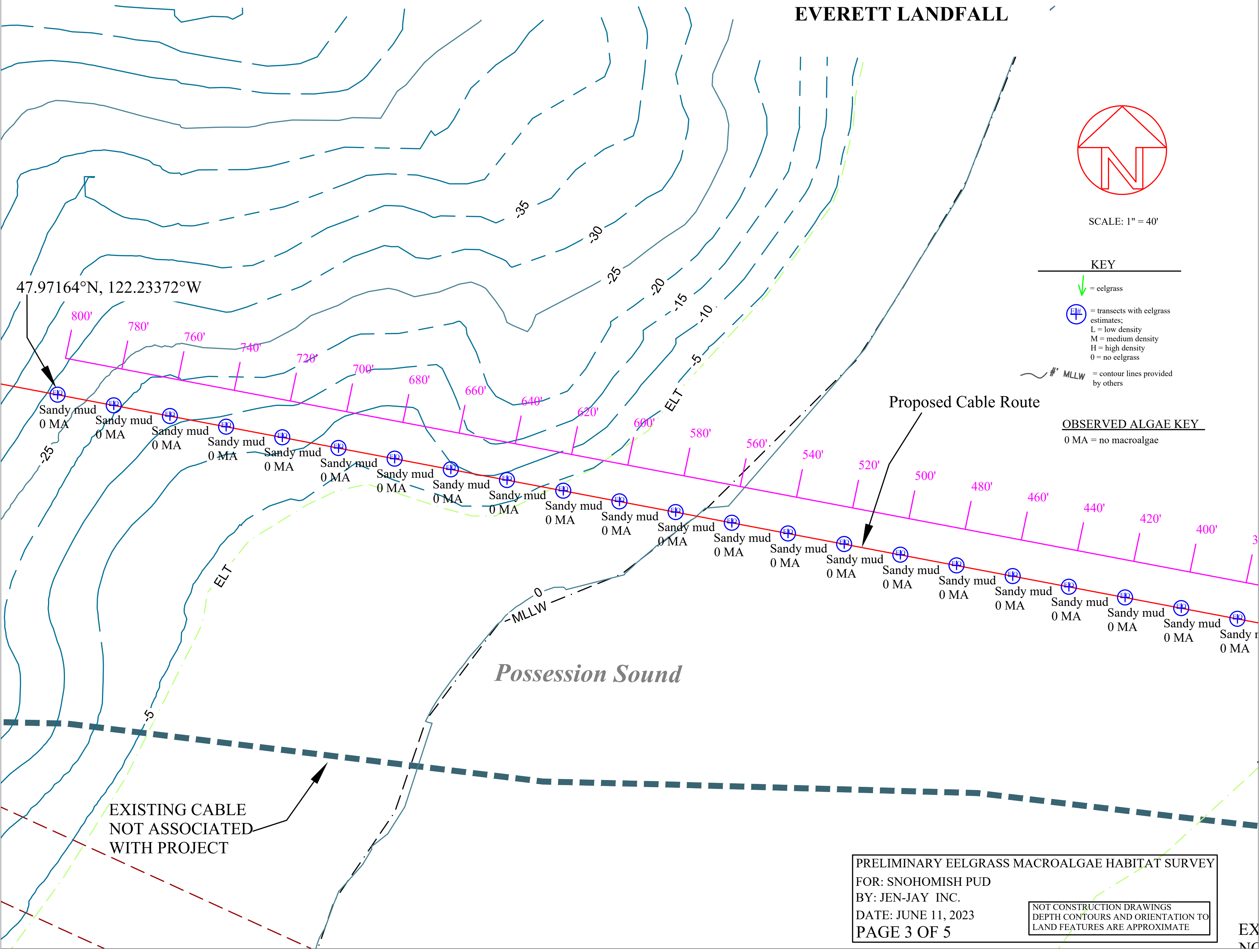
OBSERVED ALGAE KEY

0 MA = no macro algae

PRELIMINARY EELGRASS MACROALGAE HABITAT SURVEY
FOR: SNOHOMISH PUD
BY: JEN-JAY INC.
DATE: June 11, 2023
PAGE 2 OF 5

NOT CONSTRUCTION DRAWINGS
DEPTH CONTOURS AND ORIENTATION TO LAND FEATURES ARE APPROXIMATE

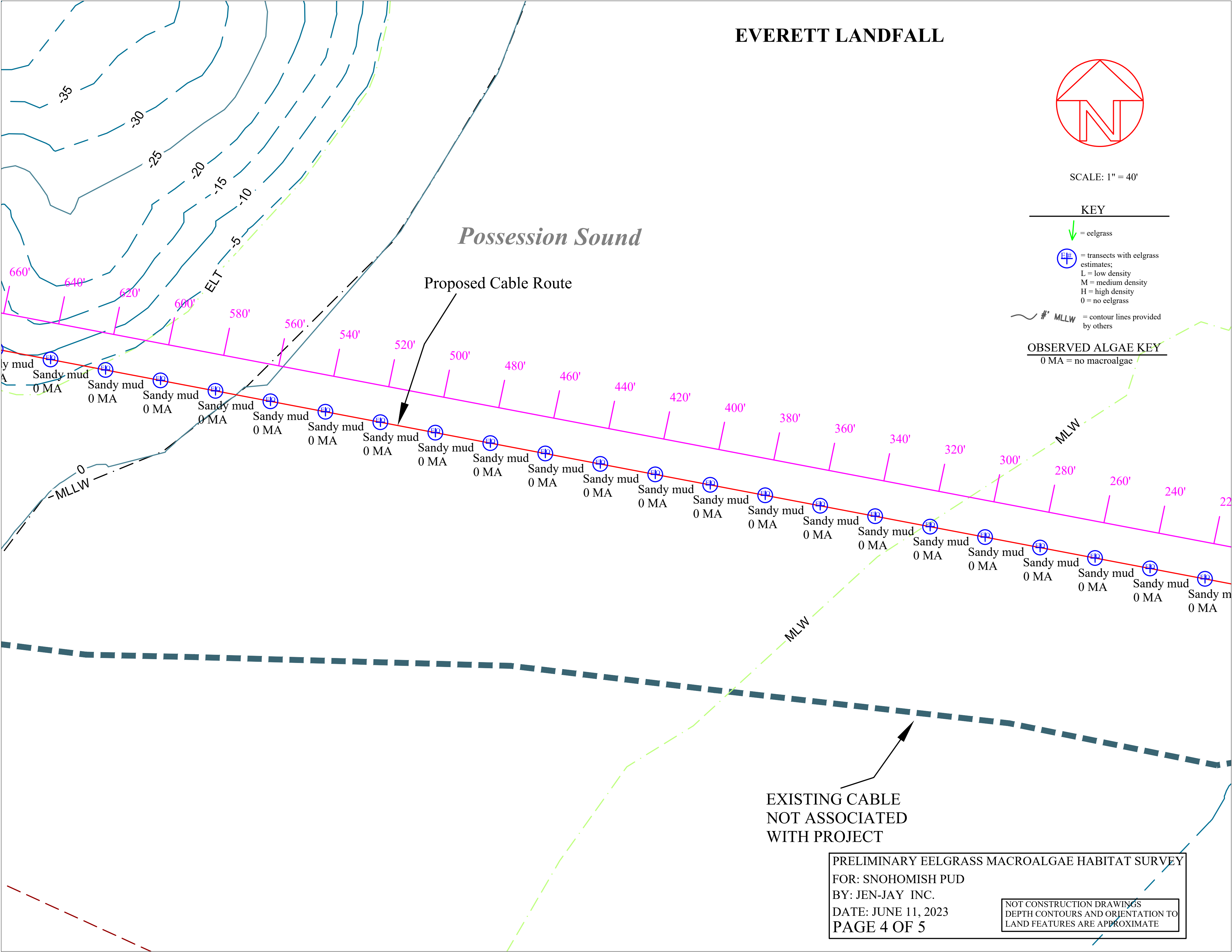
EVERETT LANDFALL



PRELIMINARY EELGRASS MACROALGAE HABITAT SURVEY
FOR: SNOHOMISH PUD
BY: JEN-JAY INC.
DATE: JUNE 11, 2023
PAGE 3 OF 5

NOT CONSTRUCTION DRAWINGS
DEPTH CONTOURS AND ORIENTATION TO LAND FEATURES ARE APPROXIMATE

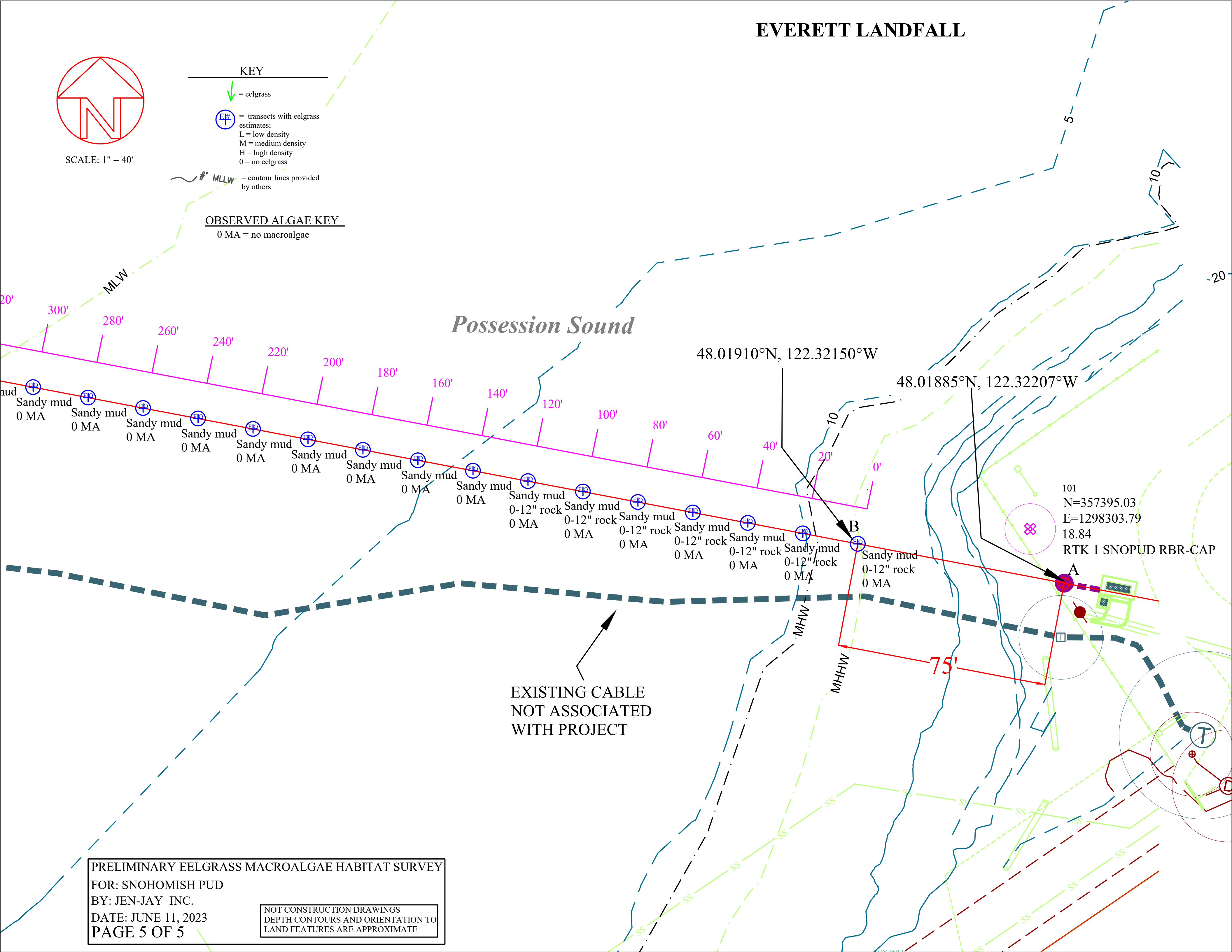
EVERETT LANDFALL



PRELIMINARY EELGRASS MACROALGAE HABITAT SURVEY
FOR: SNOHOMISH PUD
BY: JEN-JAY INC.
DATE: JUNE 11, 2023
PAGE 4 OF 5

NOT CONSTRUCTION DRAWINGS
DEPTH CONTOURS AND ORIENTATION TO
LAND FEATURES ARE APPROXIMATE

EVERETT LANDFALL



PRELIMINARY EELGRASS MACROALGAE HABITAT SURVEY
FOR: SNOHOMISH PUD
BY: JEN-JAY INC.
DATE: JUNE 11, 2023
PAGE 5 OF 5

NOT CONSTRUCTION DRAWINGS
DEPTH CONTOURS AND ORIENTATION TO
LAND FEATURES ARE APPROXIMATE

Appendix 3

HALEY & ALDRICH, INC.
3131 Elliott Avenue,
Suite 600
Seattle, WA 98121
206.324.9530

CLIENT MEMORANDUM

1 September 2023
File No. 0202881-000

TO:	D. Hittle & Associates, Inc. Bob Schneider
FROM:	Haley & Aldrich, Inc. Mark R. Zablocki, P.E. (MA), Assistant Project Manager Jeff S. Bruce, P.E., Project Manager
SUBJECT:	Soil Conditions Memorandum Hat Island Submarine Cable Snohomish County, Washington

Haley & Aldrich, Inc. (Haley & Aldrich) presents this memorandum containing information on subsurface conditions for the proposed relocation of the Hat Island Submarine Cable at the two proposed site locations on Hat Island and the "Boneyard" site at the south end of the Port of Everett. This memorandum presents our current project understanding, and detailed subsurface exploration results. This work was performed in accordance with our proposal dated 30 August 2022 and your subsequent authorization.

Introduction

The Snohomish County Public Utilities Department (SnoPUD) is considering the replacement of an existing submarine cable, which provides power to Hat Island. The existing submarine cable spans the portion of Possession Sound between Hat Island and Mission Beach. Two locations have been identified for the launching and receiving of the new submarine cable. One location is in proximity to the existing cable landing on Hat Island, in an open area south of the Hat Island Marina. The other location is referred to as the "Boneyard", which is located at the south end of the Port of Everett, west of Pigeon Creek Trail, and is currently being used to stage miscellaneous tooling and equipment.

The upland portion of the Hat Island site is relatively flat with an approximate ground surface elevation of elevation (El.) 20 feet. The shoreline at the site slopes west to east towards Possession Sound. The upland portion of the Boneyard site is relatively flat with an approximate ground surface elevation of El. 25. The shoreline at the site slopes east to west towards Possession Sound. The elevation datum used throughout this memorandum is the Mean Lower Low Water Datum (MLLW).

Subsurface Conditions

We subcontracted Holocene Drilling, Inc. of Puyallup, Washington, to conduct two test boring explorations under the technical observation of Haley & Aldrich. The test borings designated HC-1 (Hat Island) and HA22-1 (Boneyard) were advanced to depths of 76 and 80.4 feet below ground surface (bgs) respectively.

Our understanding of subsurface conditions was developed by evaluating soil conditions observed during the subsurface explorations, geotechnical laboratory testing, and information from a desktop study of geological conditions of potential replacement cable routes from Dick Sylwester[1]. The nature and extent of variations between explorations at discrete locations may not be evident until construction. Appendices provide logs of our explorations (Appendix A), geotechnical laboratory test results (Appendix B), and a copy of Sylwester 2020 (Appendix C). Note: the cable alignment from Hat Island to the Boneyard site was evaluated as Route D within Sylwester 2020.

SOIL CONDITIONS

Test boring HC-1 at the Hat Island site encountered about 35 feet of medium dense beach and bluff deposits generally consisting of sand with variable silt and gravel over dense to very dense glacially overridden sand and silty sand deposits through the end of the boring at a 76-foot depth. Sylwester 2020 indicates offshore conditions by geophysical survey to be about 10 feet of unconsolidated material (bluff erosional deposits) over 30 feet of glaciomarine sediments, above dense glacially overridden soil. As the offshore bathymetry steepens, variable thickness of unconsolidated sediments were observed, likely from erosion and historical landslides. Conditions deeper offshore, on the relatively flat seabed, typically consisted of about 30 feet of marine sediments over glacially overridden material (Sylwester 2020).

Test boring HA22-1 at the Boneyard site encountered approximately 10 feet of loose to medium dense sand and gravel fill with variable amounts of silt, organics, and detritus, overlying a 12.5-foot-thick layer of dense sand with silt and gravel, beach and bluff deposits. The bottom of the beach and bluff deposits were observed to consist of a 4.5-foot thick layer of wood debris, between 18 and 22.5 feet bgs. Very dense to very stiff glacially overridden soils were encountered below the bottom of the wood debris layer and through the bottom of the test exploration to an 80.4-foot depth. The top 11.5 feet (22.5 to 34 feet bgs) of the glacially overridden soils consisted of a silty sand with gravel and scattered organics, glacial outwash soil. Below the glacial outwash from a 34-foot depth to the bottom of the boring at 80.4 feet, the soils were observed to be generally glacio-lacustrine soils consisting of interbedded layers of clays and silts, with various amounts of sand. Between depths of 59 to 68 feet, a very dense silty gravel layer with sand was encountered.

---

[1] Sylwester, R., 2020. *Desktop Study for Replacement of SNOPUD Hat Island Power Cable*. Richard Sylwester, 2020.

Based on our observations of our two borings and review of Sylwester 2020, we organized the project site into six engineering soil units (ESUs), as discussed below.

It is important to note that the subsurface conditions are quite variable and, given the nature of glacially consolidated and recessional materials, it should be assumed that zones of coarse grained material (cobbles and boulders) and zones of collapsible sands may be encountered along the route of the horizontal drilling.

- **ESU 1 – Historical Fill.** We observed approximately 10 feet of sand and gravel fill at the Boneyard site. The fill was observed to be loose to medium dense and contained organics and debris. No fill was observed on the Hat Island project site.
- **ESU 2 – Beach/Bluff Erosional Deposits.** The Hat Island and Boneyard project sites are generally underlain by beach and bluff erosional deposits. These beach and bluff erosional deposits are composed of medium dense to dense poorly graded sand to silty sand, deposited from wave action and erosion of the coastal cliffs and shoreline. We observed wood and shell debris in these deposits between depths of about 17 and 30 feet at the Hat Island site, and between 10 and 22.5 feet at the Port of Everett. Though not encountered in our borings, we note the potential for cobbles or boulders in this ESU due to the variable nature of erosional debris. Additionally, the relatively clean poorly graded sands encountered in the borings indicate the risk of collapse during horizontal directional drilling.
- **ESU 3 – Glacial Outwash.** Beneath ESU 2, we observed glacially overridden deposits (outwash deposits) composed of dense to very dense poorly graded sand to silty sand. This layer was not penetrated at the Hat Island site but was found to be 11.5 feet thick at the Boneyard site.
- **ESU 4 – Glaciolacustrine.** We encountered a fine-grained glacially overridden deposit at the Boneyard site at approximately 34 feet bgs. The strata consisted of approximate 5- to 10-foot-thick sections of either clay or silt, with varying amounts of sand with an increasing coarse fractions beyond a 60-foot depth. At the Boneyard site, a 9-foot-thick very dense silty gravel layer with sand was encountered within the glaciolacustrine soils.
- **ESU 5 – Glaciomarine Sediments.** Possibly up to 30 feet of glaciomarine sediments can be found beneath the eroded bluff deposits off both the Hat Island and Boneyard project sites. These sediments are documented in Sylwester 2020. Deposition of this material results as the floating remnants of glaciers continue to melt, releasing sediment caught in its structure that falls to the seafloor. These deposits are likely loose to medium dense and suspected to be liquefiable.
- **ESU 6 – Fine-Grained Marine Sediments.** The seabed is composed of fine-grained marine deposits deposited overtime and likely composed of silt and clay. These deposits rest above the glaciomarine sediments and glacially overridden deposits.

GROUNDWATER

At the time of drilling, we estimated the groundwater table to range from about 5 to 10 feet bgs on Hat Island and 10 to 15 feet bgs at the Port of Everett, based on observed moisture conditions of our drilling samples. Due to the nature of mud-rotary drilling, an exact groundwater elevation could not be observed at the time of drilling.

The groundwater table is anticipated to be tidally influenced and fluctuate with the high and low tides of the adjacent Puget Sound. The nearest National Oceanic and Atmospheric Administration (NOAA) station gauge (Station ID 9447130) is located in Seattle, Washington. Tidal information is available to the public on NOAA's website <https://tidesandcurrents.noaa.gov/>.

Conclusion/Limitations

This memorandum has been prepared for specific application to the proposed Hat Island cable crossing as described herein. Our comments are based in part upon data obtained from the referenced subsurface explorations and testing. The nature and extent of variations in subsurface conditions may not become evident until further explorations are conducted or until construction. If significant variations then appear, it may also be necessary to re-evaluate the conclusions and recommendations contained herein.

We appreciate the opportunity to provide services for this project and look forward to our continued association with you and the project team through completion of design and construction. Please contact us with any questions.

Enclosures:
    Appendix A - Subsurface Exploration Logs
    Appendix B - Geotechnical Laboratory Test Results
    Appendix C - Report "Desktop Study for Replacement of SNOPUD Hat Island Power Cable"

\\haleyaldrich.com\share\sea_projects\Notebooks\1951600_Hat_Island_Submarine_Cable_Replacement\Deliverables\Memos\Soil Conditions Memo\2023_0901_HAI_HatIsland_SoilCond_F.docx

APPENDIX A

Subsurface Exploration Logs

Sample Description

Identification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. ASTM D 2488 visual-manual identification methods were used as a guide. Where laboratory testing confirmed visual-manual identifications, then ASTM D 2487 was used to classify the soils.

Relative Density/Consistency

Soil density/consistency in borings is related primarily to the standard penetration resistance (N). Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

SAND or GRAVEL Relative Density	N (Blows/Foot)	SILT or CLAY Consistency	N (Blows/Foot)
Very loose	0 to 4	Very soft	0 to 1
Loose	5 to 10	Soft	2 to 4
Medium dense	11 to 30	Medium stiff	5 to 8
Dense	31 to 50	Stiff	9 to 15
Very dense	>50	Very stiff	16 to 30
		Hard	>30

Moisture

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

USCS Soil Classification Chart (ASTM D 2487)

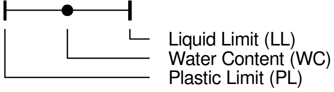
Major Divisions			Symbols		Typical Descriptions
			Graph	USCS	
Coarse Grained Soils More than 50% of Material Retained on No. 200 Sieve	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels *(<5% fines)*		GW	Well-Graded Gravel; Well-Graded Gravel with Sand
				GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Gravels *(5-12% fines)*		GW-GM	Well-Graded Gravel with Silt; Well-Graded Gravel with Silt and Sand
				GW-GC	Well-Graded Gravel with Clay; Well-Graded Gravel with Clay and Sand
				GP-GM	Poorly Graded Gravel with Silt; Poorly Graded Gravel with Silt and Sand
				GP-GC	Poorly Graded Gravel with Clay; Poorly Graded Gravel with Clay and Sand
		Gravels with Fines *(>12% fines)*		GM	Silty Gravel; Silty Gravel with Sand
				GC	Clayey Gravel; Clayey Gravel with Sand
	Sand and Sandy Soils More than 50% of Coarse Fraction Passing No. 4 Sieve	Sands with few Fines *(<5% fines)*		SW	Well-Graded Sand; Well-Graded Sand with Gravel
				SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Sands *(5-12% fines)*		SW-SM	Well-Graded Sand with Silt Well-Graded Sand with Silt and Gravel
				SW-SC	Well-Graded Sand with Clay; Well-Graded Sand with Clay and Gravel
				SP-SM	Poorly Graded Sand with Silt; Poorly Graded Sand with Silt and Gravel
				SP-SC	Poorly Graded Sand with Clay; Poorly Graded Sand with Clay and Gravel
		Sands with Fines *(>12% fines)*		SM	Silty Sand; Silty Sand with Gravel
				SC	Clayey Sand; Clayey Sand with Gravel
Fine Grained Soils More than 50% of Material Passing No. 200 Sieve	Silts			ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
				MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
	Silty Clay *(based on Atterberg Limits)*			CL-ML	Silty Clay; Silty Clay with Sand or Gravel; Gravelly or Sandy Silty Clay
	Clays			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
				CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
	Organics			OL/OH	Organic Soil; Organic Soil with Sand or Gravel; Sandy or Gravelly Organic Soil
Highly Organic *(>50% organic material)*				PT	Peat - Decomposing Vegetation - Fibrous to Amorphous Texture

Minor Constituents

	Estimated Percentage
Sand, Gravel	
Trace	<5
Few	5 - 15
Cobbles, Boulders	
Trace	<5
Few	5 - 10
Little	15 - 25
Some	30 - 45

Soil Test Symbols

%F	Percent Passing No. 200 Sieve
AL	Atterberg Limits (%)



CA	Chemical Analysis
CAUC	Consolidated Anisotropic Undrained Compression
CAUE	Consolidated Anisotropic Undrained Extension
CBR	California Bearing Ratio
CIDC	Consolidated Drained Isotropic Triaxial Compression
CIUC	Consolidated Isotropic Undrained Compression
CK0DC	Consolidated Drained k0 Triaxial Compression
CK0DSS	Consolidated k0 Undrained Direct Simple Shear
CK0UC	Consolidated k0 Undrained Compression
CK0UE	Consolidated k0 Undrained Extension
CRSCN	Constant Rate of Strain Consolidation
DS	Direct Shear
DSS	Direct Simple Shear
DT	In Situ Density
GS	Grain Size Classification
HYD	Hydrometer
ILCN	Incremental Load Consolidation
K0CN	k0 Consolidation
kc	Constant Head Permeability
kf	Falling Head Permeability
MD	Moisture Density Relationship
OC	Organic Content
OT	Tests by Others
P	Pressuremeter
PID	Photoionization Detector Reading
PP	Pocket Penetrometer
SG	Specific Gravity
TRS	Torsional Ring Shear
TV	Torvane
UC	Unconfined Compression
UUC	Unconsolidated Undrained Triaxial Compression
VS	Vane Shear
WC	Water Content (%)

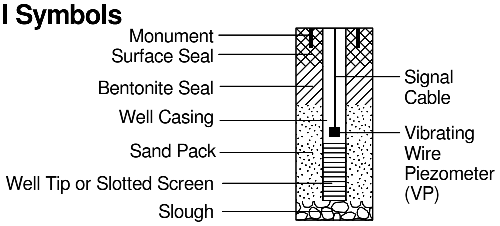
Groundwater Indicators

▽	Groundwater Level on Date or At Time of Drilling (ATD)
▼	Groundwater Level on Date Measured in Piezometer
○	Groundwater Seepage (Test Pits)

Sample Symbols

☒	1.5" I.D. Split Spoon	◧	Rock Core Run	☒	Grab
◩	3.25" O.D. Split Spoon	▢	Sonic Core	▥	Cuttings
◧	Modified California Sampler	◫	Thin-walled Sampler	◫	Push Probe

Well Symbols



HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location:
Project No.: 19516-00

Key to Exploration Logs

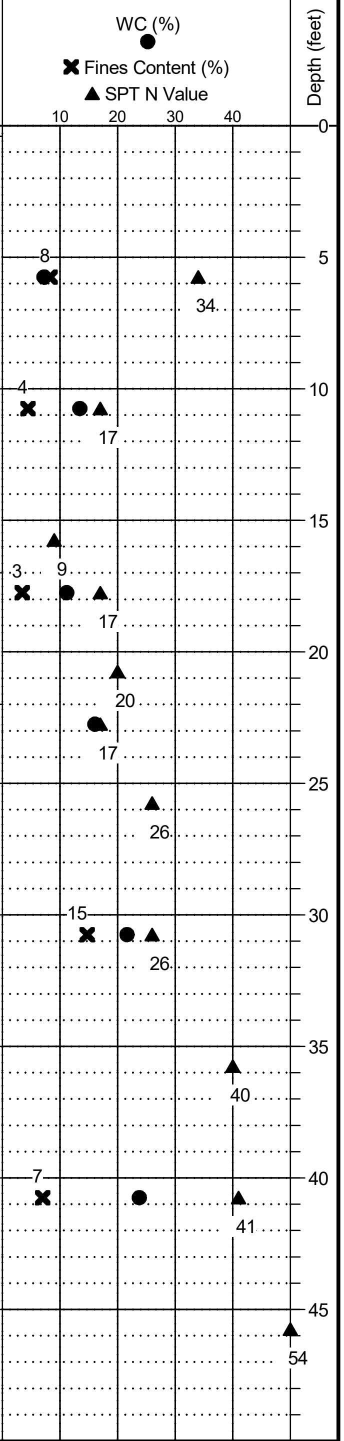
Figure **A-1**
Sheet **1 of 1**

KEY TO EXP LOGS (SOIL ONLY) - J:\GINT\HC_LIBRARY.GLB - 2/12/20 12:17 - \\SEAFS\PROJECTS\NOTEBOOKS\1951600_HAT_ISLAND_SUBMARINE_CABLE_REPLACEMENT\FIELD DATA\PERM_GINT FILES\1951600-BL.GPJ - kzl

Date Started: 02/10/2020 Date Completed: 02/10/2020
Logged by: C. Kroskie Checked by: Z. Yell
Location: Lat: 48.018713 Long: -122.321879 (WGS 84)
Ground Surface Elevation: 12.00 feet (MLLW)
Comments: Hat Island

Drilling Contractor/Crew: Holocene Drilling, Inc. / Roddy
Drilling Method: Mud Rotary
Rig Model/Type: Diedrich D-120 / Truck-mounted drill rig
Hammer Type: Auto-hammer
Hammer Weight (pounds): 140 Hammer Drop Height (inches): 30
Measured Hammer Efficiency (%): Not Available
Hole Diameter: Well Casing Diameter: NA
Total Depth: 76 feet Depth to Groundwater: Not Identified

Elevation (feet)	Depth (feet)	Blow Count	Type	Recovery	Length (inches)	Number Tests	Material Description	Fines Content (%)	SPT N Value
	0						Sand/Grass.		
10 5	5	6 17 17	☒	12in.	18	S-1 GS, WC	WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), dense, moist, gray-brown, medium to coarse sand.	8	34
0	10	7 8 9	☒	12in.	18	S-2 GS, WC	WELL-GRADED SAND WITH GRAVEL (SW), medium dense, wet, gray-brown, medium sand.	4	17
	15	4 5 4	☒	0in.	18		No Recovery		9
-5		8 9 9 8	▮	12in.	18	S-3 GS, WC	POORLY GRADED SAND WITH GRAVEL (SP), medium dense, wet, gray, medium to coarse sand, angular, scattered organics (charcoal, wood).	3	17
	20	8 9 11	☒	0in.	18		No Recovery		20
-10		6 8 9	▮	12in.	18	S-4 WC	POORLY GRADED SAND (SP), few gravel, medium dense, wet, gray, medium to coarse sand, angular, scattered organics (charcoal, wood).		17
-15	25	11 12 14	☒	18in.	18	S-5	POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, medium dense, wet, gray, fine to medium sand, scattered organics (wood, shells).		26
-20	30	12 15 11	☒	18in.	18	S-6 GS, WC	SILTY SAND (SM), medium dense, wet, gray, fine to medium sand, occasional pockets of iron oxide staining.	15	26
-25	35	19 20 20	☒	18in.	18	S-7	POORLY GRADED SAND WITH SILT (SP-SM), dense, moist to wet, gray-brown, gap graded (fine to medium sand).		40
-30	40	17 19 22	☒	18in.	18	S-8 GS, WC	POORLY GRADED SAND WITH SILT (SP-SM), dense, moist, gray-brown, fine sand, occasional layers of fine sand with silt.	7	41
-35	45	25 28 26	☒	18in.	18	S-9	POORLY GRADED SAND (SP), very dense, moist, gray-brown, fine sand.		54



General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

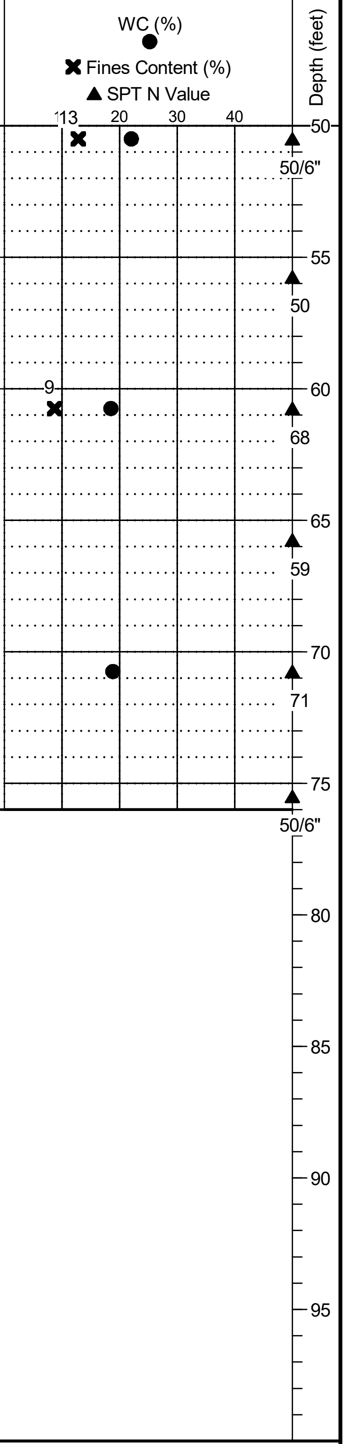
Boring Log
HC-1

Figure **A-2**
Sheet **1 of 2**

Date Started: 02/10/2020
Date Completed: 02/10/2020
Logged by: C. Kroskie
Checked by: Z. Yell
Location: Lat: 48.018713 Long: -122.321879 (WGS 84)
Ground Surface Elevation: 12.00 feet (MLLW)
Comments: Hat Island

Drilling Contractor/Crew: Holocene Drilling, Inc. / Roddy
Drilling Method: Mud Rotary
Rig Model/Type: Diedrich D-120 / Truck-mounted drill rig
Hammer Type: Auto-hammer
Hammer Weight (pounds): 140
Hammer Drop Height (inches): 30
Measured Hammer Efficiency (%): Not Available
Hole Diameter:
Well Casing Diameter: NA
Total Depth: 76 feet
Depth to Groundwater: Not Identified

Elevation (feet)	Depth (feet)	Sample Data: Blow Count	Type	Recovery	Length (inches)	Number Tests	Material Description
	50	35 50	⊠	12in.	12	S-10 GS, WC	SILTY SAND (SM), very dense, moist, gray-brown, fine sand.
-40							
	55	25 25 25	⊠	18in.	18	S-11	POORLY GRADED SAND (SP), very dense, moist, gray-brown, fine sand, occasional organics (wood).
-45							
	60	26 32 36	⊠	12in.	18	S-12 GS, WC	POORLY GRADED SAND WITH SILT (SP-SM), very dense, moist, gray-brown, fine to medium sand.
-50							
	65	25 28 31	⊠	18in.	18	S-13	
-55							
	70	32 33 38	⊠	18in.	18	S-14 WC	
-60							
	75	38 50	⊠	12in.	12	S-15	
							Bottom of Borehole at 76.0 feet.
-65							
	80						
-70							
	85						
-75							
	90						
-80							
	95						
-85							



General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

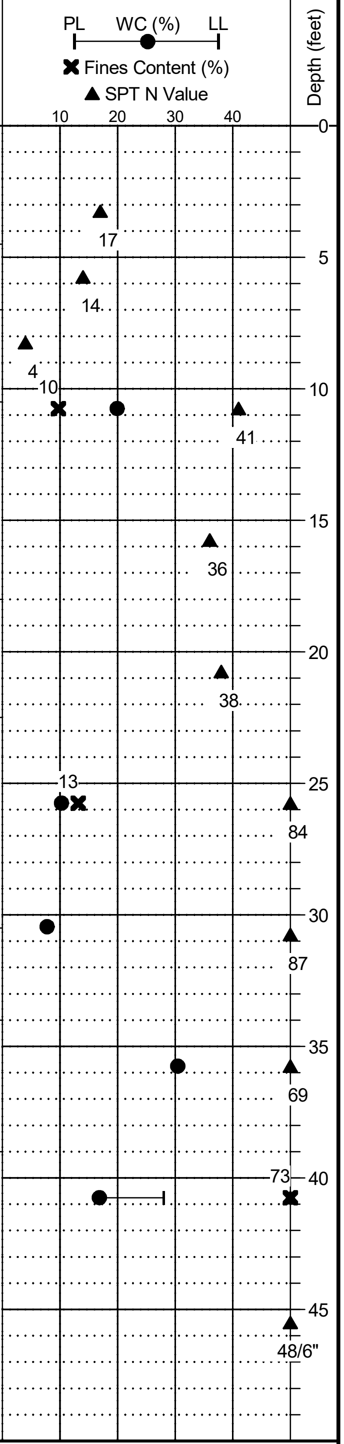
Boring Log
HC-1

Figure **A-2**
Sheet **2 of 2**

Date Started: 09/12/2022
Date Completed: 09/12/2022
Logged by: Z. McIntire
Checked by: M. Espinoza
Location: Lat: 47.971234 Long: -122.229924 (WGS 84)
Ground Surface Elevation: 25.00 feet (MLLW)
Comments:

Drilling Contractor/Crew: Holocene Drilling, Inc.
Drilling Method: Mud Rotary
Rig Model/Type: Diedrich D-70 Turbo / Track-mounted drill rig
Hammer Type: Auto-hammer
Hammer Weight (pounds): 140
Hammer Drop Height (inches): 30
Measured Hammer Efficiency (%): Not Available
Hole Diameter:
Well Casing Diameter: NA
Total Depth: 80.4 feet
Depth to Groundwater: Not Identified

Elevation (feet)	Depth (feet)	Sample Data: Blow Count	Type	Recovery	Length (inches)	Number Tests	Material Description
	0						SILTY SAND WITH GRAVEL (SM), medium dense, moist, dark gray, numerous organics. [FILL]
		10 8 9	☒	7.8in.	18	S-1	
20	5	2 12 2	☒	8.4in.	18	S-2	SILTY GRAVEL (GM), loose, moist, dark gray to black, numerous organics.
		1 1 3	☒	18in.	18	S-3	POORLY GRADED GRAVEL (GP), very dense, moist, dark gray to black, numerous organics, wood chips, and plastic.
15	10	13 21 20	☒	8.4in.	18	S-4 GS, WC	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), dense, moist, dark gray to black, numerous organics.
10	15	11 17 19	☒	10.8in.	18	S-5	
5	20	14 17 21	☒	6in.	18	S-6	wood debris with some sand, dense, moist, dark brown
0	25	33 42 42	☒	12in.	18	S-7 GS, WC	SILTY SAND WITH GRAVEL (SM), very dense, moist, blue-gray, scattered organics. [GLACIAL OUTWASH]
-5	30	20 47 40	☒	18in.	18	S-8a WC S-8b	SILTY SAND (SM), very dense, moist, blue-gray.
-10	35	9 28 41	☒	16.8in.	18	S-9 WC	LEAN CLAY WITH SAND (CL), very dense, moist, blue-gray. [GLACIO-LACUSTRINE]
-15	40	38 50	☒	12in.	18	S-10 AL, GS, WC	SILT WITH SAND (ML), hard, moist, gray.
-20	45	40 48 50	☒	12in.	12	S-11	



General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

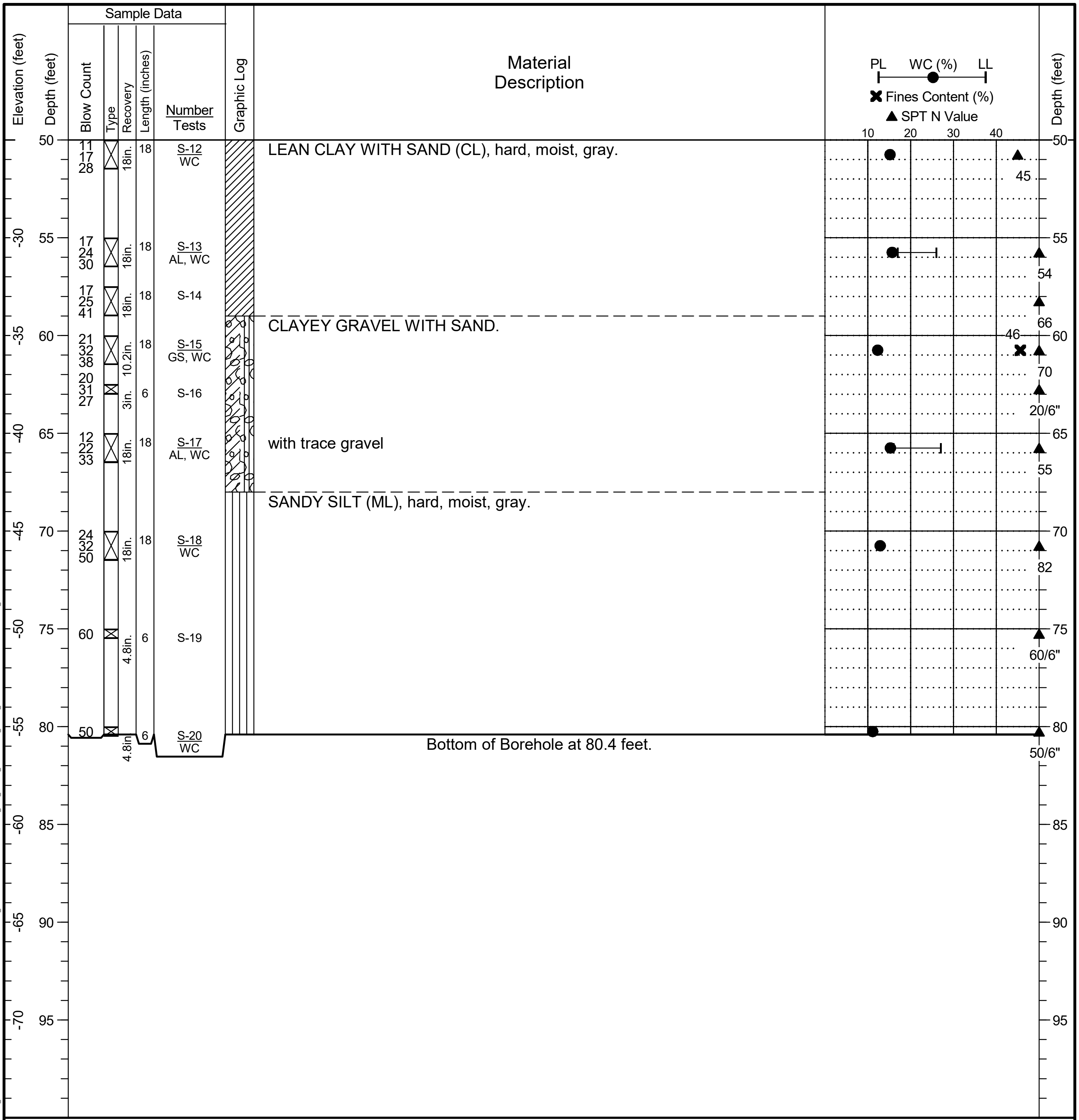
Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

Boring Log
HA22-1

Figure **A-3**
Sheet **1 of 2**

Date Started: 09/12/2022
Date Completed: 09/12/2022
Logged by: Z. McIntire
Checked by: M. Espinoza
Location: Lat: 47.971234 Long: -122.229924 (WGS 84)
Ground Surface Elevation: 25.00 feet (MLLW)
Comments:

Drilling Contractor/Crew: Holocene Drilling, Inc.
Drilling Method: Mud Rotary
Rig Model/Type: Diedrich D-70 Turbo / Track-mounted drill rig
Hammer Type: Auto-hammer
Hammer Weight (pounds): 140
Hammer Drop Height (inches): 30
Measured Hammer Efficiency (%): Not Available
Hole Diameter:
Well Casing Diameter: NA
Total Depth: 80.4 feet
Depth to Groundwater: Not Identified



Blow Count	Recovery	Length (inches)	Number	Tests
11 17 28	18in.	18	S-12	WC
17 24 30	18in.	18	S-13	AL, WC
17 25 41	18in.	18	S-14	
21 32 38	10.2in.	18	S-15	GS, WC
20 31 27	3in.	6	S-16	
12 22 33	18in.	18	S-17	AL, WC
24 32 50	18in.	18	S-18	WC
60	4.8in.	6	S-19	
50	4.8in	6	S-20	WC

LEAN CLAY WITH SAND (CL), hard, moist, gray.

CLAYEY GRAVEL WITH SAND.

with trace gravel

SANDY SILT (ML), hard, moist, gray.

Bottom of Borehole at 80.4 feet.

General Notes:

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

Boring Log
HA22-1

Figure **A-3**
Sheet **2 of 2**

APPENDIX B

Geotechnical Laboratory Test Results

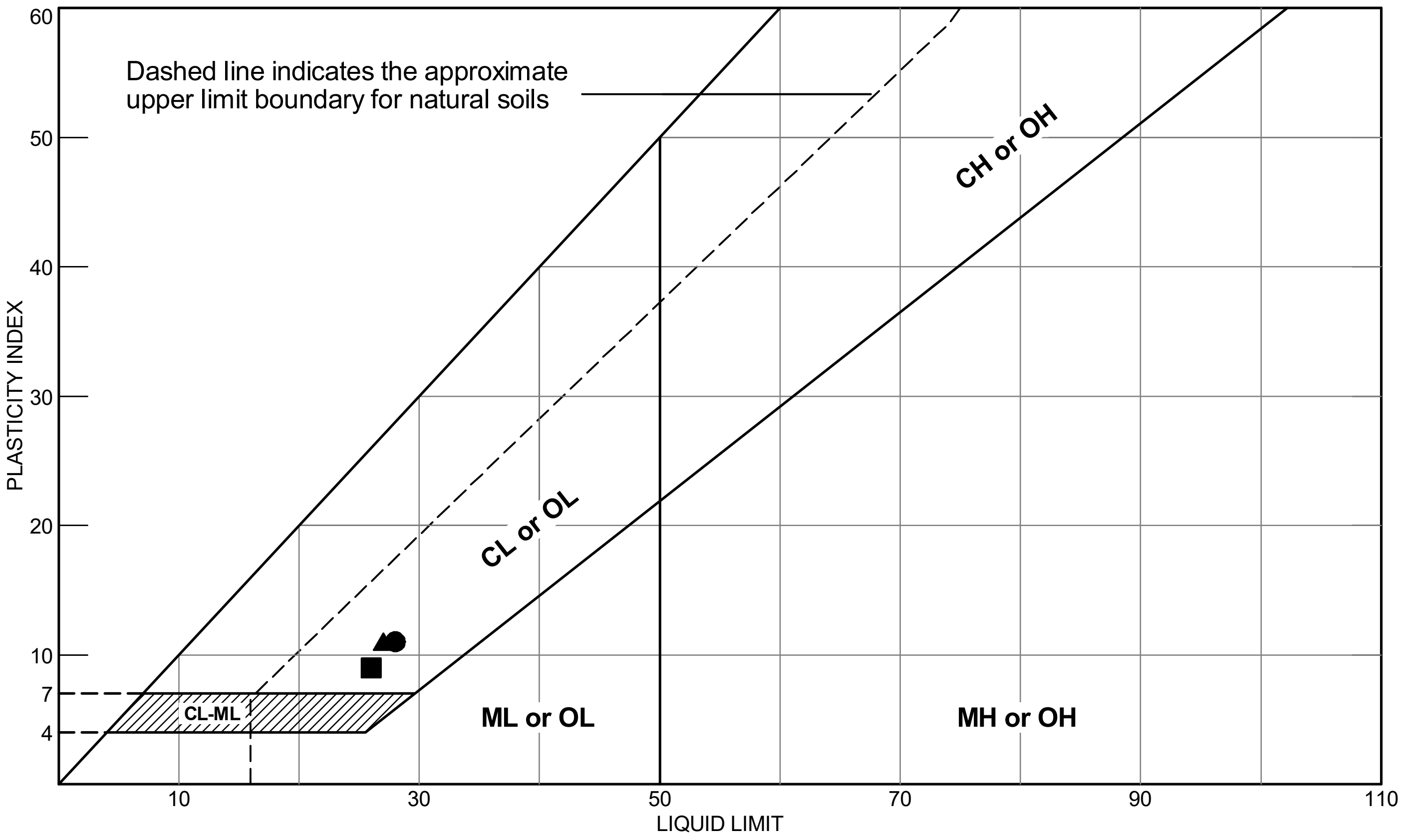
Exploration	Sample ID	Depth	Gravel (%)	Sand (%)	Fines (%)	Liquid Limit	Plastic Limit	Water Content (%)	USCS Group Symbol	Soil Description
HC-1	S-1	5.0	37.8	54.0	8.3			7.2	SW-SM	WELL-GRADED SAND WITH SILT AND GRAVEL
HC-1	S-2	10.0	24.8	70.7	4.4			13.4	SW	WELL-GRADED SAND WITH GRAVEL
HC-1	S-3	17.0	39.7	56.9	3.5			11.2	SP	POORLY GRADED SAND WITH GRAVEL
HC-1	S-4	22.0						16.1		
HC-1	S-5	25.0								
HC-1	S-6	30.0	0.5	84.7	14.7			21.6	SM	SILTY SAND
HC-1	S-7	35.0								
HC-1	S-8	40.0	0.0	93.0	7.0			23.8	SP-SM	POORLY GRADED SAND WITH SILT
HC-1	S-9	45.0								
HC-1	S-10	50.0	0.0	87.2	12.8			22.0	SM	SILTY SAND
HC-1	S-11	55.0								
HC-1	S-12	60.0	0.0	91.3	8.7			18.5	SP-SM	POORLY GRADED SAND WITH SILT
HC-1	S-13	65.0								
HC-1	S-14	70.0						18.8		
HC-1	S-15	75.0								
HA22-1	S-1	2.5								
HA22-1	S-2	5.0								
HA22-1	S-3	7.5								
HA22-1	S-4	10.0	42.3	47.9	9.7			19.9	SP-SM	POORLY GRADED SAND WITH SILT AND GRAVEL
HA22-1	S-5	15.0								
HA22-1	S-6	20.0								
HA22-1	S-7	25.0	42.6	44.2	13.2			10.3	SM	SILTY SAND WITH GRAVEL
HA22-1	S-8a	30.0						7.8		
HA22-1	S-8b	30.9								
HA22-1	S-9	35.0						30.4		
HA22-1	S-10	40.0	5.9	21.0	73.2	28	17	16.8	CL	LEAN CLAY WITH SAND
HA22-1	S-11	45.0								
HA22-1	S-12	50.0						15.2		
HA22-1	S-13	55.0				26	17	15.7	CL	LEAN CLAY WITH SAND
HA22-1	S-14	57.5								
HA22-1	S-15	60.0	27.8	26.6	45.6			12.3	GC-GM	silty,clayey gravel with sand
HA22-1	S-16	62.5								
HA22-1	S-17	65.0				27	16	15.3	CL	LEAN CLAY WITH SAND
HA22-1	S-18	70.0						12.9		
HA22-1	S-19	75.0								
HA22-1	S-20	80.0						11.1		

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

Summary of Laboratory Results

Figure **B-1**
Sheet **1 of 1**



Location and Description	LL	PL	PI	-#200	MC%	USCS
● **Source:** HA22-1 **Sample No.:** S-10 **Depth:** 40.0 to 41.5 LEAN CLAY WITH SAND	28	17	11	73	17	CL
■ **Source:** HA22-1 **Sample No.:** S-13 **Depth:** 55.0 to 56.5 LEAN CLAY WITH SAND	26	17	9	NT	16	CL
▲ **Source:** HA22-1 **Sample No.:** S-17 **Depth:** 65.0 to 66.5 LEAN CLAY WITH SAND	27	16	11	NT	15	CL

Remarks:

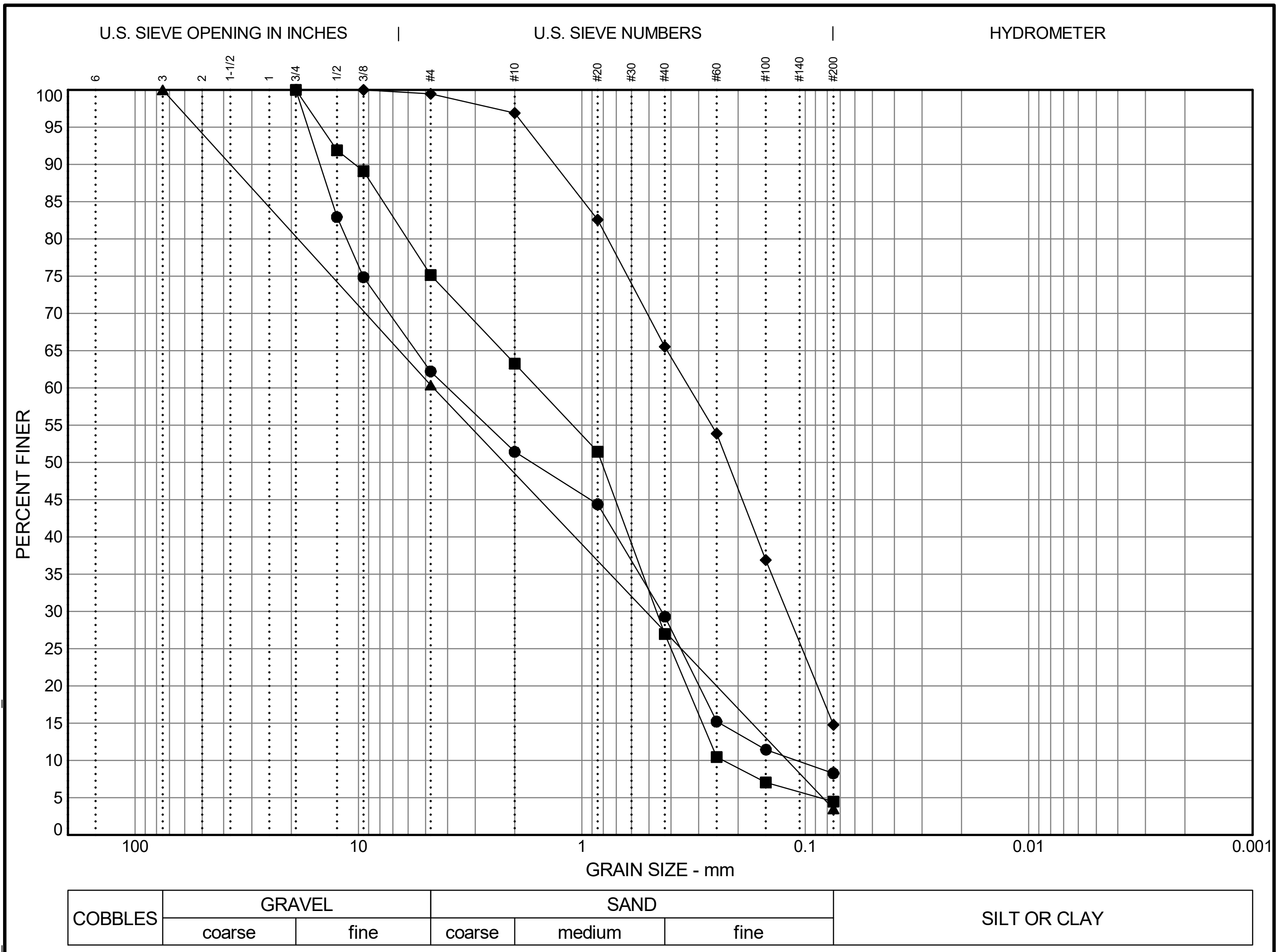
● AL performed on -#40 fraction
■ AL performed on -#40 fraction
▲ AL performed on -#40 fraction

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

Liquid Limit, Plastic Limit, and Plasticity Index

Figure **B-2**
Sheet **1 of 1**



Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** HC-1 **Sample No.:** S-1 **Depth:** 5.0 to 6.5 WELL-GRADED SAND WITH SILT AND GRAVEL	0.0	37.8	54.0	8.3		7	SW-SM
■ **Source:** HC-1 **Sample No.:** S-2 **Depth:** 10.0 to 11.5 WELL-GRADED SAND WITH GRAVEL	0.0	24.8	70.7	4.4		13	SW
▲ **Source:** HC-1 **Sample No.:** S-3 **Depth:** 17.0 to 18.5 POORLY GRADED SAND WITH GRAVEL	0.0	39.7	56.9	3.5		11	SP
◆ **Source:** HC-1 **Sample No.:** S-6 **Depth:** 30.0 to 31.5 SILTY SAND	0.0	0.5	84.7	14.7		22	SM

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			13.152	3.976	1.685	0.439	0.243	0.110	0.44	36.28
■			7.758	1.579	0.816	0.463	0.289	0.233	0.58	6.77
▲			26.411	4.633	2.234	0.519	0.174	0.121	0.48	38.35
◆			0.981	0.330	0.222	0.121	0.076			

Remarks:

●

■

▲

◆

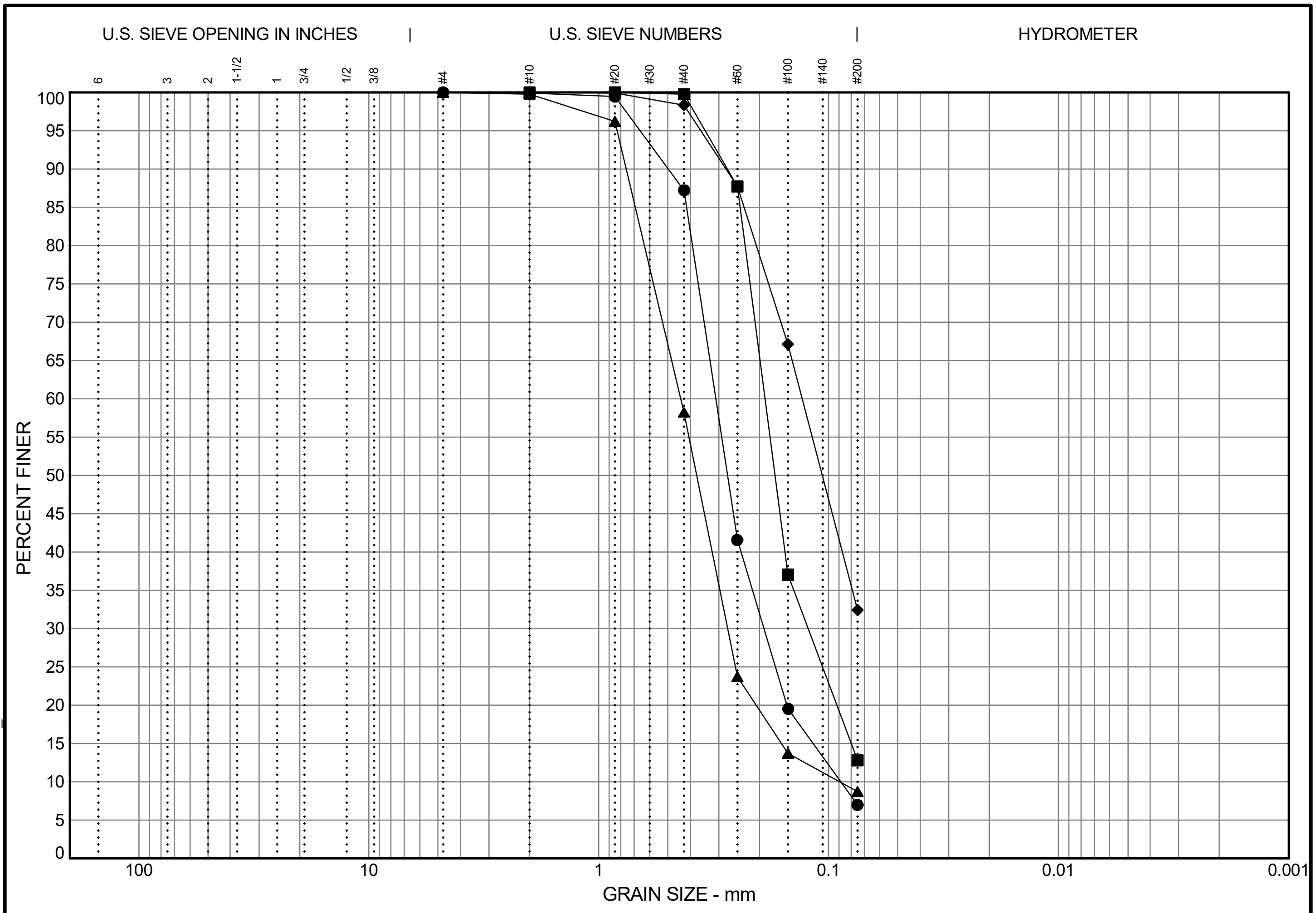
HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location:
Project No.: 19516-00

Particle-Size Analysis

Figure **B-3**
Sheet **1 of 3**

HC GRAIN SIZE - J:\GINT\HC_LIBRARY.GLB - 4/16/20 09:49 - L:\NOTEBOOKS\1951600_HAT_ISLAND_SUBMARINE_CABLE_REPLACEMENT\FIELD DATA\PERM_GINT FILES\1951600-BL.GPJ - hclab



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** HC-1 **Sample No.:** S-8 **Depth:** 40.0 to 41.5 POORLY GRADED SAND WITH SILT	0.0	0.0	93.0	7.0		24	SP-SM
■ **Source:** HC-1 **Sample No.:** S-10 **Depth:** 50.0 to 51.0 SILTY SAND	0.0	0.0	87.2	12.8		22	SM
▲ **Source:** HC-1 **Sample No.:** S-12 **Depth:** 60.0 to 61.5 POORLY GRADED SAND WITH SILT	0.0	0.0	91.3	8.7		18	SP-SM
◆ ~~**Source:** HC-2 **Sample No.:** S-3 **Depth:** 15.0 to 16.5~~ ~~SILTY SAND~~	~~0.0~~	~~0.0~~	~~67.6~~	~~32.4~~		~~27~~	~~SM~~

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.414	0.310	0.276	0.191	0.117	0.089	1.33	3.50
■			0.243	0.189	0.171	0.123	0.080			
▲			0.693	0.439	0.375	0.275	0.160	0.089	1.93	4.91
◆			~~0.234~~	~~0.130~~	~~0.107~~					

Remarks:

●

■

▲ Sample S-3 from test boring HC-2 was from a previous study and is not a part of our subsurface

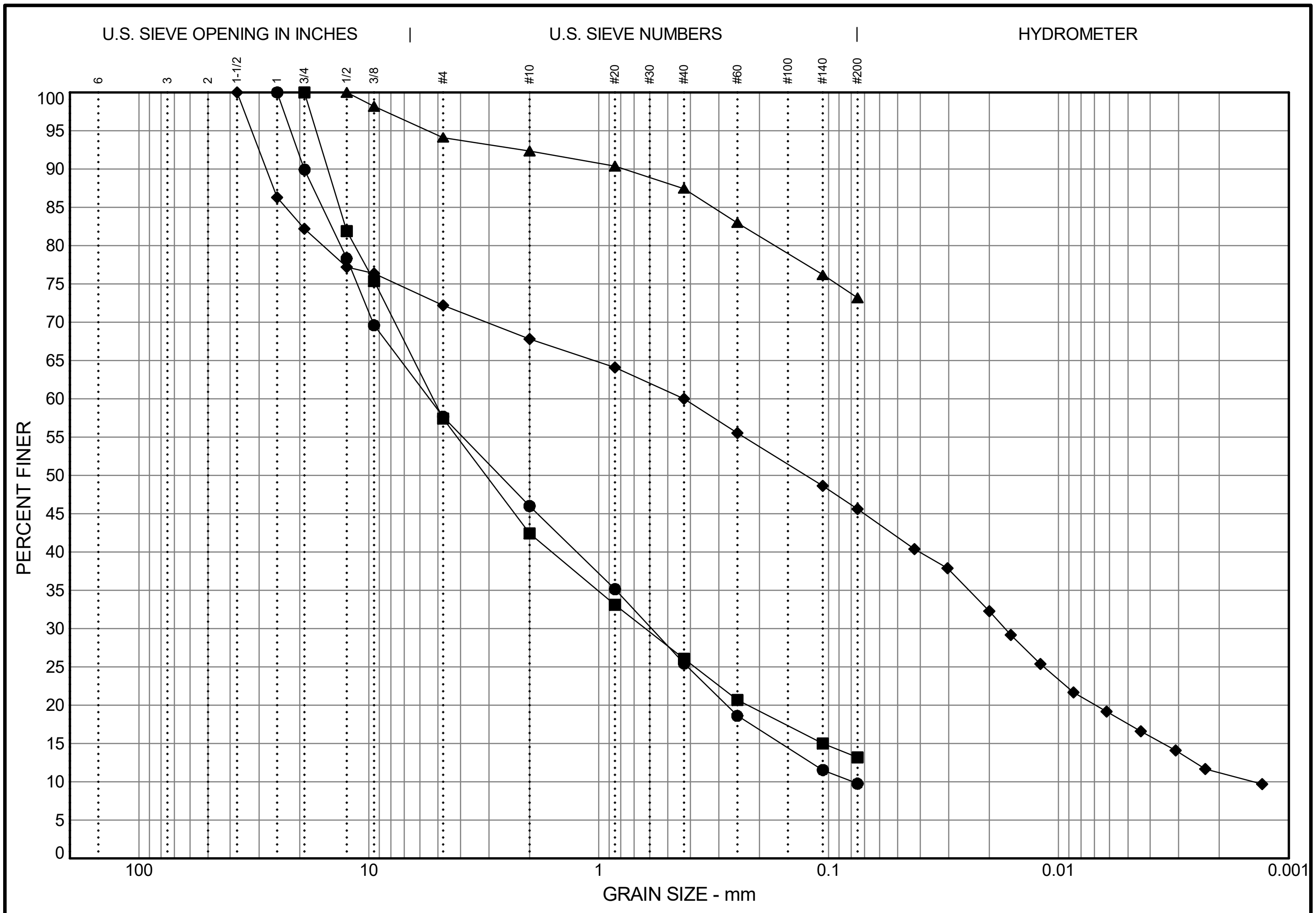
◆ understanding for either the Hat Island or Boneyard sites.

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location:
Project No.: 19516-00

Particle-Size Analysis

Figure **B-3**
Sheet **2 of 3**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** HA22-1 **Sample No.:** S-4 **Depth:** 10.0 to 11.5 POORLY GRADED SAND WITH SILT AND GRAVEL	0.0	42.3	47.9	9.7		20	SP-SM
■ **Source:** HA22-1 **Sample No.:** S-7 **Depth:** 25.0 to 26.5 SILTY SAND WITH GRAVEL	0.0	42.6	44.2	13.2		10	SM
▲ **Source:** HA22-1 **Sample No.:** S-10 **Depth:** 40.0 to 41.5 LEAN CLAY WITH SAND	0.0	5.9	21.0	73.2		17	CL
◆ **Source:** HA22-1 **Sample No.:** S-15 **Depth:** 60.0 to 61.5 SILTY,CLAYEY GRAVEL WITH SAND	0.0	27.8	26.6	28.0	17.6	12	GC-GM

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			15.906	5.435	2.689	0.589	0.161	0.079	0.81	69.03
■			13.431	5.249	3.100	0.626	0.106			
▲	28	11	0.318							
◆			22.917	0.425	0.126	0.017	0.004	0.001	0.48	300.11

Remarks:

●
■ Scattered wood debris
▲ AL performed on -#40 fraction
◆

HALEY ALDRICH

Project: Hat Island Submarine Cable Replacement
Location: Everett, Washington
Project No.: 0202881-000

Particle-Size Analysis

Figure **B-3**
Sheet **3 of 3**

APPENDIX C

Report “Desktop Study for Replacement of SNOPUD Hat Island Power Cable”

DESKTOP STUDY FOR REPLACEMENT OF SNOPUD HAT ISLAND POWER CABLE

Prepared for: Snohomish County PUD
2012 California Avenue
Everett, Washington 98203
Contract No. CW2238251

Prepared by: Richard Sylwester
dicksylwester@gmail.com

Mr. Éric Schneider, Project Manager
Snohomish PUD
2012 California Avenue Everett, WA 98203

Reference: DESKTOP STUDY FOR REPLACEMENT OF SNOPUD TULALIP TO HAT (GEDNEY) ISLAND, POWER CABLE, SNOHOMISH COUNTY, WASHINGTON

Dear Mr. Schneider:

This desktop study provides preliminary information on the interpreted geologic and geophysical characteristics of seabed and sub-seabed conditions along an existing cable corridor. In addition, supplemental information is provided on three proposed alternative routes. The compiled information will be used by others to assist in selecting a route for a replacement power cable and for evaluating cable installation methods.

The existing corridor extends 2.5 nautical miles southwest from Mission Beach, located on the east shoreline of Possession Sound, to the northeast shoreline of Hat (Gedney) Island (Fig.1). The maximum water depth along this route is approximately 340 feet (Terrasond, 2019).

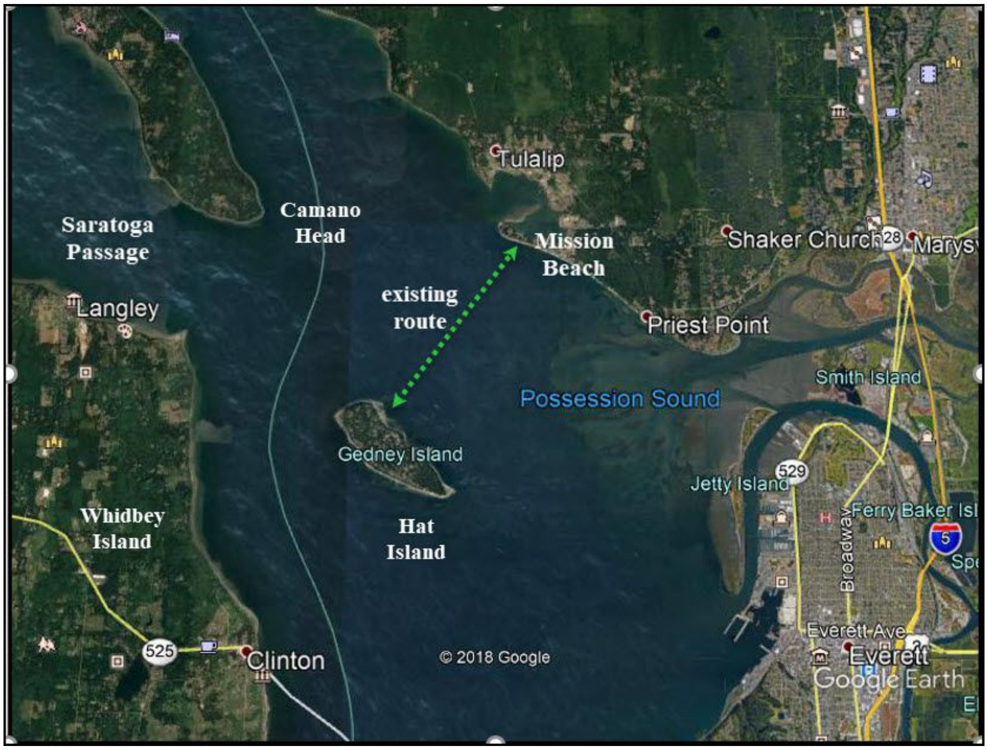


Figure 1. Location of existing power cable crossing

Sources for the geological and geophysical information presented in this document include: Washington State Department of Natural Resources (DNR) geologic information databases, Washington State Department of Ecology, the United States Geologic Survey office of Marine Geology data bases, the University of Washington Department of Oceanography, published papers, reports from several geophysical investigations for pipeline and cable route studies in Puget Sound and a reconnaissance seismic reflection survey conducted for this study.

A. SUMMARY OF GEOLOGIC HISTORY

The geologic history of the Puget Sound Lowlands (Puget Sound trough and marine waters adjacent rivers, valleys and islands) was predominated by continental glaciation (Bretz, 1913). Ice sheets and glaciers expanded south from Canada due to increased accumulation of snow and ice with an associated decrease in sea-level. Glacial advance and subsequent retreat occurred at least 4 times over the past 2 million years. The last advance and retreat (16,000 to 12,000 years before present) of the Cordilleran glacier was the Fraser glaciation that produced most of the present day geologic and topographic features (Thorson, 1980).

During the maximum advance ice thickness in Puget Sound was over 3,000 feet and there was a subsequent sea level lowering of 300 feet (Fig 2).

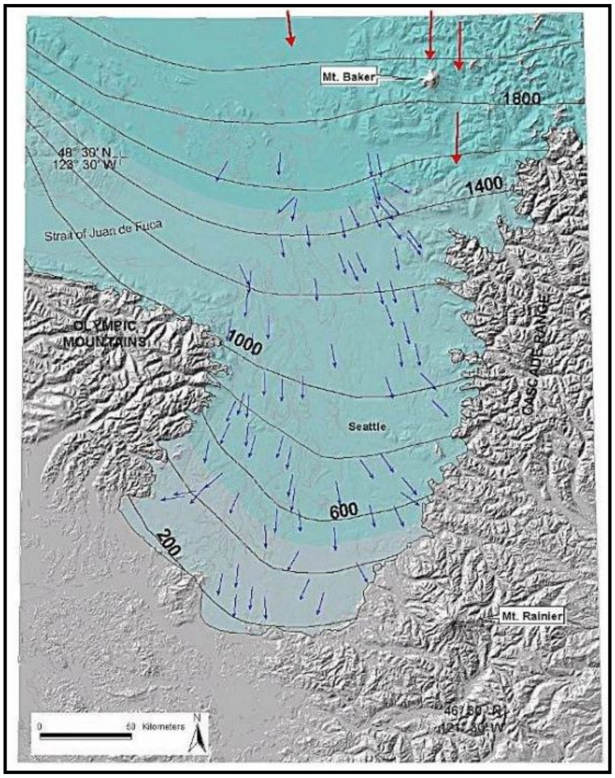


Figure 2. Thickness of continental glacier (m) over Puget Sound 16,000 years ago (Easterbrook, 1966).

During the glacier advance, sediments composed of proglacial lake deposits (silt and clay), advance outwash material (sand and gravel) were deposited on older Pre-Vashon deposits. The older Pre-Vashon deposit are predominantly glacial and nonglacial sediments deposited during repeated glacial and interglacial periods during the past 2 million years.

As the Puget Lobe of the Vashon Stade glacier retreated northward, it deposited a discontinuous veneer of recessional outwash (sand and gravel) and local deposits of ablation till upon the glacial landscape. As the ice receded northward it thinned and begin to float on the waters flooding in from the Strait of Juan de Fuca resulting in glaciomarine drift being deposited offshore over earlier deposits of recessional outwash.

The geology of Whidbey and Camano Island and Mission Beach area south of Deception Pass area is glacial and interglacial. Along the shoreline the bluff deposits range from laminated silty clay to pebbly silt, stratified sand and gravel to well sorted sand and silt. The sea has been gradually eroding these coastal bluffs since the Vashon glacier began to melt. These sediments are now found on the wave cut benches (beaches) and cover the glacial sediment that underlie the offshore slopes.

Offshore, in deep-water, the seafloor is mantled with 10 to 30 feet of recent, fine-grained marine sediment overlain on glaciomarine and older glacial deposits that are thousands of feet thick in what is known as the Everett Basin (Barnett, 2010)

There is no evidence of bedrock outcrops on shore or in the reconnaissance seismic reflection data obtained for this investigation. However, Hat Island apparently has a bedrock core, the Fidalgo formation, that is an intrusive igneous mass characteristic of other rock formations on the San Juan Islands (McClellan, 1927). There is also evidence of exposed bedrock offshore on a seismic reflection profile obtained by the USGS that traversed from Possession Sound northward into Saratoga passing on the west side of Hat Island (Harding et.al., 1988).

B. POTENTIAL SUBMARINE GEOLOGIC HAZARDS

Several events and processes can occur that may have an adverse effect on the marine cable at the shore landings, on the adjacent offshore slopes and/or across the deep-water crossing. The following is a brief summary of these potential events.

Earthquakes: Earthquakes are the primary driver for most of the events and processes discussed below. Earthquakes may occur along any of the numerous faults found in Puget Sound as well as on the major Cascadia subduction zone located on the west coast of Washington. An earthquake associated with this subduction zone occurred approximately 300 years ago and is estimated to have produced a magnitude 9. Based on historical geologic investigation and related recent studies, the maximum recurrence interval for large ground-rupturing crustal-fault earthquakes in the Puget Lowland is about 400 to 600 years (Pratt, 1997).

Faults: Beneath the heavily populated Puget Sound region (Puget Lowland) is a regional complex of interrelated seismogenic (earthquake-causing) geologic faults (Fig. 3, Wikipedia). From north to south these include:

- *Devils Mountain Fault*
- *Strawberry Point and Utsalady Point faults*
- *Mount Vernon/Woods Creek fault (Rogers Belt)*
- *Cherry Creek Fault Zone*
- *Southern Whidbey Island Fault (SWIF)*
- *Rattlesnake Mountain Fault Zone*
- *Seattle Fault*
- *Tacoma Fault*
- *Saddle Mountain Faults*
- *Olympia structure*
- *Doty Fault*
- *Saint Helens Zone and Western Rainier Zone*

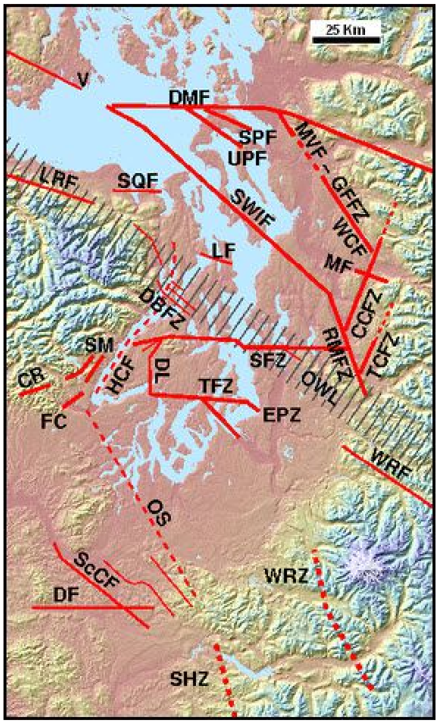


Figure 3. Puget Sound Faults.

Two fault zones are located relatively close to the cable crossing corridor. These are the South Whidbey Island Fault Zone (SWIF) and the Utsalady/Strawberry Fault Zone (UPF, SPF). The cumulative slip rate on the faults in this zone probably exceeds 0.5 mm/yr. and could be much larger (Fig. 4)

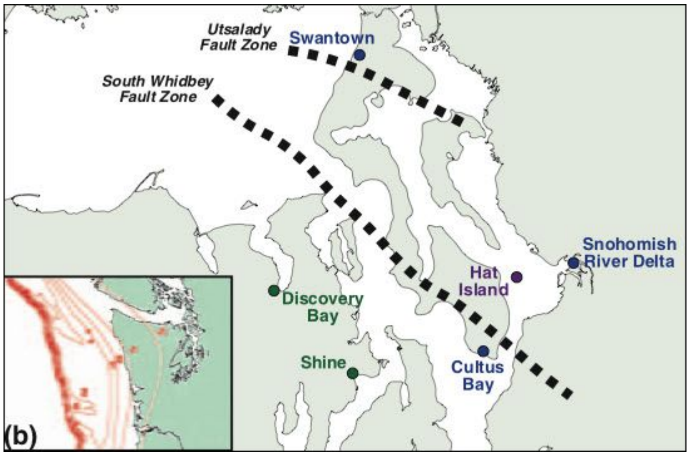


Figure 4. Faults closest to cable.

South Whidbey Island Fault Zone: SWIF is a broad, north-side-up fault zone (6–11 kilometers; 4–7 miles wide) dipping steeply to the northeast (Johnson 1996). The magnitude 7.4 earthquake modeled for the southern Whidbey Island fault zone is a shallow or crustal earthquake (Fig. 5). The black box shows the area of the modeled rupture and the intensity within the rupture zone varies from severe to violent (Intensity of VIII to IX).

Shallow quakes tend to be much more damaging than deep quakes of comparable magnitude (such as the M6.8 Nisqually earthquake in 2001). Excavations across several scarps near Woodinville revealed evidence of at least four earthquakes since deglaciation about 16,000 years ago, the most recent being less than 2,700 years ago.

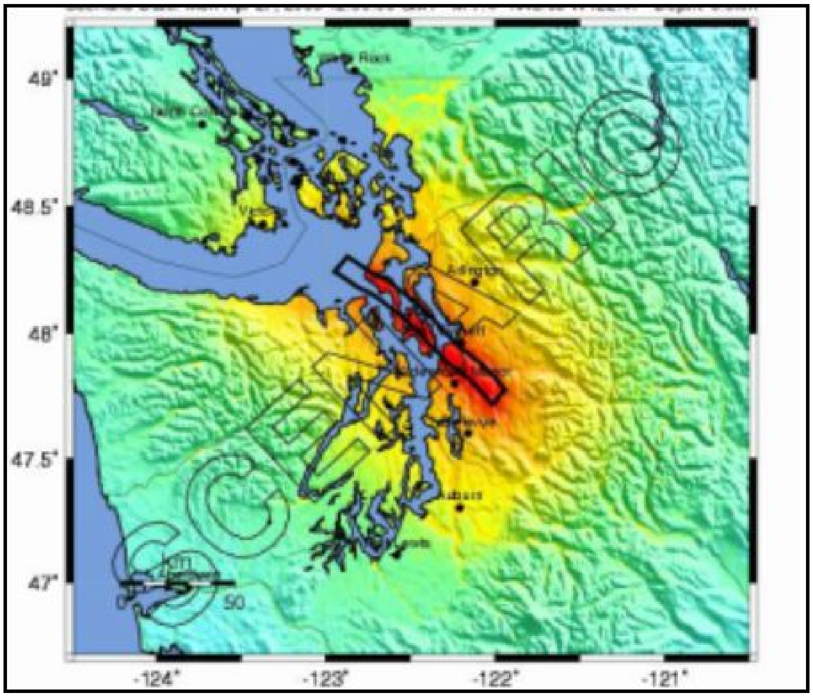


Figure 5. Intensity along rupture of SWIF.

Utsalady Fault Zone

This fault (Fig. 6) is an oblique-slip and shows both horizontal and vertical slip as the crustal blocks are pressed together (Johnson 2004). Trenching on the UPF (at a scarp identified by LIDAR) shows at least one and probably two Holocene earthquakes of magnitude 6.7 or more. The most recent one occurred between AD 1550 to 1850 and was possibly triggered by the 1700 Cascadia Subduction Zone fault located off the Washington coast. These earthquakes probably produced tsunamis. Several nearby locations show evidence of tsunamis not correlated with other known earthquakes.

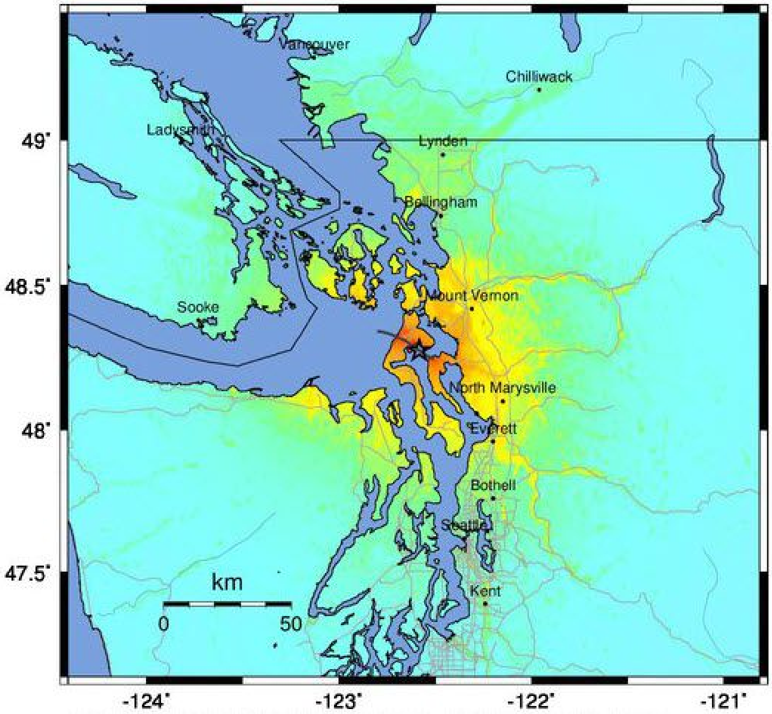


Figure 6. Ultsalday fault zone and intensity for VII earthquake.

Landslides: Water saturation of loose sediments is the primary trigger of landslides in Puget Sound (Fig. 7). Other triggers can result from seismic events (earthquakes), deposition of eroded bluff sediments on the steep slopes, and rapid deposition of sediment offshore from flooding rivers. Slope failures in the loose, fine to medium-grained glaciomarine sediment occur as either retrogressive flow slides (RFS) or spontaneous liquefaction (SL). The RFS start in some area of the slope and develop retrogressively up slope. SL slides initiate at a point and spread in all direction, up and down slope at a very high rate.

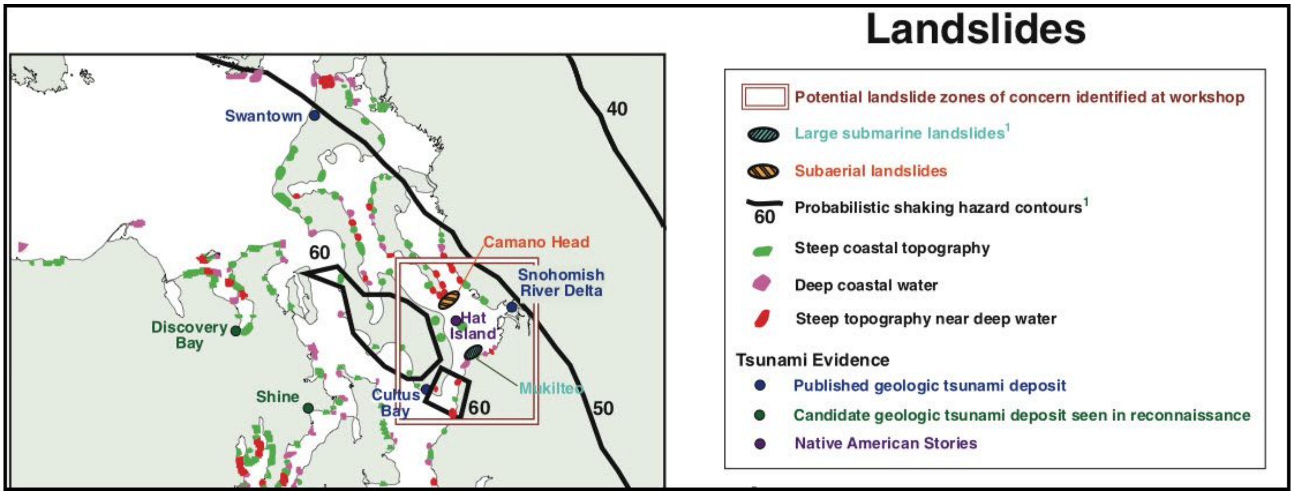


Figure 7. Examples of landslides in Puget Sound (Walsh 2002).

Although steep slopes are very susceptible to landslides, old, deep-seated landslides may be reactivated, even where gradients are low. A change in slope of the terrain with an increased sediment loading, shocks and vibrations, change in water content, groundwater movement, and removing or changing the type of vegetation covering slopes are all contributing factors. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 40 percent
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel.

Tsunamis: Large coastal and underwater landslides and seismic events may produce tsunamis, or tidal waves. These are a series of waves caused by the displacement of a large volume of water that moves away from the area of disturbance. This creates potential hazards in areas not located near the actual source of the wave. At least nine earthquake related tsunami deposits, dating back 2500 years, have been mapped in Washington with the youngest being from the 1700 A.D. Cascadia earthquake (Haugerud and Kelsey, 2017).

A landslide in 1820 at Camano Head generated a tsunami that inundated a fishing village on Hat Island (Shipmen, 2001). In addition to offshore landslides the collapses of river deltas have produced tsunamis. There are several potential sources for generating tsunamis in Puget Sound on river delta that are highly susceptible to seismic soil liquefaction and potentially prone to submarine landsliding and disintegrative flow failure (Fig. 8)

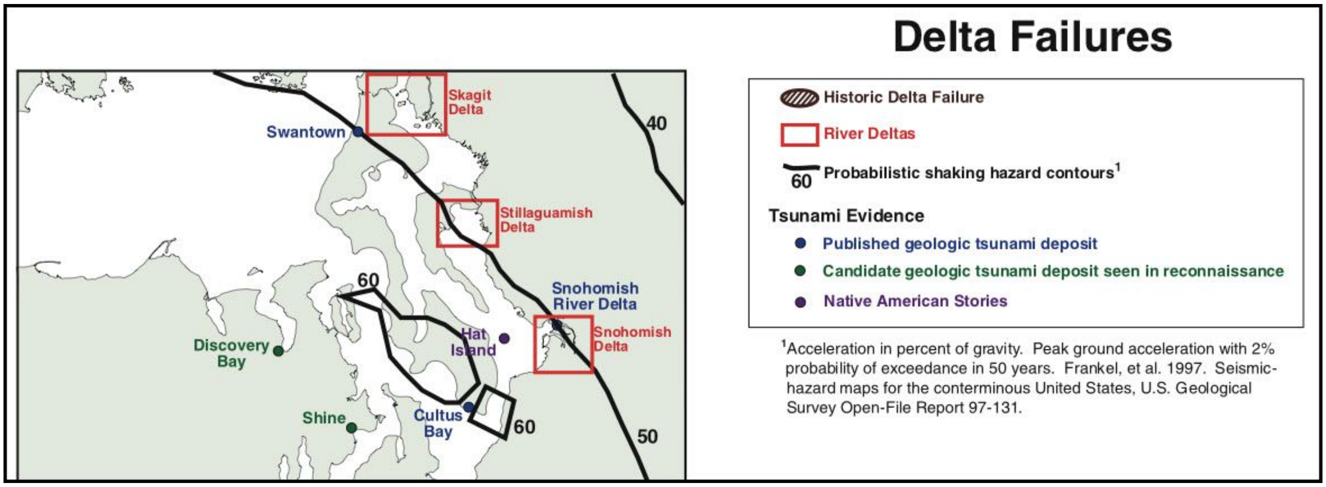


Figure 8. Areas of potential delta failures that may generate tsunamis or turbidity currents (Walsh 2002).

Liquefaction: This is a phenomenon in which earthquake shaking causes soils to rapidly lose their strength and behave like quicksand. This typically occurs in areas of loose, sandy, saturated soils often found in low-lying coastal areas, underwater marine and riverine deposits, river deltas, artificial fills, and tidal flats. These areas of poorly consolidated soils tend to have a high liquefaction potential. For example, the liquefaction susceptibility of many river valleys and deltas—such as the land on either side of the Stillaguamish and Snohomish rivers is rated moderate to high (Fig. 8).

Turbidity Currents and Debris flow: Turbidity currents are sediment laden water that can result from the failure of sediment buildup on delta or steep slopes. They are high-density currents that have considerable scour and erosion capability. For example, in SE Alaska an earthquake triggered the collapse of a delta and the subsequent submarine landslide produced a turbidity current that flowed across a power cable resulting in failure of the cable (personal communication). The submarine delta was fed by a bedload dominated river, such as what occurs on the Snohomish River during heavy run-off.

Ship Traffic and Anchor Drag: Commercial seagoing vessel as well as fishing vessels may drop and drag an anchor in areas such as cable corridors, that are marked as exclusive zones. Since most of the planned cable is laid on the seabed, and not buried, it is susceptible to damage should such an anchor drop event occur.

The offshore area around Hat Island is in the Puget Sound Vessel Traffic Service Area (NOAA Chart 18443 which provides information to vessels regarding obstructions, cables, etc.

C. DISCUSSION OF CABLE CORRIDOR SEISMIC REFLECTION DATA

The following summarizes the results of the seismic reflection data obtained on a reconnaissance geophysical survey in the vicinity of the Hat Island and Mission Beach shore landings and along a single transect between the two landings. The seismic reflection data were obtained with a low-frequency (400 to 800 Hz), low power (60 joules, 120 db re 1 microbar at 1m) seismic reflection system and acquired on a digital acquisition system interfaced with GPS navigation (Sylwester, 1982).

Hat Island

Subbottom seismic reflection data were acquired on several parallel transects offshore of Hat Island (Fig. 9). Images of the subsurface reflection data for the three transects are presented below (Figs. 10, 11 and 12).

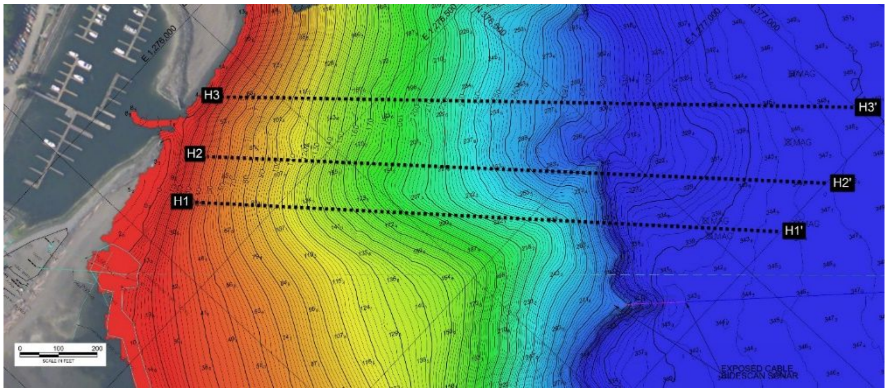


Figure 9. Location of transects for seismic reflection data.

The seabed in shallow water appears to be covered with approximately 10 feet of unconsolidated material obtained from bluff erosion and then reworked by wave action. The divers report from the eel grass survey describes the seabed as sand and 0 to 4-inch rock from the shoreline to a depth of approximately 0 feet. From 0 to the -10-foot depth contour the seabed was predominantly sand and eel grass and sand between the -10- and -30-foot depth contour. This material overlays about 30 feet of glaciomarine deposits that rest on a thick sequence (in excess of 200 feet) of horizontally bedded glacial deposits. The slope is covered with unconsolidated sediment of variable thickness that shows hummocky surface expressions that are evidence of submarine slides (Line H1 and H2). A thick deposit of loose material truncates the underlying horizontally stratified glacial sediment (Line H3). Offshore in deep-water the seabed is mantled with approximately 30 feet of fine-grained, marine sediment overlain on glacial marine deposits.

The sequence shown in the three figures is most likely characteristic of the strata that would be observed on seismic data obtained along other areas of the eastern shoreline of Hat Island.

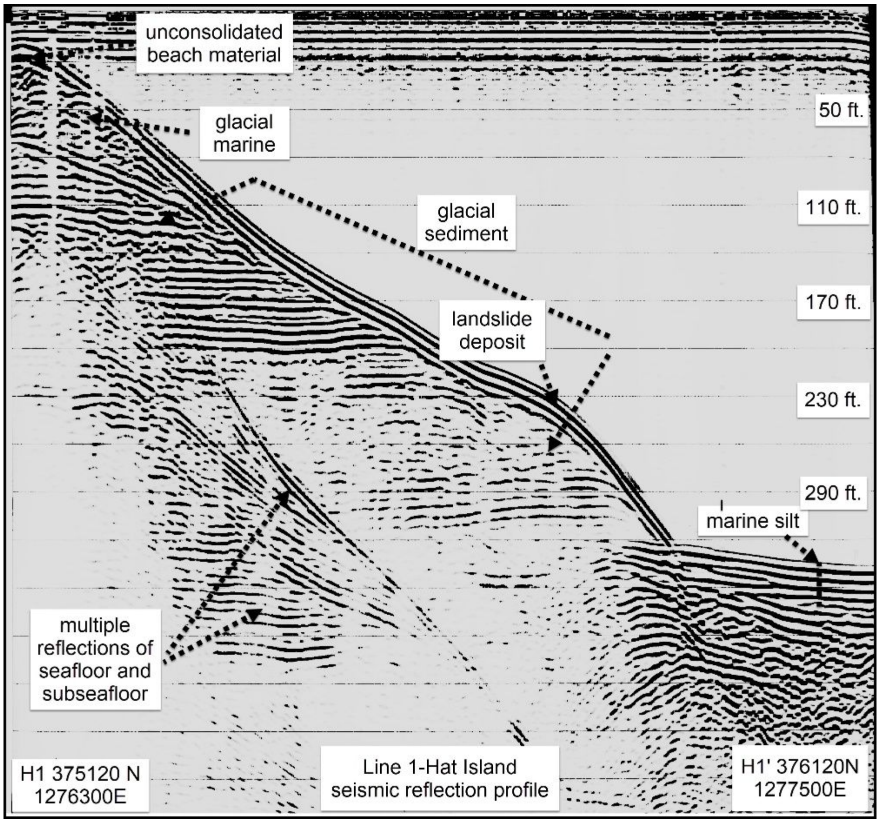


Figure 10. Examples of seismic reflection data on Line H1.

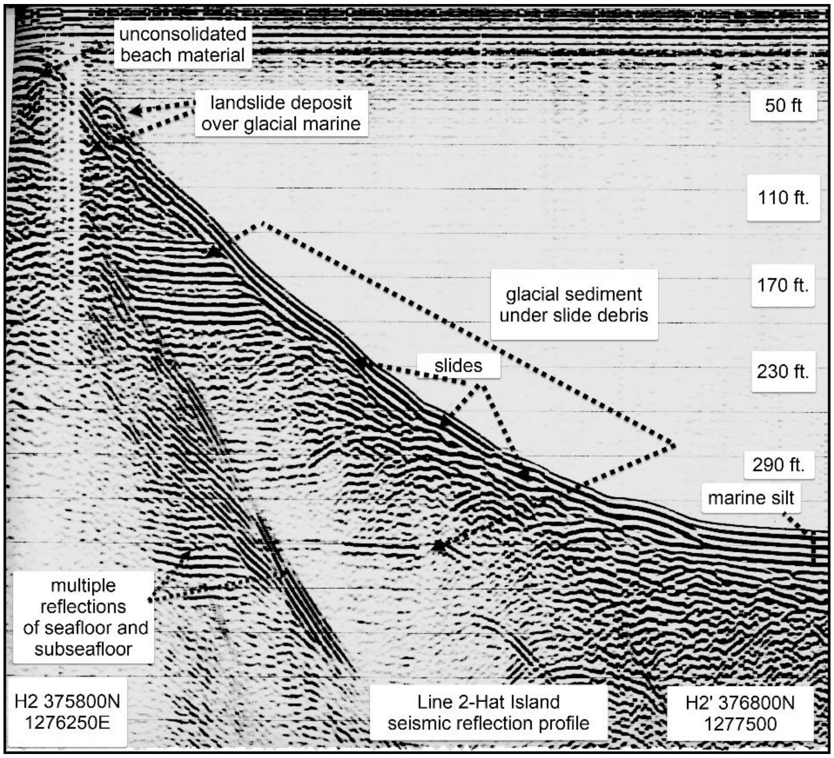


Figure 11. Examples of seismic reflection data on Line H2.

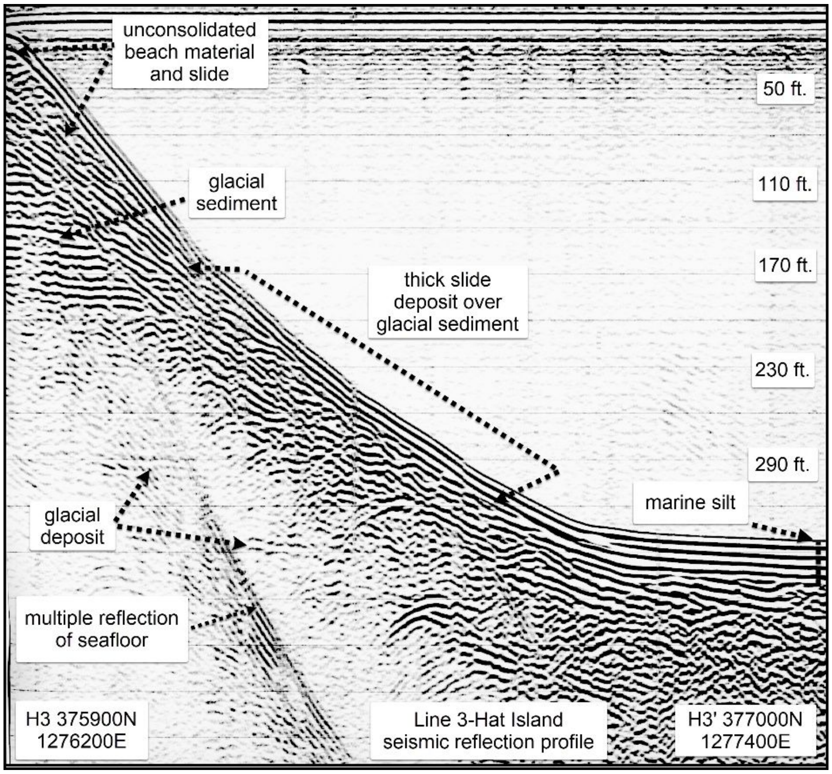
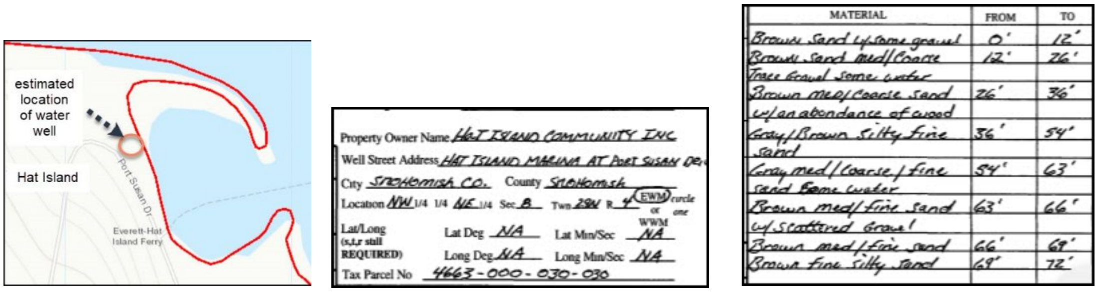


Figure 12. Examples of seismic reflection data on Line H3

Water well data: There is one well on Hat Island that is located between the marine ramp and the shoreline (Steve Stangvik personal communication). Ecology has it mapped offshore but describes the location to be on Port Susan Drive. This is where it is shown on the attached image but needs to be surveyed for an exact location. The borehole log describes 72 feet of fine to medium sand (Fig. 13).



Property Owner Name HAT ISLAND COMMUNITY INC
Well Street Address HAT ISLAND MARINA AT PORT SUSAN DR
City SNOHOMISH CO. County SNOHOMISH
Location NW 1/4 1/4 NE 1/4 Sec B Twn 29N R 4 [✓ EWM] or WWM circle one
Lat/Long (s,t,r still REQUIRED) Lat Deg NA Lat Min/Sec NA
Long Deg NA Long Min/Sec NA
Tax Parcel No 4663-000-030-030

MATERIAL	FROM	TO
Brown Sand w/some gravel	0'	12'
Brown Sand med/Coarse	12'	26'
Trace Gravel some water		
Brown med/Coarse sand	26'	36'
w/an abondance of wood		
Gray/Brown silty fine	36'	54'
sand		
Gray med/Coarse/fine	54'	63'
sand some water		
Brown med/fine sand	63'	66'
w/scattered Gravel		
Brown med/fine sand	66'	69'
Brown fine silty sand	69'	72'

Figure 13. Beach Well 1 on Hat Island.

Tulalip-Mission Beach

Subbottom seismic reflection data were acquired on a series of parallel transects offshore of Tulalip/Mission Beach (Fig.14).

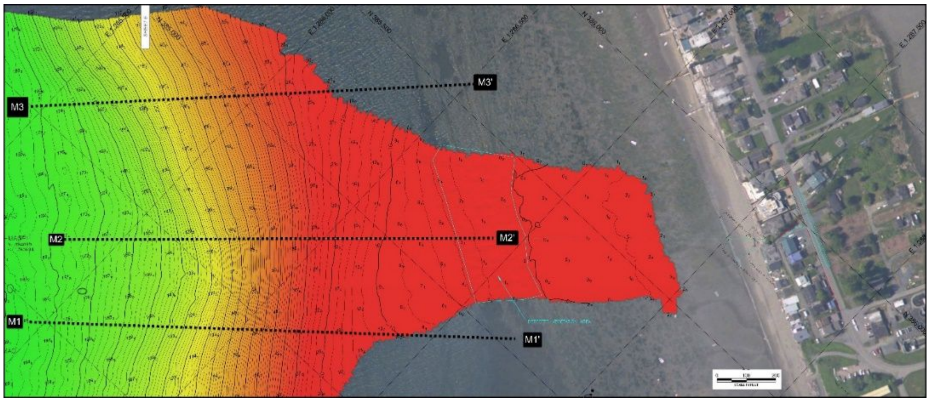


Figure 14. Location of transects for seismic reflection data shown in Figures 15, 16 and 17.

The subsurface reflection data on the three transect are all quite similar (Figs. 14, 15, 16) and have some similarity to the Hat Island seismic profiles. The seabed in the shallow water is covered with unconsolidated material from the beach that are bluff erosion deposits. These materials are continually transported downslope and on the seismic data show evidence of slumping and/or submarine landslides. The diver’s eelgrass report describes the presence of sand from the shoreline to a depth of -2 feet and mud from -2 feet to -30-foot water depth. Eel grass was mapped between the -2- and -6-foot depth contours. There is no evidence of the eel grass beds on the data due to the limited resolution of the seismic signal.

The unconsolidated beach and shelf sediments overlay about 30 feet of glaciomarine deposits that rest on a thick sequence (in excess of 200 feet) of horizontally stratified glacial deposits. Approximately 500 feet offshore the subsurface strata, particularly the horizontal glacial deposits, can no longer be detected. The lack of subsurface penetration is most likely due to the presence of organic material laying on the seabed or within surficial fine-grained sediment. The degradations of organic debris generate gas (methane) that blocks the acoustic signal; quite common in many offshore areas in Puget Sound. However, it can be assumed that the horizontally stratified glacial deposits extend offshore to the slope and remain at the same relative depth.

Although the subsurface horizontal reflections cannot be detected beneath the areas that are acoustically opaque or blanked by the organic material, it is assumed that the slope is covered with a variable thickness of recent sediment, including slide material. Beneath these deposits are the horizontally stratified glacial deposits detected near shore and at the Hat Island landing as well. Offshore the seabed is mantled with at least 30 feet of fine-grained marine sediment.

There was no evidence on the seismic reflection data of the eel grass that was mapped near shore on the bathymetric survey (Fig. 14).

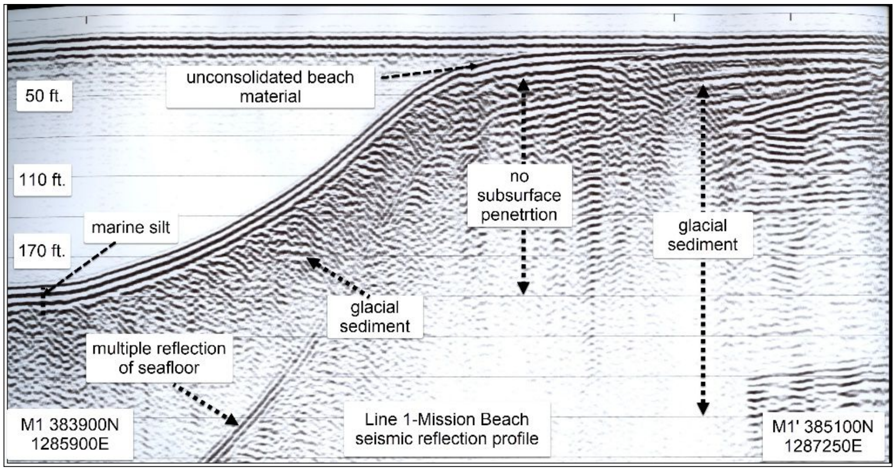


Figure 15. Example of seismic reflection data on Line M1.

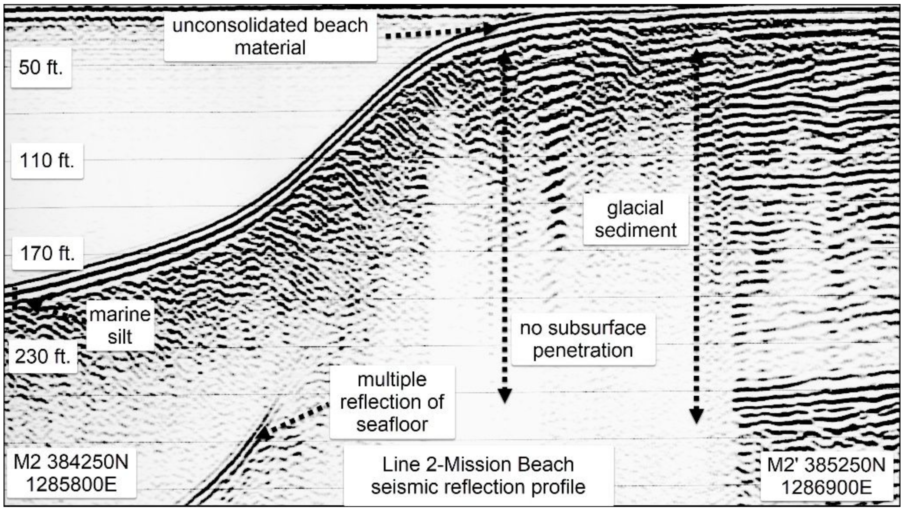


Figure 16. Example of seismic reflection data on Line M2

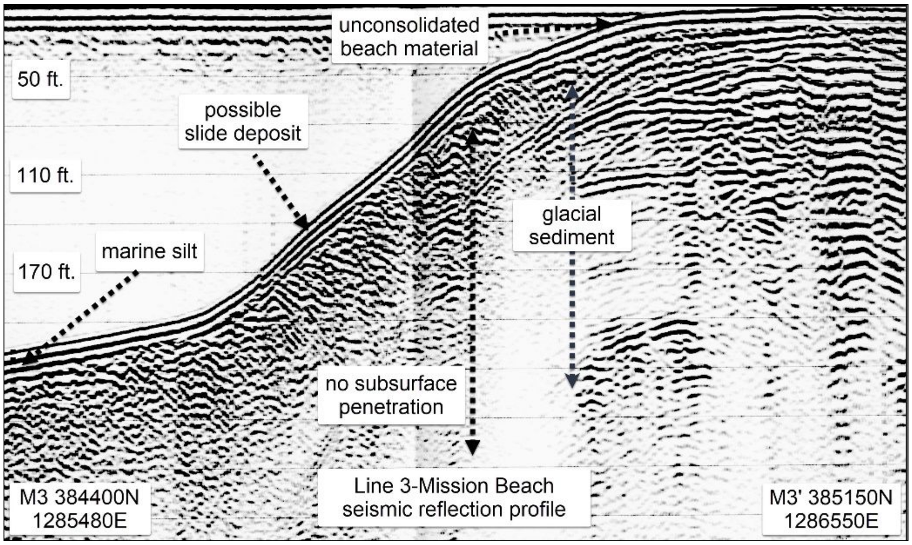
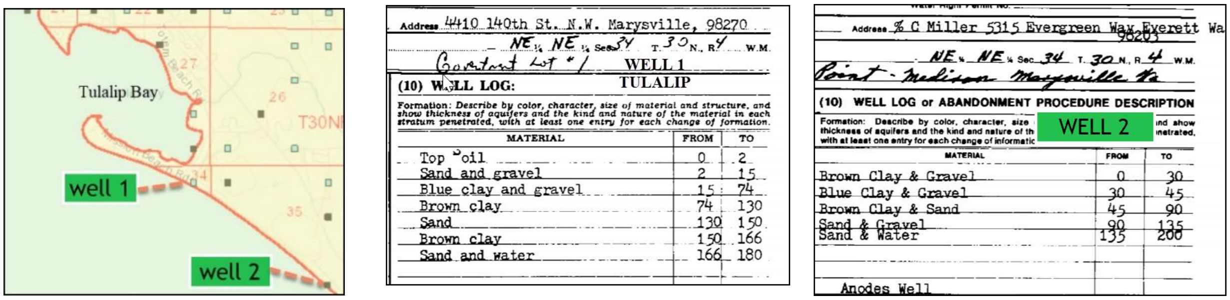


Figure 17. Example of seismic reflection data on Line M3

Water Well Data (Fig. 18): One well was located close to where the existing cable lands on shore; approximately 400 feet eastward of the end the offshore geophysical survey transect (Well 1). A second well is located on Priest Point (Well 2). Elevations are not given for either well. Soils are sand, gravel and clay.



Address 4410 140th St. N.W. Marysville, 98270
NE ¼ NE ¼ Sec 34 T. 30 N., R. 4 W.M.
Government Lot #1 WELL 1

(10) WELL LOG: TULALIP

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Top Soil	0	2
Sand and gravel	2	15
Blue clay and gravel	15	74
Brown clay	74	130
Sand	130	150
Brown clay	150	166
Sand and water	166	180

Water Right Permit No.
Address % C Miller 5315 Evergreen Way Everett Wa 98203
NE ¼ NE ¼ Sec 34 T. 30 N., R 4 W.M.
Point - Madison Marysville Wa

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size WELL 2 ind show thickness of aquifers and the kind and nature of th inetrated, with at least one entry for each change of informatic

MATERIAL	FROM	TO
Brown Clay & Gravel	0	30
Blue Clay & Gravel	30	45
Brown Clay & Sand	45	90
Sand & Gravel	90	135
Sand & Water	135	200
Anodes Well		

Figure 18. Water well 1 (ID 79775) and water well 2 (ID 79775)
https://fortress.wa.gov/ecy/wellconstruction/map/WCLSWebMap/WellConstructionMapSearch.aspx

Deep-water, Main Corridor Crossing

A single seismic reflection profile was obtained on a transect that ran approximately parallel to the existing cable route from Hat Island to Mission Beach. The subsurface stratigraphy was very uniform with approximately 30 feet of fine-grained marine sediment overlain on glacial marine deposits of unknown thickness (Fig. 19). Surface sediment samples obtained in deep-water by the Department of Ecology in the Port Gardner/Hat Island area classify the seabed sediment as a mixture of silt and clay (Port Gardner, 2014). Additional information on seafloor sediment is shown in several places on NOAA chart 18433.

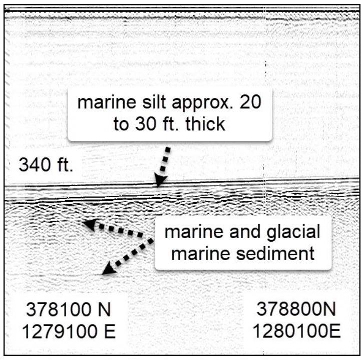


Figure 19. Example of seismic reflection data near mid-channel

D. SUPPLEMENTAL GEOPHYSICAL SURVEYS

Two additional offshore surveys were conducted within the existing cable route by another contractors. The details and results of these investigations are presented in a separate report (Terrasond, 2019). Briefly summarized the geophysical methods and information obtained are as follow.

1. Bathymetric Survey: A multibeam bathymetric survey was conducted along a corridor centered on the existing cable route. The corridor was approximately 1200 feet wide and narrowed to 200 feet at each landing. Images of the bathymetric contours for Hat Island and Mission Beach, are presented below (Fig. 20). Not shown near Hat Island is a possible sunken barge located 450 feet north of the centerline (377,700N, 1,278,100E). It is quite apparent that the seafloor on the Hat Island landing is considerably more complex, with incised canyons and escarpments, compared to the gentle slope on Mission Beach. The entire profile shows that the seabed in deep-water (approximately 340 feet) is extremely flat. The locations of the existing power cable, mapped using a magnetometer and sidescan sonar, is near the as-built cable location (Figs. 20 and 21).

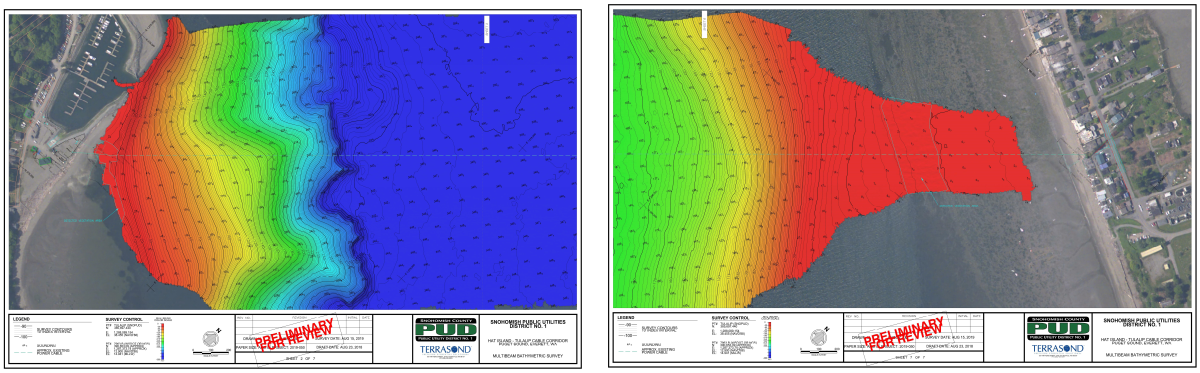


Figure 20. Bathymetry offshore Hat Island (left) and Mission Beach (Terrasond Ltd., 2019)

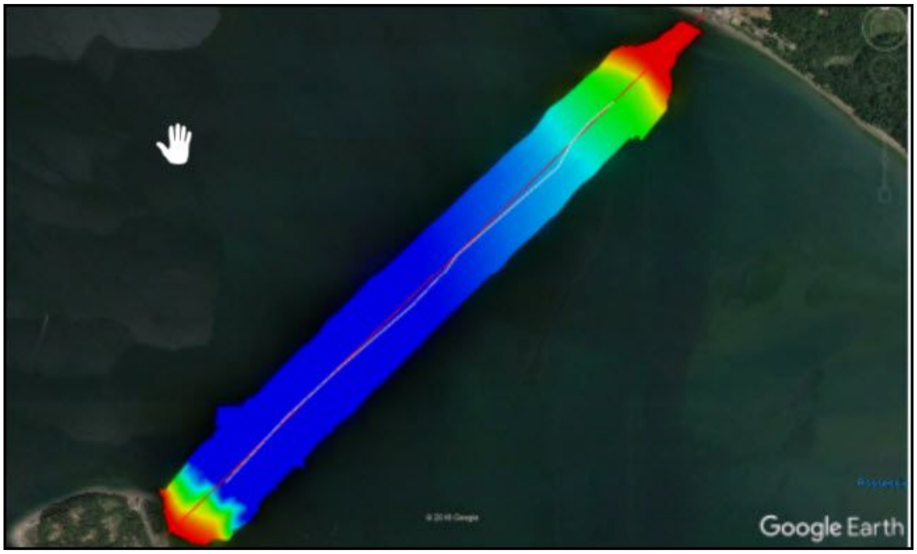


Figure 21. Bathymetry along cable route and location of existing cable (Terrasond Ltd, 2019).

2. Cable Survey: Data were acquired with a magnetometer and sidescan sonar to locate the actual position of the existing cable within the cable corridor. The sidescan sonar only detected the cable at the base of the slope near Hat Island. This suggests that the cable is buried in the soft sediment in deep-water and beneath landslide material on each slope. However, the magnetometer was able to detect several magnetic anomalies as the survey vessel traversed back and forth across the cable corridor. These magnetic anomalies are interpreted to indicate the presence of ferrous objects including the existing power cable and possibly crab pots or miscellaneous debris (Fig. 22).

Figure 22. Magnetometer and sidescan sonar data. White marks are location of magnetic anomalies Bathymetry along entire cable route and location of existing power cable based on interpreted magnetometer and sidescan sonar data (Terrasond Ltd., 2019).

E. ALTERNATE ROUTES

Four crossing routes are being evaluated for installation of the replacement marine cable to Hat Island (Fig. 23). These crossings originate at Mission Beach (A), the existing cable route, Camano Head (B), Whidbey Island (C), and Everett (D) and terminate at the appropriate location on Hat Island.

Figure 23. Proposed alternate routes to Hat Island.

Route A – Parallel to the existing marine power cable route, but slightly offset . This route runs from Mission Beach to an area just east of the Hat Island marina (Fig. 23).

Mission Beach and Mission Beach Heights Road above and below the bluff are extremely vulnerable to landslides based on field observations by the Tulalip Department of Community Development (Hazard Mitigation Plan 2010). Offshore there is evidence on the marine seismic reflection data, acquired during the reconnaissance survey, of several submarine landslides. On the Hat Island landing the slopes are quite steep particularly at the bottom of the slope where there appears to be an escarpment (Figure 20). Apparently, these conditions created no difficulty during installation of the existing cable nor resulted in failure where the cable passes over the escarpment. Based on the detailed bathymetric data it should be possible to select a route from shoreline to deep-water that would avoid the escarpment and areas of apparent submarine landslides.

Route B - extends from the southernmost tip of Camano Island (Camano Head), to the northeastern end of Hat Island (Fig. 23).

Previous recorded landslide at Camano Head suggests this is a very unstable slope. One failur produced a tsunami wave that inundated the north shore of Gedney Island. The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel are prone to failure when saturated (Fig. 24). Future landslides would potentially result in burial, suspension or separation of power cable.

There is also an obstruction, Fish Haven, locate just southeast of Camano Head. This is mapped on NOAA Chart 18443.

Historical Note 1: People at Hat Island in the early summer morning (1820) saw Camano Island bluff smoking; they couldn't see it for the smoke; and there was something black coming toward them, and then they saw it was a wave. They fled to high land. Some the men and women, some of the children were drowned (Tweddell, 1953 p. 67)

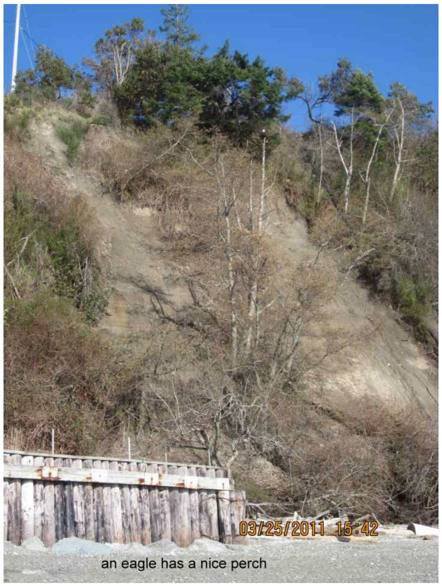
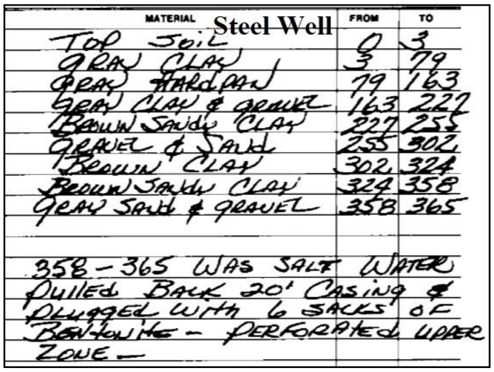


Figure 24. Camano Head

Historical Note 2: Camano Island Head landslide and subsequent tsunami (1820). Interview of Indian tribe conducted by the U.S. Government in 1888. The extreme southern end of Camano Island collapsed and fell into the bay creating a huge tsunami that traveled across Gardner Bay destroying the Snohomish Indian village of Hibulb, located along the western shoreline of what is now Everett, Washington, It also buried an Indian encampment at the base of the collapsed bluff before continuing on and wiping out a seasonal fishing village on Hat Island.(Washington State History/Geology Shipman, 2001).

Water well logs: Several water wells are in the immediate area and the log from the deepest one was selected. All wells showed a sequence of interbedded silt, clay and sand. There was no elevation information on the well (Fig. 25). Soils are clay, sand and gravel.



Steel Well

MATERIAL	FROM	TO
TOP SOIL	0	3
GRAY CLAY	3	79
GRAY HARDPAN	79	163
GRAY CLAY & GRAVEL	163	227
BROWN SANDY CLAY	227	255
GRAVEL & SAND	255	302
BROWN CLAY	302	324
BROWN SANDY CLAY	324	358
GRAY SAND & GRAVEL	358	365

358 - 365 WAS SALT WATER
PULLED BACK 20' CASING &
PLUGGED WITH 6 SACKS OF
BENTONITE - PERFORATED UPPER
ZONE -

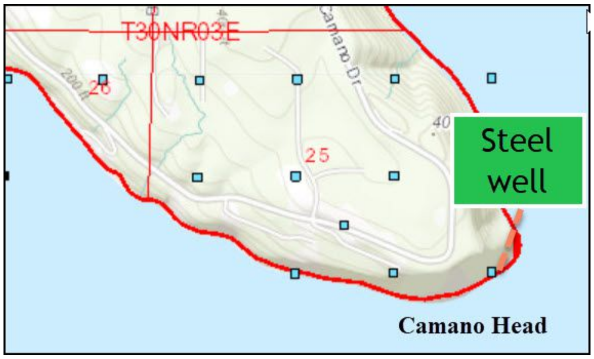


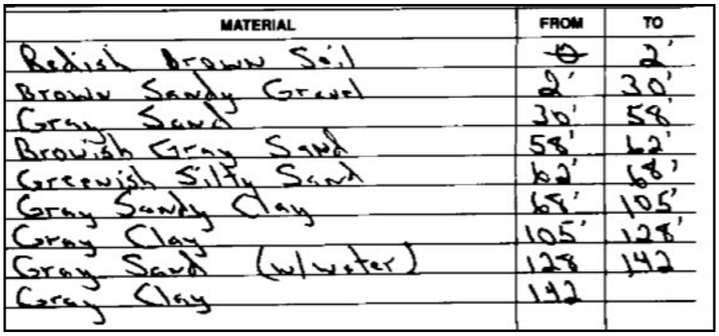
Figure 25. Water well data at Camano Head. Steel Well (ID 83500).
https://fortress.wa.gov/ecy/wellconstruction/map/WCLSWebMap/WellConstructionMapSearch.aspx

Route C - extends from the eastern shore of Whidbey Island to the northwestern tip of Hat Island (Fig. 23).

At this landing impermeable soils, silt or clay, are mixed with granular soils including sand and gravel. This combination is highly prone to failure particularly on the heavily forested, steep slopes. Large trees leaning downslope are evidence of active slope movement and may result in a catastrophic slope failure such as is evident in the right hand image below (Fig. 26).

Figure 26. East shoreline of Whidbey Island showing Alt Route C and landslide

The water wells are located on top of the bluff and show that the soils are predominantly silty sand and clay (Figure 27)



MATERIAL	FROM	TO
Redish Brown Soil	0	2'
Brown Sandy Gravel	2'	30'
Gray Sand	30'	58'
Browish Gray Sand	58'	62'
Greenish Silty Sand	62'	68'
Gray Sandy Clay	68'	105'
Gray Clay	105'	128'
Gray Sand (w/water)	128	142
Gray Clay	142	

Figure 27. Water well, Whidbey 1870403

https://fortress.wa.gov/ecy/wellconstruction/map/WCLSWebMap/WellConstructionMapSearch.aspx

There are several potential problems with this route.

On the westside of Hat Island, in Saratoga Passage, a USGS geophysical seismic survey mapped a bedrock intrusion which must be associated with the igneous intrusive rock forming the core of Hat Island (Harding 1988, McClellan, 1927). This rock obstruction and rock debris on the seabed would require a detailed to survey to map a safe and unobstructed route through the area (Fig 28).

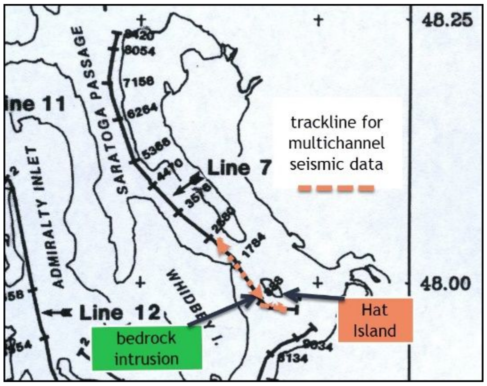
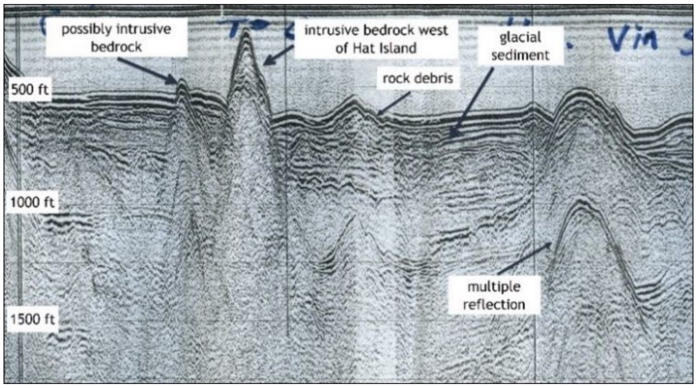


Figure 28. Location of seismic image



Located in Saratoga Passage, approximately 6500 feet west of Hat Island is a 1000-foot-wide cable corridor that runs north-south. This may contain a fiberoptic communications cable and a potential conflict with a power cable (NOAA Chart 18445).

There are documented landslides on western shore of Camano in Saratoga Passage (Whiteaker, 2008) and at the southernmost tip of Camano. These have the potential for producing tsunami wave and turbidity currents on the seabed that could part or bury the cable.

Route D - extends from the Port of Everett to the easternmost tip of Hat Island (Figure 23).

Snohomish River during flooding transports large concentrations of logs and debris. This debris if discharged into Possession Sound could impact the marine power cable.

Turbidity currents may be produced by Snohomish River and/or failure of the delta front. This area was impacted by tsunami wave that generated by1820 Camano Head landslide.

Historical Note: Exposed channel banks along distributaries of the lower Snohomish delta reveal evidence of at least three episodes of liquefaction, one event of abrupt subsidence and at least one tsunami during the past 1200 years (Bourgeois, 2001).

F. CLOSING

This work was performed in accordance under Professional Services Contract No. CW2238251 agreement between SNOPUD and Richard Sylwester. I trust this letter report meets your needs and ask that you contact me with any questions or comments on the content.

Sincerely

Richard Sylwester

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Northwest Geophysical Services

State of Washington Licensed Geologist
Engineering Geologist
2455
Richard E. Sylwester

APPENDIX: BIBLIOGRAPHY AND REFERENCES

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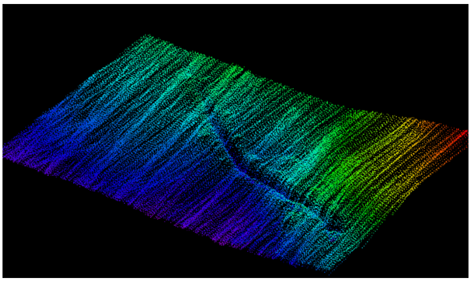
https://www.nps.gov/parkhistory

Appendix 4



DRAFT

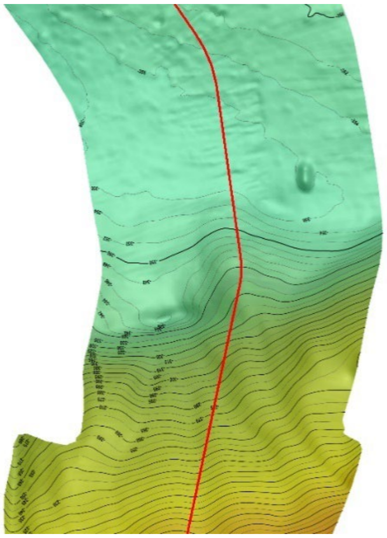
Hat Island Multibeam Bathymetric Survey Report

Prepared for

Public Utility District No. 1 of Snohomish County

Submitted by:

Tetra Tech, Inc.
19803 North Creek Parkway
Bothell, WA 98011



September 9, 2022

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1. INTRODUCTION

Public Utility District No. 1 of Snohomish County (District) issued professional services contract CW2248694 Hat Island Multibeam Echosounder (MBE) Bathymetric Survey to Tetra Tech on August 1, 2022 and notice to proceed on August 2, 2022. The bathymetric survey is needed to support planning and route siting for a replacement of the existing power supply cable.

The District provides electrical service to Hat Island, also known as Gedney Island located near Everett, WA, via a 45-year old submarine power distribution cable. The existing 3-phase cable was installed in 1974. The 12kV electrical distribution cable extends from Mission Beach (west of Marysville, WA, on the Tulalip reservation) to Hat Island, a distance of approximately 16,000 feet. The District serves Hat Island from Tulalip substation, circuit 12-507. The District provides service to approximately 250 residential and business customers on Hat Island, and its population fluctuates seasonally. The island's electric service also powers its drinking water system. The existing submarine cable is nearing the end of its serviceable life and is at risk of failure. To avoid a potential emergency situation which would isolate the residents of Hat Island from electric service, the District plans to install a new 3-phase electric submarine cable along a route from Everett to Hat Island (Fig. 1).

To continue reliable service to District customers, the existing cable will remain energized while the new line is installed. The new cable will be installed from the shoreline in Everett to Hat Island. The shore ends at both landings will be installed via horizontal directional drilling (HDD) to avoid the sensitive nearshore environment and surface laid between the HDD punchouts at each landing.

This report summarizes the bathymetric survey effort, data acquired and the project deliverables. The deliverables include an updated digital terrain model (DTM) along the survey routes to assist the District with planning a follow on geophysical survey and to inform the future cable replacement and installation efforts.

Figure 1-1. Hat Island to Port of Everett Preliminary Cable Route Including alternative landing at Harborview Park

The survey scope of work included:

1. Develop a detailed bathymetric map at both shore landings and along the cable route as follows:
    a. Map areas containing seagrass(es), <40m water depth (WD) to ≥15m WD, at the landing sites;
    b. Identify areas of active or potential submarine landslides and/or mobile sediments (i.e. sand waves) at each landing (<40m WD to ≥15m WD); and
2. Data processing, reporting and charting

2. TECHNICAL APPROACH

2.1 Primary and Alternative Cable Routes

Following noticed to proceed the District provided Tetra Tech with the primary and alternative routes in a format exported from Navionics software. Tetra Tech reviewed the routes and available existing data and proposed a survey plan based on District input and requirements.

2.2 Bathymetric Survey

A high-resolution MBE bathymetric survey was conducted between August 8 and September 15, 2022. The survey equipment, control and methods are summarized in the following Sections.

2.3 Survey Equipment

The equipment used to complete the survey efforts is summarized in Table 2-1.

Table 2-1. Survey Equipment

Equipment	System(s)	Details
Multibeam Echosounder	R2Sonic 2026	90/170-455 kilohertz (kHz) (selectable) 0.45 x 0.45° beamwidth and TruePix enabled
Heading and Motion Reference System	SBG Ekinox 2-D	Pitch, roll, and heading (yaw) accuracy of <0.02°. Heave accuracy of 5 centimeters or 5%, whichever is greater for period of 20 seconds or less.
Sound Velocity Profiler	YSI Castaway CTD	Conductivity, temperature, depth, and sound velocity
Sound Speed Sensor for MBE	Valeport, MiniSVS	Direct velocity measurement

2.4 Survey Vessels

The 24-foot survey vessel, R/V David Humes shown in Figure 2-1, was mobilized to Everett, WA and calibrations, including a multibeam patch test, were completed before commencing the bathymetric survey.

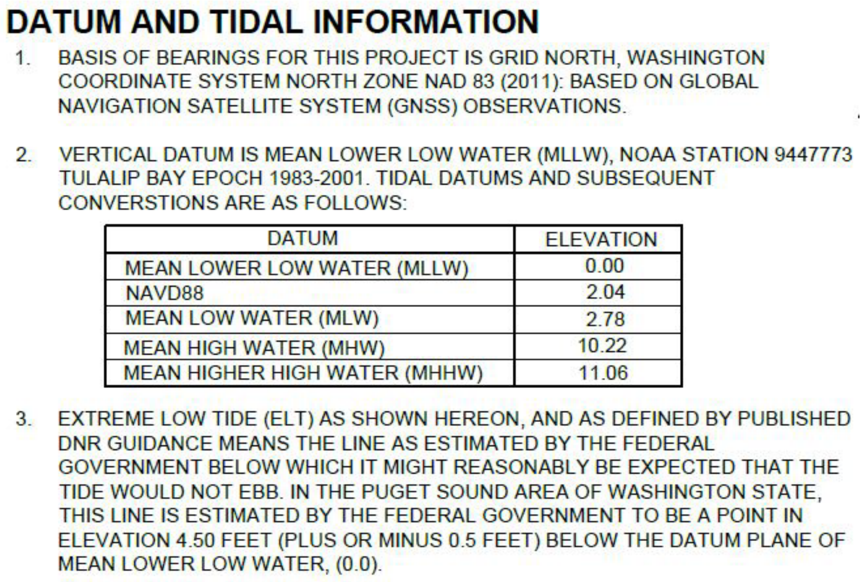
Figure 2-1. Tetra Tech Survey Vessel with R2Sonic 2026 MBE on Starboard Stern

2.5 Geodesy

Horizontal (X, Y) positioning data for the project were collected in North American Datum 1983 (2011 Adjustment (NAD83[2011]), State Plane Washington North. Elevation data (Z) were collected in North American Vertical Datum 1988 (NAVD-88) using Geoid18 and converted into Mean Lower Low Water (MLLW) heights using a conversion provided by the District (Table 2-2 and Figure 2-1). Distance and depth information were recorded in and provided digitally and on charts in U.S. Survey Feet.

Table 2-2. Survey Geodesy

Parameter	Setting
Projection	State Plane
Zone	Washington North (FIPS 4601)
Horizontal Datum	NAD83 (2011)
Vertical Datum	NAVD88 (Geoid18) and MLLW 1983 - 2001
Distance Unit	U.S. Survey Feet
Depth Unit	U.S. Survey Feet
Geoid Model	2018-CONUS



DATUM AND TIDAL INFORMATION

1. BASIS OF BEARINGS FOR THIS PROJECT IS GRID NORTH, WASHINGTON COORDINATE SYSTEM NORTH ZONE NAD 83 (2011): BASED ON GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) OBSERVATIONS.

2. VERTICAL DATUM IS MEAN LOWER LOW WATER (MLLW), NOAA STATION 9447773 TULALIP BAY EPOCH 1983-2001. TIDAL DATUMS AND SUBSEQUENT CONVERSTIONS ARE AS FOLLOWS:

DATUM	ELEVATION
MEAN LOWER LOW WATER (MLLW)	0.00
NAVD88	2.04
MEAN LOW WATER (MLW)	2.78
MEAN HIGH WATER (MHW)	10.22
MEAN HIGHER HIGH WATER (MHHW)	11.06

3. EXTREME LOW TIDE (ELT) AS SHOWN HEREON, AND AS DEFINED BY PUBLISHED DNR GUIDANCE MEANS THE LINE AS ESTIMATED BY THE FEDERAL GOVERNMENT BELOW WHICH IT MIGHT REASONABLY BE EXPECTED THAT THE TIDE WOULD NOT EBB. IN THE PUGET SOUND AREA OF WASHINGTON STATE, THIS LINE IS ESTIMATED BY THE FEDERAL GOVERNMENT TO BE A POINT IN ELEVATION 4.50 FEET (PLUS OR MINUS 0.5 FEET) BELOW THE DATUM PLANE OF MEAN LOWER LOW WATER, (0.0).

Figure 2-2. NAVD-88 to MLLW Conversion used for Deliverables

2.6 Survey Control and Validation

Vertical and horizontal positioning was achieved using a high-accuracy global navigation satellite system (GNSS) system with real-time kinematic (RTK) corrections from the Washington State Reference Network (WSRN) utilizing a single station/mount point. Corrections were received via cellular data network from station “CBLV.”

Prior to mobilizing for the bathymetric survey Tetra Tech coordinated with the District’s survey department manager (Michael Lynch) who established control on Port of Everett Property as shown in Figure 2-3 and Figure 2-4. The control information is provided in Table 2-3.

N= 357472.423
E= 1298464.931
El= 18.15
Mag Nail in Asphalt

N= 357395.034
E= 1298303.786
El= 18.84
Rebar w/Yellow Cap

Figure 2-3. Survey Control Established at the Port of Everett by the District

Figure 2-4. Photos of the District's Survey Control on Port of Everett Property (rebar w/ yellow cap photo on left used for RTK and mag nail in asphalt photo on right)

Table 2-3. Survey Control Points

Control Points (Boneyard POE)	Northing	Easting	Elev. (NAVD88)
Rebar w/Yellow Cap (Base)	357395.034	1298303.786	18.84
Mag Nail in Asphalt (QC)	357472.423	1298464.931	18.15

Each day of the survey effort the Mag Nail QC point was occupied with the rover GNSS and the measured position compared to the recorded position shown in Table 2-3. The offsets between the measured and recorded positions are provided in Table 2-4. These QC efforts documented that the GNSS system provided positional accuracy of better than 0.1 feet which was within positioning tolerance for the system and survey effort.

Table 2-4. GNSS QC Results

Trimble R10 Rover RTK QC	Northing (feet)	Easting (feet)	Elevation (feet)	Delta North	Delta East	Delta Elev.
220805 QC Mag	357472.394	1298464.908	18.174	-0.029	-0.023	0.024
2220811 QC Mag	357472.407	1298464.910	18.133	-0.016	-0.021	-0.017
2220812a QC Mag	357472.395	1298464.939	18.099	-0.028	0.008	-0.051
22220815 QC Mag	357472.362	1298464.939	18.147	-0.061	0.008	-0.003

Throughout the survey, sound velocity profiles were collected and applied to the MBE data to correct for any variations in sound velocity in the water column.

An inertial measurement unit (IMU) was used to define the origin and orientation of the X, Y, and Z axes of the vessel's local reference frame. Table -5 provides the offsets, measured in feet, used for the QINSY hydrographic survey software, hardware setup. These measurements were also utilized in the Qimera, hydrographic data processing software, Vessel Configuration File (VCF) during processing of the multibeam data.

Table 2-5. R/V David Humes Sensor Offsets (in feet)

Sensor	Across (Starboard Positive)	Along (Forward Positive)	Vertical (Down Negative)
R2Sonic 2026 Tx	1.242	1.477	-4.375
Motion Sensor / Navigation (Ekinox 2-D)	0.00	0.00	-0.246

2.6.1 MBE Patch Test

A standard MBE patch test, also known as an installation calibration test, was carried out to calculate the angular offsets between the MBE and the motion reference unit (MRU). The installation calibration process is used to derive the roll, pitch, and yaw angular offsets between the multibeam sonar and the local reference frame defined by the MRU's IMU. The installation calibration tests are also used to determine latency in the positioning equipment. The sonar, positioning system, and data collection computer are all time-synchronized to GPS Coordinated Universal Time (UTC), which should result in a zero-position latency (Table 2-6.6). The sonar mount was reconfigured on 11 and 15 August, which required patch tests.

Table 2-6. MBE Patch Test Calibration Results for 08/11/2022 and 08/15/2022

Device	Date	Latency	Roll	Pitch	Yaw
R2Sonic 2026	11-August	0.00	2.487	0.188	-0.296
R2Sonic 2026	15-August	0.00	2.386	0.019	1.242

2.6.2 Quality Control Procedures

Quality control procedures were performed to confirm the vessel draft as well as the measured ellipsoidal height of the R/V *David Humes'* Center of Gravity (COG). This procedure was conducted by taking consecutive RTK shots at the waterline with a Trimble R10 Rover while simultaneously recording the vessel's waterline elevation display by the data acquisition software (Qinsy) on the R/V *David Humes*.

A test referred to as a "bar check" was conducted to verify the operation and accuracy of the multibeam sonar. A reflective target was suspended at a known depth below the sonar head and a depth measurement was taken using the survey software, correcting for the measured distance to the acoustic center of the sonar below the water surface. The sonar depth was determined by measuring the depth of a defined point on the sonar mount, then adding the known vertical offset between the mount point position and the sonar acoustic center. This offset was then added to the depth reported by the sonar and compared to the depth of the acoustic target. The bar checks verified the sonar was accurately measuring depths.

Table 2-7. R/V David Humes Bar Check Results

Date	QINSy Measured Depth	Mount Point Draft	Mount Point to Acoustic Center Offset	Total Draft (feet)	Bar Depth (feet)	Delta
12-Aug	7.1	2.462	0.476	10.038	10	0.038
15-Aug	7.7	1.806	0.476	9.982	10	-0.018

2.6.3 Sound Speed Casts

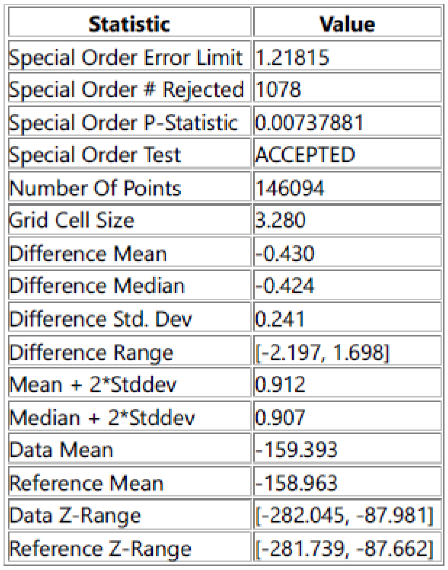
Changes in sound speed through the water column affect the MBE's individual beams in both the angle and distance calculated from the propagation times. To compensate for these effects, data processing must model the effects as a function of beam launch angle and time. To implement these calculations, sound speed profiles were recorded through the water column using conductivity, temperature, depth (CTD) sensors from which sound speeds versus depths are derived. Sound velocity casts were performed at the start and end of data collection each day and taken as needed throughout the day using a handheld CastAway-CTD device.

2.6.4 Data Processing

A SBG Ekinox 2-D inertial navigation system with RTK corrections from the WSRN, station PFLD, were used for real time horizonal and vertical positioning of the survey data. Following the survey, the real-time inertial navigation data were post-processed using the base station RINEX files to improve accuracy using SBG Qinertia software. The post processed positioning and attitude solution was applied to the data in Qimera and the sounding data was then filtered and reviewed to remove clearly erroneous soundings.

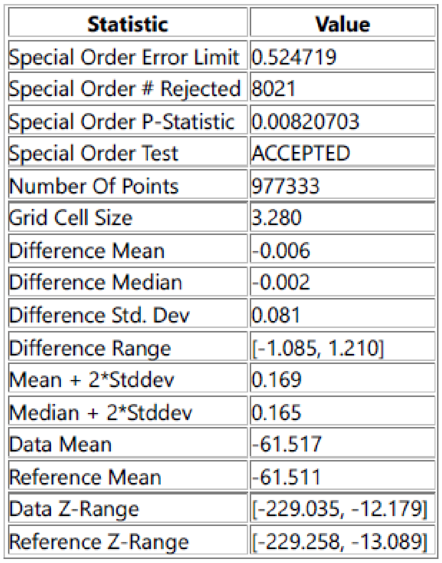
Accuracy and precision are a function of the positioning and attitude measurements errors, timing errors, water depth, and water sound speed profile. To confirm accuracy and precision Tetra Tech performed additional QC measures after the data was post processed. This method compares the final surface to a processed data cross line that provides a statistical analysis to confirm the effort met or exceeded project specifications. A Qimera processing software tool that evaluates compliance with International Hydrographic Organization (IHO) standards was used to verify the accuracy of the data products. This tool compares MBE cross line data with survey main line data. Separate checks were conducted at each of the landings and in one of the deepest areas of the survey. The landing areas (<40 m deep) were evaluated for compliance with the IHO Special Order specifications, and the deep area (>40 m deep) was evaluated relative to IHO Order 1a specifications. These checks verified that IHO Special Order specifications and IHO Order 1a specifications were achieved in the shallow and deepwater, respectively. Figures 2-2 through 2-5 provide the results for the four areas in both tabular and graphic format.

An additional check for errors was performed with a comparison between the bathymetry surface, delivered with this report, and soundings from the NOAA S-57 charts covering the survey area. Survey data near the landing areas typically matched the chart soundings to within 0.1 to 0.2 feet. More variability was observed in the deepest (>400ft) areas of the survey, however all comparisons were within the IHO Order 1a specification limit.



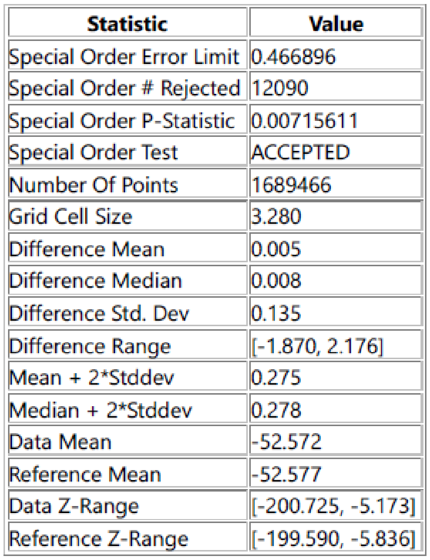
Statistic	Value
Special Order Error Limit	1.21815
Special Order # Rejected	1078
Special Order P-Statistic	0.00737881
Special Order Test	ACCEPTED
Number Of Points	146094
Grid Cell Size	3.280
Difference Mean	-0.430
Difference Median	-0.424
Difference Std. Dev	0.241
Difference Range	[-2.197, 1.698]
Mean + 2*Stddev	0.912
Median + 2*Stddev	0.907
Data Mean	-159.393
Reference Mean	-158.963
Data Z-Range	[-282.045, -87.981]
Reference Z-Range	[-281.739, -87.662]

Figure 2-5. Everett Landing North – IHO Special Order Compliance Test



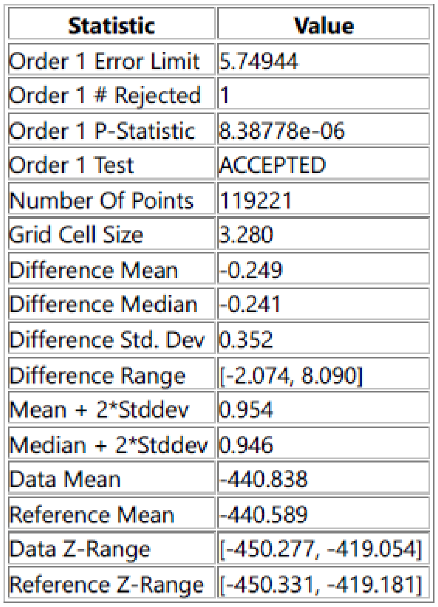
Statistic	Value
Special Order Error Limit	0.524719
Special Order # Rejected	8021
Special Order P-Statistic	0.00820703
Special Order Test	ACCEPTED
Number Of Points	977333
Grid Cell Size	3.280
Difference Mean	-0.006
Difference Median	-0.002
Difference Std. Dev	0.081
Difference Range	[-1.085, 1.210]
Mean + 2*Stddev	0.169
Median + 2*Stddev	0.165
Data Mean	-61.517
Reference Mean	-61.511
Data Z-Range	[-229.035, -12.179]
Reference Z-Range	[-229.258, -13.089]

Figure 2-6. Everett Landing South – IHO Special Order Compliance Test



Statistic	Value
Special Order Error Limit	0.466896
Special Order # Rejected	12090
Special Order P-Statistic	0.00715611
Special Order Test	ACCEPTED
Number Of Points	1689466
Grid Cell Size	3.280
Difference Mean	0.005
Difference Median	0.008
Difference Std. Dev	0.135
Difference Range	[-1.870, 2.176]
Mean + 2*Stddev	0.275
Median + 2*Stddev	0.278
Data Mean	-52.572
Reference Mean	-52.577
Data Z-Range	[-200.725, -5.173]
Reference Z-Range	[-199.590, -5.836]

Figure 2-7. Hat Island Landing – IHO Special Order Compliance Test



Statistic	Value
Order 1 Error Limit	5.74944
Order 1 # Rejected	1
Order 1 P-Statistic	8.38778e-06
Order 1 Test	ACCEPTED
Number Of Points	119221
Grid Cell Size	3.280
Difference Mean	-0.249
Difference Median	-0.241
Difference Std. Dev	0.352
Difference Range	[-2.074, 8.090]
Mean + 2*Stddev	0.954
Median + 2*Stddev	0.946
Data Mean	-440.838
Reference Mean	-440.589
Data Z-Range	[-450.277, -419.054]
Reference Z-Range	[-450.331, -419.181]

Figure 2-8. Cable Route Deep Water – IHO Order 1a Compliance Test

As a final comparison an area of overlap between this survey and MBE data previously collected by Tetra Tech, in 2017, off the Everett landing was examined. The two surveys showed excellent alignment with contours closely matching over most of the area, and some variations attributed to sediment movement identified around Pigeon Creek outflow. An example of the comparison with the new data on top and the border identified in dashed red is provided in Figure 2-9.

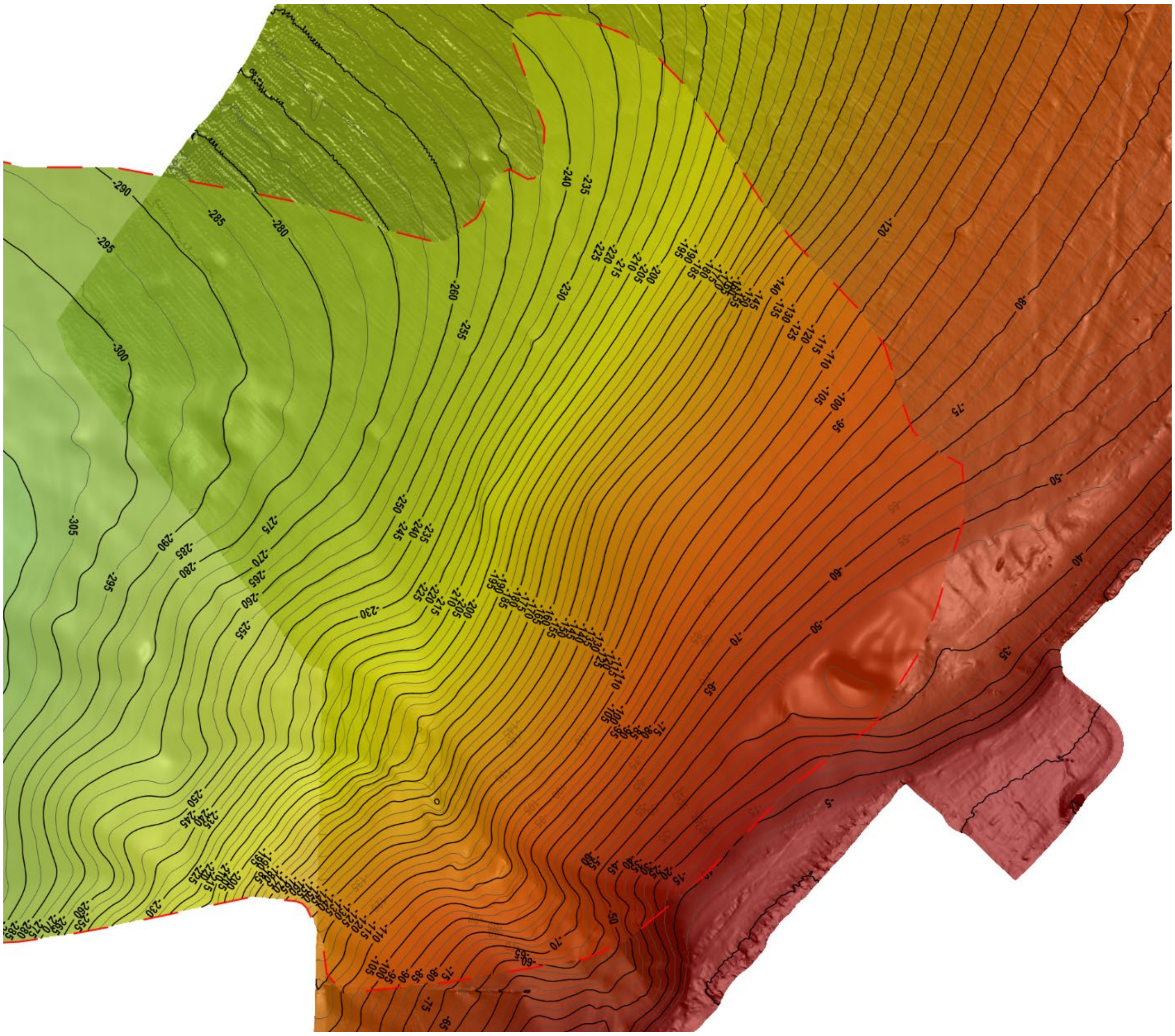


Figure 2-9. **Data Comparison between Tetra Tech Data Recorded in this Survey, and an Overlapping Survey Area from 2017**

3. DATA DELIVERABLES

The bathymetric survey data were incorporated into the project deliverables which include the following:

1. Bathymetry - ASCII format gridded bathymetry of the multibeam data service gridded to 1.5 x 1.5 ft, 3.0 x 3.0 ft and 4.5 x 4.5 ft sizes (delivered electronically)
2. Bathymetric contours at 5 and 10 ft elevation intervals, in shapefile (.shp) format (Attachment C, delivered electronically)

3. Charts showing the shaded relief bathymetry DEM surface with elevation contours and slope (included in Attachment D and delivered electronically as .pdf)
4. A brief survey report (this report) summarizing survey methods, data acquired, and the data deliverables.

4. DATA DISCUSSION

4.1 General Morphology

The general morphology along the route reflects the origins of Puget Sound as a glacially sculpted environment with steep, rocky slopes on the islands and mainland shoreline separated by relatively flat, sedimented seabed. The route runs between Hat Island to the south and the Port Gardner Bay embayment to the northeast. The Snohomish River system, the second largest river discharge into Puget Sound, empties into Port Gardner Bay at the City of Everett, north of the Primary and Alternate landings. Sediment waves are apparent along the western slope of the embayment and numerous turbidity flows cut the slope, bringing sediments across route corridor, particularly in the narrow channel between Hat Island and the embayment slope. Mobile sediments are also apparent on the western side of the route on the submerged portion of Hat Island that extends to the southeast. These mobile sediments are evident in regional bathymetry and in the bathymetric survey data along both sides of the survey corridor.

In the narrowest portion of the channel, mid-way between the landings, the seabed drops steeply to the maximum depth along the roue of approximately 454 feet and the route crosses a turbidity flow where sediments have spread into a fan shape that abuts the eastern slope of Hat Island (Figure 4-1 and Figure 4-2).

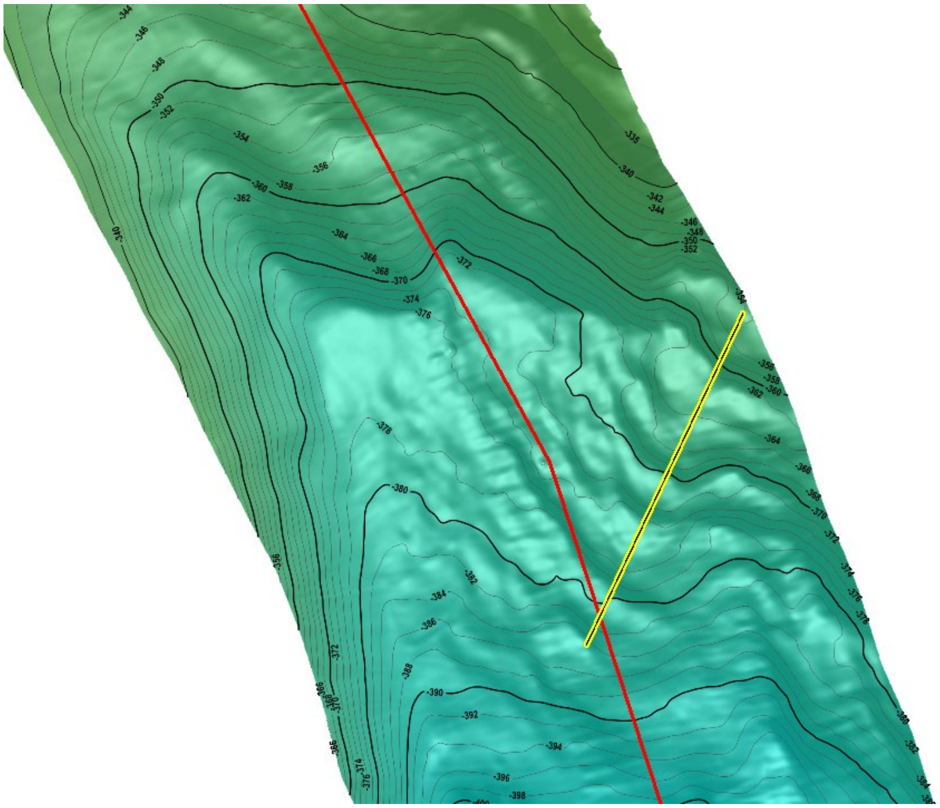


Figure 4-1. **Seabed descends steeply and route crosses the tow of a turbidity flow.**

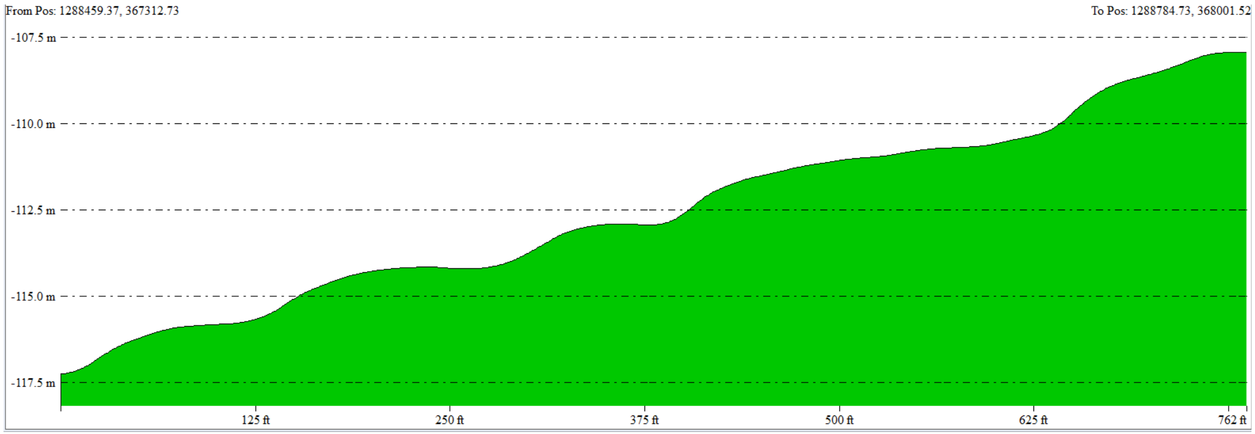


Figure 4-2. **Cross-sectional profile through an area of side slopes**

From the split between the Primary and Alternate routes to the landings at Everett the depths generally shoal gradually until they reach the base of the slope of the shoreline at a point about 2,500 feet from the cable termination. In the last 2,500 feet of the routes at the Everett landing the depths shoal rapidly from approximately 340 feet to the landfalls.

4.1.1 Hat Island Landing

The bathymetry at Hat Island has a moderate slope (5°-10°) from the shallow water limit of the survey to approximately 60 feet of water, then the seabed descends steeply to very steeply (15° to >20°) to the base of the slope at approximately 340 feet deep before essentially flattening out (slopes generally <1°) (Figure 4-3).

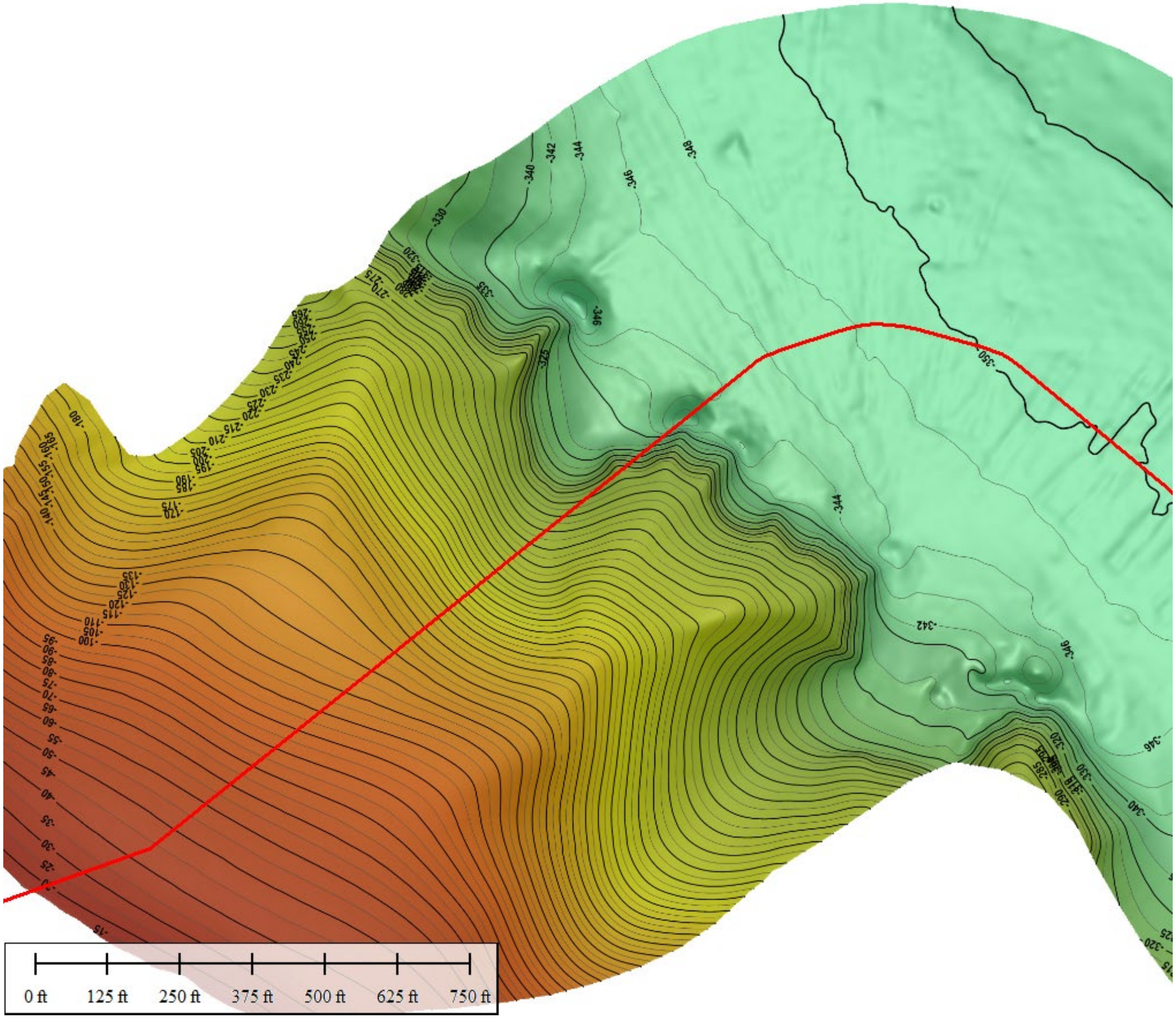


Figure 4-3. Hat Island Landing Bathymetry

4.1.2 Everett Primary Landing

The bathymetry towards the approach to the Primary landing shoals gently to approximately 310 feet of water. From approximately the 330-foot contour to the base of the slope numerous point features are scattered across the corridor. These objects, typically under 2 feet in height, are likely boulders or glacial erratics or other obstructions (Figure 4-4).

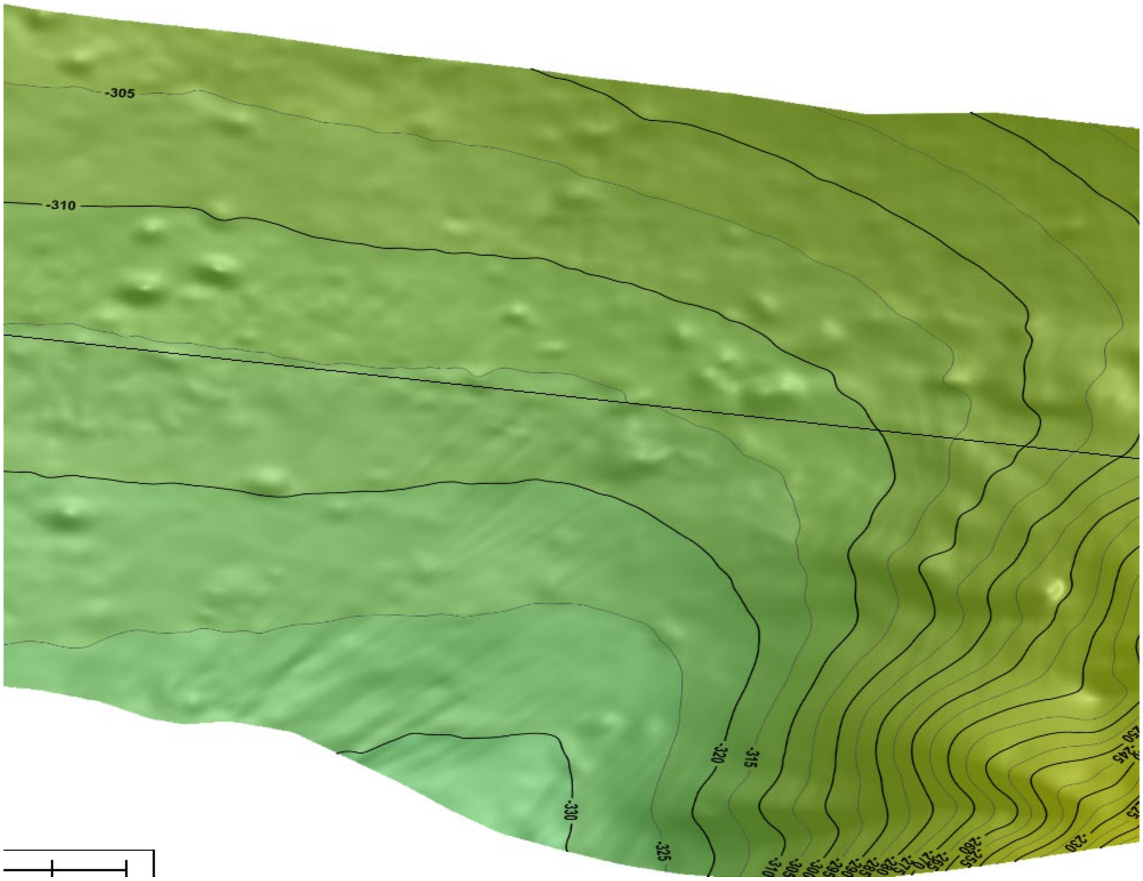


Figure 4-4. Approach to Everett Primary Landing

From approximately the 310-foot contour the seabed steepens moderately to steeply (5° to 20°) to the top of the slope and the shallow water limit of the survey vessel. The slope is generally smooth.

Approximately 300 feet south of the survey route is a submerged channel associated with Pigeon Creek. The Pigeon Creek channel feature has a depth of approximately 15 feet and comparisons with other data indicate potential sediment mobility in this area (Figure 4-5).

The approach to the Primary Landing area also includes a prominent seabed scar (potential anchor drag scar) detailed in Section 4.2.

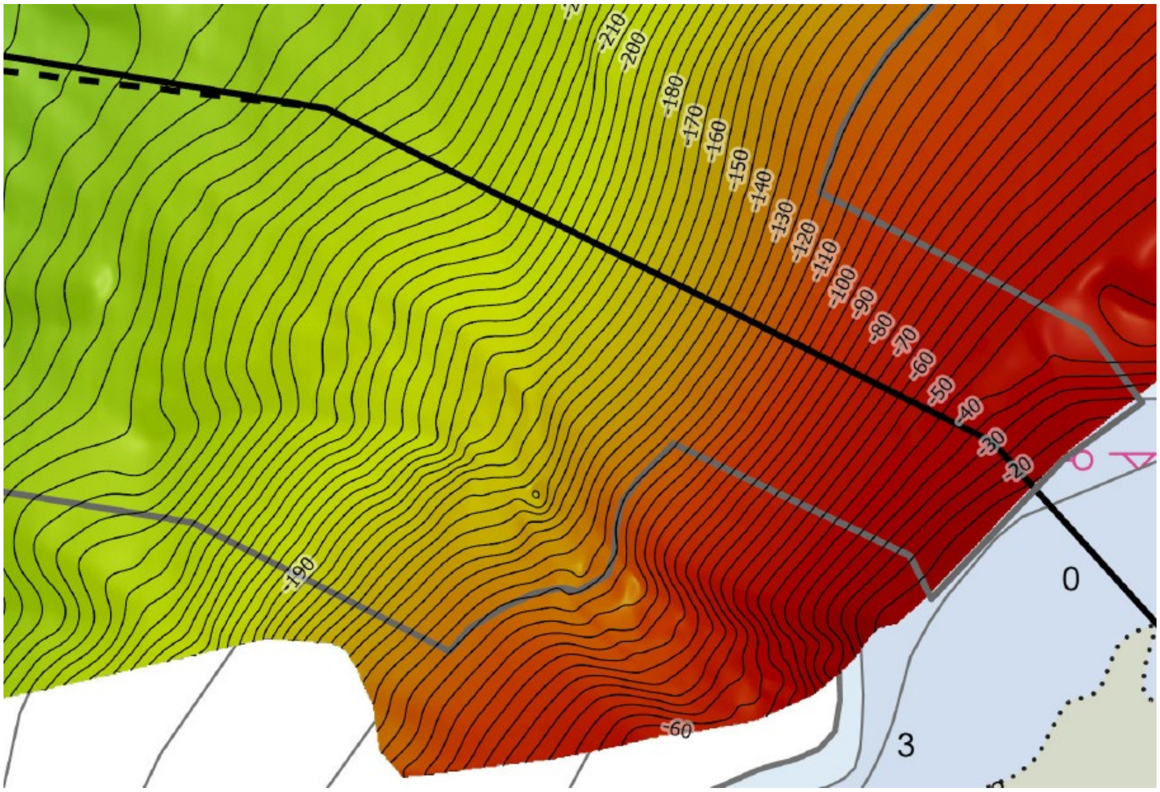


Figure 4-5. Slope to Everett Primary Landing

4.1.3 Everett Alternative Landing

From the split off the Primary route the Alternate route crosses seabed that is relatively flat to gently sloping (<5°) to the west and southwest. A few scattered point features as noted on the approach to the Primary Landing as likely glacial erratics (approximately 3 feet in height) were observed in approximately 350 feet of water. From a water depth of approximately 340 feet the seabed steepens quickly (5°-20°) to the shallow water limit of the survey vessel at the Alternative Landing.

The Alternative Landing area includes two potential anthropogenic objects that area detailed in Section 4.2.

4.2 Features of Interest

Tetra Tech reviewed the bathymetry data for evidence of sea grasses, shipwrecks, debris or other features that may present a hazard to the proposed cable. Findings are presented in Sections 4.2.1 and 4.2.2.

4.2.1 Features and Potentially Anthropogenic Objects

Details on features observed in the bathymetry data are provided in Table 4-1.

Table 4-1. Features Observed in Bathymetric Data

	X	Y	Lat	Long	Z/Depth (ft)
Alternative Everett Landing Object 1	1293869	355853	47.96682316	-122.24802518	353.4
Primary Everett Landing Feature 1	1294104	359252	47.97615096	-122.24732298	314.2
Seabed Scars on Main Line (center point position)	1281664	373460	48.014459	-122.299203	330.4

The object detected at the Alternative Everett Landing is rectangular in shape and measures approximately 110 feet x 45 feet, with a height of approximately 5 feet. The top appears generally flat (Figure 4-6).

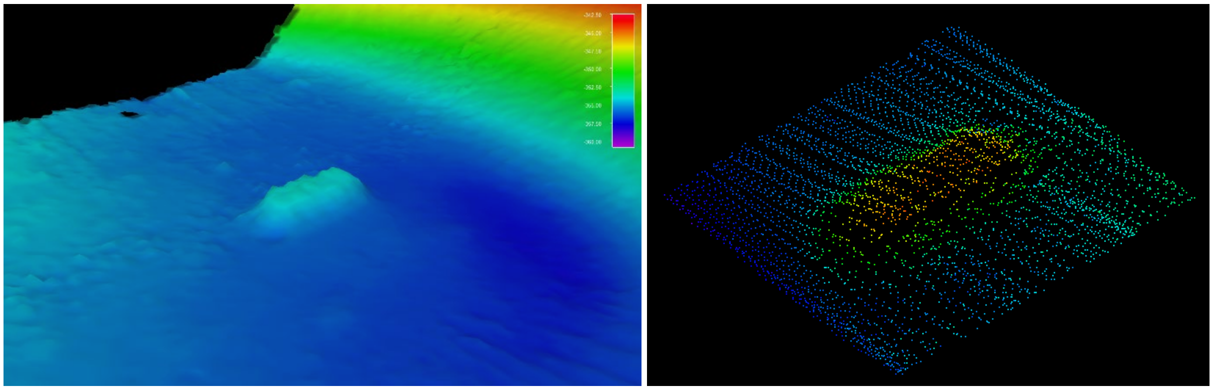


Figure 4-6. Alternate Everett Landing Object 1

At the approach to the Primary Everett Landing, numerous seabed scars were observed in the data at the base of a debris flow coming into the route corridor from the north; the largest scar is detailed in Figure 4-7. The stretch of the route is also located just over 385 feet from the southern corner of the main anchorage are for the Port of Everett (General Anchorage Area No. 110.230 on NOAA charts).

The largest and deepest scar is approximately 500 feet in length and 18 feet wide. These features are likely anchor drag scars.

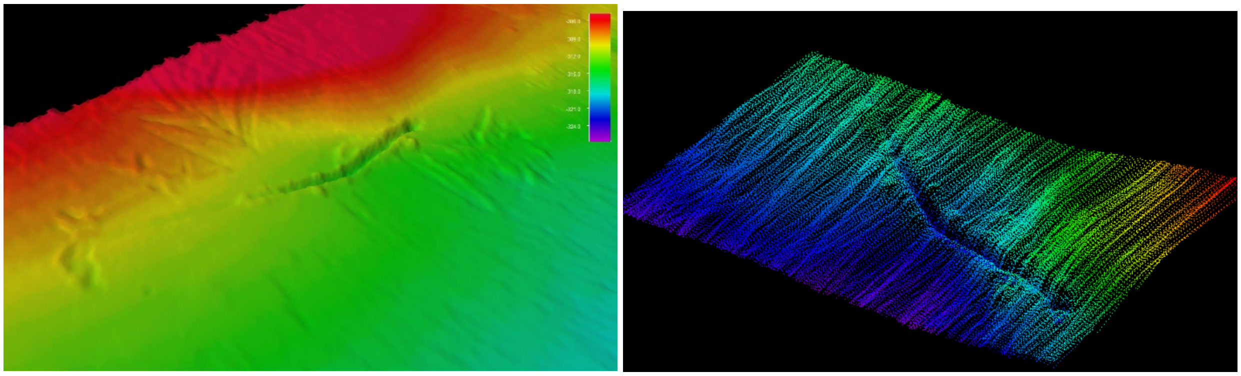


Figure 4-7. Primary Everett Landing Seabed Scars

Additional seabed scars were detected approximately 1.3 miles from the Hat Island landing. Two scars form a ‘Y’ shaped depression oriented approximately N70°E. Another, less distinct scar oriented N3°W was detected approximately 2,000 feet to the east along the route. The first set of scars are 0.3 to 0.9 feet deep compared to the surrounding seabed, generally deepening toward its western extent, and are approximately 20-30 feet wide with no furrows Figure 4-8).

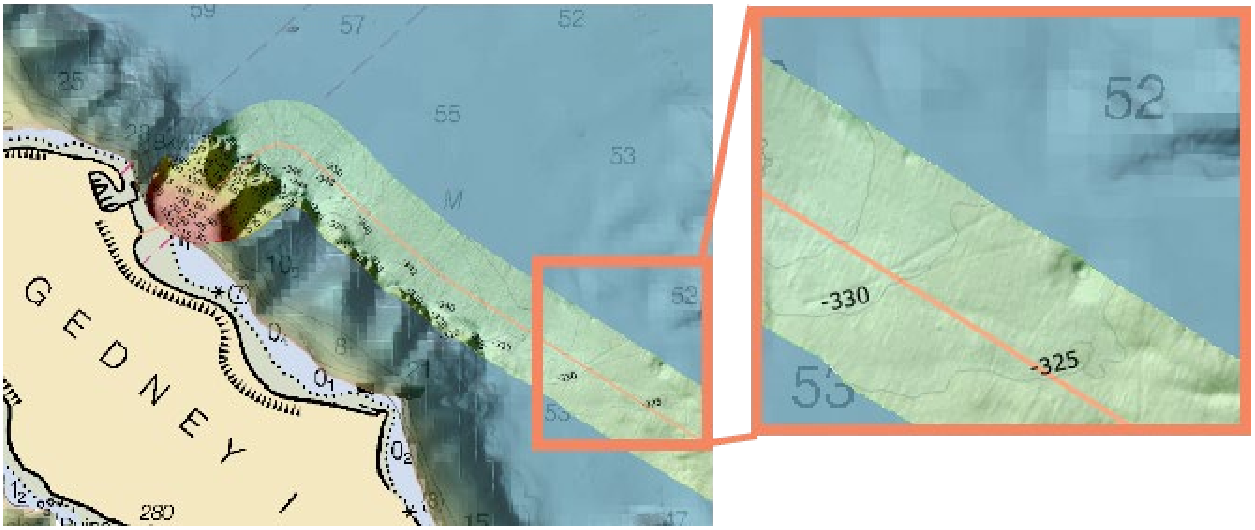


Figure 4-8. **Linear Seabed Scars Near Hat Island**

4.2.2 Sea Grasses

The bathymetry data were assessed for the presence of sea grasses at each landing. These areas are shown in green on the charts provided in Appendix C. Small areas (approx. 600 x 10 feet) of possible sea grasses were identified at the Hat Island in the survey corridor but not along the planned cable route. At the Alternate Everett Landing, possible seagrasses were detected across the survey corridor, including on the planned cable route. Possible sea grass areas were only detected in water depths shallower than 25 feet, at the extreme shallow water limits of the bathymetry survey coverage.

Seagrasses were not detected in the Primary Everett Landing data.

APPENDIX A: ASCII FORMAT GRIDDED BATHYMETRY OF THE MULTIBEAM DATA

(DELIVERED ELECTRONICALLY)

APPENDIX B: SHP FILES OF CONTOURS AT 5 AND 10FT ELEVATION INTERVALS

(DELIVERED ELECTRONICALLY)

APPENDIX C: CHARTS SHOWING THE SURVEY CORRIDOR, HILLSHADE DEM SURFACE, ELEVATION CONTOURS AND SLOPE