

Early Warning Offshore Cascadia Desktop Survey

Date: 13 November 2018

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Revision Control		
Revision No.	Date	Description
1	20 October 2018	Initial Issue
2	13 November 2018	Edits based on Review of Initial Issue

Historic of Revisions			
Revision No.	Prepared by:	Checked by:	Approved by:
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Contents

LIST OF FIGURES.....	4
LIST OF TABLES.....	5
LIST OF ACRONYMS AND ABBREVIATIONS	6
1. INTRODUCTION.....	7
2. CABLE SYSTEM OVERVIEW	8
3. DESK TOP STUDY OBJECTIVES.....	9
4. COORDINATE SYSTEM	9
5. METHODS.....	9
6. FACTORS IN SELECTING CABLE ROUTE	10
7. RISK OVERVIEW.....	11
8. FISHING THREATS TO THE EWOC CABLE	11
9. SEISMIC THREATS TO THE EWOC CABLE	12
10. ROCKY AREA THREATS TO EWOC CABLE	15
11. EXISTING CABLES IMPACT ON EWOC CABLE	16
12. CABLE ENGINEERING RECOMMENDATIONS.....	17
12.1. Cable Type Selection.....	17
12.2. Cable Slack Allocation.....	18
13. CABLE ROUTE DESCRIPTION.....	19
13.1. Segment 1 Neah Bay to Pacific Beach.....	19
13.2. Segment 2 Pacific Beach to Warrenton.....	21
13.3. Segment 3 Warrenton to Pacific City	23
13.4. Segment 4 Pacific City to Florence	25
13.5. Segment 5 Florence to Bandon	27
13.6. Segment 6 Bandon to Crescent City.....	29
13.7. Segment 7 Crescent City to Eureka	31
14. ROUTE POSITION LISTS	34
15. STRAIGHT LINE DIAGRAMS	55
16. CHARTS	63
17. REFERENCES	71

LIST OF FIGURES

Figure 2-1 System Overview	8
Figure 8-1 Bottom Trawling Density	11
Figure 9-1Earthquakes in the Project Area.....	12
Figure 9-2 Taiwan 2006 Earthquake Cable Breaks	14
Figure 9-3 Taiwan 2006 Earthquakes and Cable Break Timeline	14
Figure 9-4 Japan 2011 Earthquake Cable Breaks.....	15
Figure 13.1-1Segment 1 Cable Landing.....	19
Figure 13.1-2 Segment 1 Cable Route and Sensor Locations.....	20
Figure 13.2-1 Segment 2 Cable Landing	21
Figure 13.2-2 Segment 2 Cable Route and Sensor Locations.....	22
Figure 13.3-1 Segment 3 Cable Landing.....	23
Figure 13.3-2 Segment 3 Cable Route and Sensor Locations.....	24
Figure 13.4-1Segment 4 Cable Landing.....	25
Figure 13.4-2 Segment 4 Cable Route and Sensor Locations.....	26
Figure 13.5-1 Segment 5 Cable Landing.....	27
Figure 13.5-2 Segment 5 Cable Route and Sensor Locations.....	28
Figure 13.6-1 Segment 6 Cable Landing	29
Figure 13.6-2 Segment 6 Cable Route and Sensor Locations	30
Figure 13.7-1 Segment 7 Cable Landing	31
Figure 13.7-2 Segment 7 Cable Route and Sensor Locations	32

LIST OF TABLES

Table 1-1 Designated Beach Manhole Locations	8
Table 4-1 Coordinate System Parameters	9
Table 11-1 Cable Crossings.....	17
Table 12.1-1 Cable Types	17
Table 12.1-2 Cable Lengths	18
Table 12.2-1Cable Slack Allocation.....	18
Table 13.1-1 Segment 1 Sensor Locations	21
Table 13.2-1 Segment 2 Sensor Locations	23
Table 13.3-1 Segment 3 Sensor Locations	25
Table 13.4-1 Segment 4 Sensor Locations	27
Table 13.5-1 Segment 5 Sensor Locations	29
Table 13.6-1 Segment 6 Sensor Locations	31
Table 13.7-1 Segment 7 Sensor Locations	33

LIST OF ACRONYMS AND ABBREVIATIONS

Acron./Abrev.	Description
AC	Alter Course
AIS	Automated Identification System
AP	Articulated Pipe
AUFS	Alaska United Fiber Optic Cable System
BMH	Beach Manhole
CA	California
CHUS	China US
cm	centimeter
CPT	Core Penetrometer Test
CRS	Cable Route Survey
CSZ	Cascadia Subduction Zone
DA	Double Armor
DTS	Desk Top Study
EOB	End of Burial
EWOC	Early Warning Offshore Cascadia
GMRT	Global Multi-Resolution Topography
GPS	Global Positioning System
HDD	Horizontal Directional Drill
ICPC	International Cable Protection Committee
km	kilometer
KML	Keyhole Markup Language
kPa	Kilo Pascals
kts	knots
LWA	Light Wire Protected
m	meter
M	Magnitude
m/s	meters per second
MGDS	Marine Geoscience Data System
NOAA	National Oceanic and Atmospheric Administration
OCNMS	Olympic Coast National Marine Sanctuary
OOS	Out of Service
OR	Oregon
OSI	Ocean Specialists Inc
ROV	Remote Operated Vehicle
RPL	Route Position List
RSN	Regional Scale Nodes
SLD	Straight Line Diagram
SPA	Special Purpose Application
TGN	Tata Global Network
TPC	Trans Pacific Cable
WA	Washington
WD	Water Depth
WGS84	World Geodetic System 1984
XNG	Crossing

1. INTRODUCTION

The Early Warning Offshore Cascadia (EWOC) group is studying the costs, benefits and technical feasibility of installing an instrumented seafloor cable network along the Cascadia Subduction Zone (CSZ). The EWOC system will be designed to provide the early warning of large earthquakes and/or tsunamis off the coast of the Pacific Northwest.

To study the technical feasibility of the working group's proposed design, The University of Washington (UW) has commissioned Ocean Specialists Inc (OSI) to carry out a Desk Top Study for the EWOC Cable System.

Starting with a notional cable route provided by UW that included shore landing locations and the spacing between instrument locations, OSI has developed preliminary cable Route Position Lists (RPLs) based on published data and maps available in the public domain.

A key requirement for the system is that it shall continue to operate to the greatest extent possible during and after a large (up to M9.0) earthquake event and to continue to provide tsunami warning to the affected communities.

This Desktop Study provides:

- Recommendations for the types of telecom cables to use and where burial is recommended.
- Recommendations for cable placement, slack requirements and other techniques that can minimize the chance of cable breakages due to slumps and slides along the slope during or after a seismic event.
- A proposed cable layout in KML format based on the above guidelines.
- A discussion of the areas at greatest risk to cable breaks along the proposed cable layout.

This DTS document covers the entire system comprising seven (7) separate offshore segments.

The system segments are as follows:

Segment 1	Neah Bay WA to Pacific Beach WA	403.138 km
Segment 2	Pacific Beach WA to Warrenton OR	382.584 km
Segment 3	Warrenton OR to Pacific City OR	312.995 km
Segment 4	Pacific City OR to Florence OR	350.755 km
Segment 5	Florence to Bandon OR	246.238 km
Segment 6	Bandon OR to Crescent City CA	270.407 km
Segment 7	Crescent City CA to Eureka CA	232.091 km

Site Visits were not included in this Desk Top Study Scope of Work. For planning purposes, the sites detailed in Table 1-1 have been designated as Beach Manhole (BMH) positions.

Location	Latitude	Longitude
Neah Bay WA	48° 20.415'N	124° 40.021'W
Pacific Beach WA	47° 12.370'N	124° 12.201'W
Warrenton OR	46° 9.007'N	123° 57.732'W
Pacific City OR	45° 12.140'N	123° 58.024'W
Florence OR	44° 2.098'N	124° 7.956'W
Bandon OR	43° 15.069'N	124° 23.070'W
Crescent City CA	41° 44.923'N	124° 12.379'W
Eureka CA	40° 49.266'N	124° 11.365'W

Table 1-1 Designated Beach Manhole Locations

This study has been compiled on behalf of UW as part of the initial cable system route planning and system design. As such, it is a precursor to an industry standard Desk Top Study (DTS), Cable Route Survey (CRS) and installation of the cable.

2. CABLE SYSTEM OVERVIEW

The EWOC cable system is a festooned system that runs north to south along the Washington, Oregon and California coasts connecting eight landing sites. Seven separate segments of submarine cable and sensors each extend seaward beyond the continental shelf and then back to shore crossing the Cascadia Subduction Zone.



Figure 2-1 System Overview

Final cable type selection and transition depths will be based on the results of the Cable Route Survey and the Cable Supplier's cable engineering guidelines.

3. DESK TOP STUDY OBJECTIVES

The primary objectives of this study are as follows:

- Provide a Preliminary cable route and System Design that provides a safe and economic route for the cable.
- Analyze the designed route and determine the risks to system security
- Assess these risks and recommend how these risks can be minimized
- Make recommendations on routing, landing sites, cable type selection, burial and protection.
- Identify potential areas of difficulty for installation
- Identify permitting, licensing and regulatory requirements that might affect the system

This study provides detailed information on several different factors that have affected the routing and design of the EWOC system and which will impact on the marine survey, cable route engineering and installation of the system. Because of the nature of the information available and the limited time available to collate this information, this Streamlined DTS should not be viewed as an alternative to a comprehensive DTS and a properly conducted Cable Route Survey. Additional literature on historic turbidite flows exists and should be consulted prior to finalizing cable routes.

4. COORDINATE SYSTEM

All positions in this Cable Route Study are referenced to the WGS84 Ellipsoid and Datum.

Datum	WGS84
Ellipsoid	WGS84
Semi-major Axis (meters)	6 378 137.000
Reciprocal Flattening	298.257 223 563 4

Table 4-1 Coordinate System Parameters

5. METHODS

This study was conducted by OSI and includes preliminary cable routing, available data research, risk assessment and writing the Desk Top Study

Site Visits were not included in the DTS Scope of Work; therefore, all landing sites are estimated based on connection requirements provided by UW. Several established submarine fiber optic cable landing sites were selected for this DTS.

Public domain data was sourced from the internet or existing publications.

This study provides analysis of the available information for the proposed routes regarding geophysical hazards, maritime restrictions, commercial fishing, existing cables and cable engineering methods.

OSI utilized Global Multi-Resolution Topography (GMRT) during the cable route selection process. The GMRT synthesis is a multi-resolutional compilation of edited multibeam sonar data

collected by scientists and institutions worldwide, that is reviewed, processed and gridded by the MGDS Team and merged into a single continuously updated compilation of global elevation data. Prior to performing an actual bathymetric survey during a Cable Route Survey, this is an accurate estimation of available bathymetry.

NOAA raster nautical charts were referenced to identify data on wrecks and obstructions, military exercise areas, cable areas, and any potential hazards to the cable along the cable route.

In addition, cable databases were utilized along the route and examined to maintain adequate cable separation and acceptable crossing angles at each cable crossing.

This DTS should serve as an initial stage in the overall route selection and cable engineering process. Subsequent steps in the process will add information that will augment or correct information within this streamlined DTS.

6. FACTORS IN SELECTING CABLE ROUTE

A major objective of this Desk Top Study is to establish a Preliminary Cable Route that provides a safe route for the cable while maintaining industry standard cable routing guidelines.

The factors affecting route selection can be summarized as:

- Seabed Geology
- Commercial Fishing
- Environmental Hazards
- Existing Submarine Cables
- Engineering Requirements

Of the natural factors, by far the most significant is the seabed bathymetry. The objective is generally to proceed into deep water as rapidly as possible to leave the least possible amount of cable exposed to human factors, which have a reducing significance as the water depth increases. Seabed steepness and roughness are also considered at this stage. The cable routes are designed to run perpendicular up and down steep slopes. Where possible, the cable route is directed at right angles to bathymetric contours and ridges are preferred to canyons to minimize risks to the cable from slumping and turbidity flows.

Rock outcrops and areas of hard bottom should be avoided or minimized whenever possible. Detailed information of these areas is limited at the DTS stage; however, armor cables have been selected to the deepest depths allowable to protect the cables from abrasion.

Of the human factors, the risk from commercial fishing, specifically bottom trawlers, is the most significant threat to the cable system. In the past, cable owners have worked closely with local fisheries to negotiate cable routes to minimize impacts to fishermen and minimize risk to the cable. Cable burial with a target burial depth is proposed down the 1000 m contour.

Existing cables also placed constraints on the EWOC cable routing. Industry guideline recommend at least three (3) water depths of separation between cables to allow for cable repairs if necessary. Crossing angles are ideally engineered at 90° and cable crossing with angles less than 45° strongly discouraged. All cable crossing angles for active cable crossings are greater than 45°. Out of Service cables crossed will be cut and cleared along the EWOC cable route.

7. RISK OVERVIEW

Several major risks to the EWOC cable have been identified and measures to mitigate these risks are presented on the following sections.

The major hazards identified along the EWOC:

- Commercial fishing bottom trawlers
- Earthquakes and sediment movement along steep slopes
- Rock outcrops and hard bottom abrasion.
- Steep slopes suspensions and cable strumming
- Crossings with in-service cables

In addition to the risk mitigation measures that have been applied to the preliminary cable routing and cable engineering, it is recommended that a more extensive Desk Top Study and a comprehensive Cable Route Survey (CRS) be conducted based on the routes suggested in this study. This survey should use a modern swath-mapping system. In depths where the cable is to be buried, the mapping system should be capable of producing accurate 1- or 2-meter contours. Along with the high-resolution bathymetry survey, the route in the burial area should use high-quality side-scan sonar and sub bottom profiling equipment to characterize the upper few meters of seafloor. A burial assessment survey including gravity cores and Core Penetrometer (CPT) measurements should also be conducted.

8. FISHING THREATS TO THE EWOC CABLE

Extensive bottom trawling fishing occurs along those portions of the cable routes that cross the continental margin offshore the Washington, Oregon and California landing sites. The bottom trawl fishery presents a significant threat to an unburied cable which can become entangled with the trawl net or crushed by otter doors. Figure 8-1 shows a plot of fishing trawler density in the project area. The highest concentration of commercial bottom trawling occurs in water depths less than 1000 m.

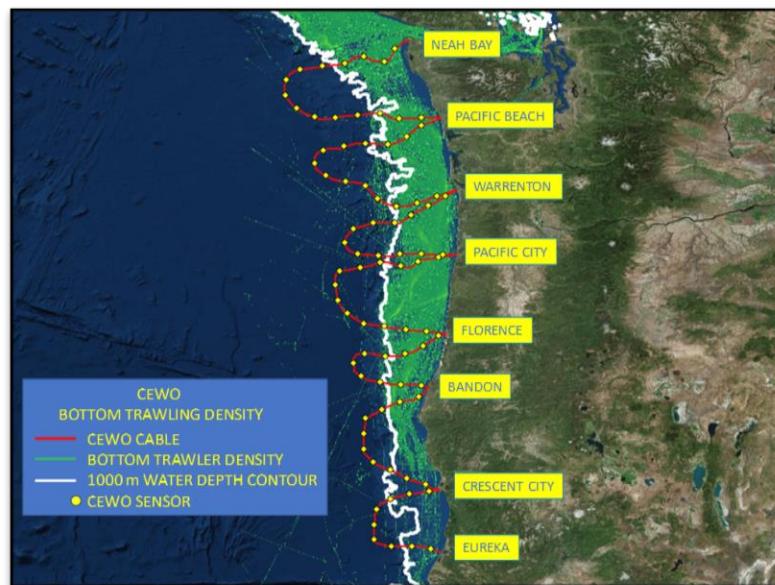


Figure 8-1 Bottom Trawling Density

To provide protection from entanglements with bottom fishing gear, it is recommended that the cables be buried down to 1000 meters water depth in these areas. Depth of burial should be targeted at 1.5 meters. Burial to deeper water depths may be required based on data collected and observations made during the Cable Route Survey.

Where cable burial is recommended, offshore approaches should have adequate sediment thickness with soil shear strengths less than 120 kilo Pascals (kPa) to facilitate burial by plowing. Cable burial will be very limited in areas of hard bottom, stiff clay, slopes greater than 15° and in areas where the seabed undulates along the cable's path.

Cable burial should be attempted in all areas where the seabed is compatible (subject to survey) with cable burial. The proposed cable burial will be carried out wherever possible using a Towed Sea Plow. In areas where Sea Plow burial is prohibited (i.e. across in-service cables and pipelines) retro-burial with Remotely Operated Vehicles (ROV) may be proposed.

9. SEISMIC THREATS TO THE EWOC CABLE

The Cascadia Subduction Zone extends 1100 km from Cape Mendocino, California to northern Vancouver Island and marks the boundary along which the small Juan de Fuca oceanic plate subducts beneath North America. Convergence occurs in a northeast direction at modest rates ranging from 30 mm/yr off northern California to over 40 mm/yr off Vancouver Island.

A plot of earthquakes greater than M4.0 is provided in Figure 9-1. A concentration of offshore earthquakes is near the southern end of the Cascadia Subduction Zone between the Mendocino Ridge and Blanco Fracture Zone. Given the lack of cable breaks identified as earthquake related in the project area, shearing or damage to a cable by ground movement is a relatively low risk.

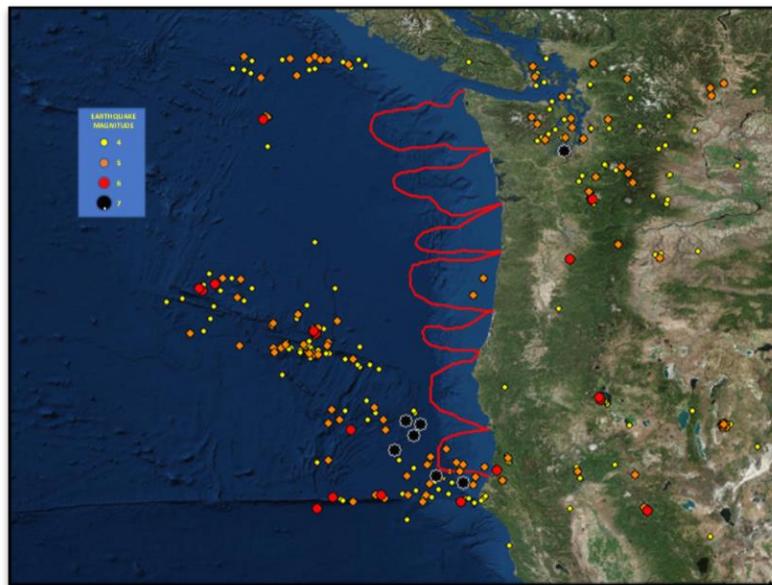


Figure 9-1 Earthquakes in the Project Area

Undersea landslides triggered by earthquakes pose a much higher risk since mass sediment movement can easily break or abrade telecommunication cables. This has been observed in other areas of the world where multiple cables breaks occurred either during or soon after major seismic events. These cable breaks have been attributed to mass sediment movements such as sediment slumps and turbidity flows.

On 18 November 1929, a magnitude M7.2 earthquake shook the seabed off the Grand Banks, Newfoundland. At least eight submarine cables were broken concurrent with the main shock. Subsequent studies showed that these initial breaks resulted from a series of landslides triggered by severe ground shaking within a 100 km radius of the earthquake epicenter.

Some of the landslides were transformed into a fast-moving mud- and sand-laden turbidity current that moved down-slope breaking at least five additional submarine cables. From the timing of the cable breaks and their location it was possible to estimate current speeds, which reached 65 km/hour on a journey over 650 km.

On Tuesday December 26, 2006 at 12:25 UTC (20:25 local time), a magnitude 7.0 earthquake struck approximately 22.8 km off the southwest coast of Taiwan. After the earthquake and its aftershocks, eight (8) submarine cable systems were damaged, disrupting Internet services in Asia.

The main shock and aftershocks of similar magnitude had epicenters 20–55 km offshore resulting in strong ground shaking. The main shock was accompanied by the near simultaneous failure of three cables due to mass sediment movements. At least three turbidity currents, related to the main shock and large aftershocks followed at various times. These turbidity currents passed rapidly down-slope to cause additional cable breaks. Most of the breaks occurred sequentially over a period of nine hours as the first turbidity current traveled at least 246 km to water depths of over 4000m. Times and distances between breaks indicated average speeds of 46 km/hr along steep areas of the seabed.

Figure 9-2 shows recent plots of submarine cables southwest of Taiwan. Numerous repair bights (i.e. cable added so that a repair splice can be made on the surface and which is then laid down in a V-shape) are evident in the updated cable records.

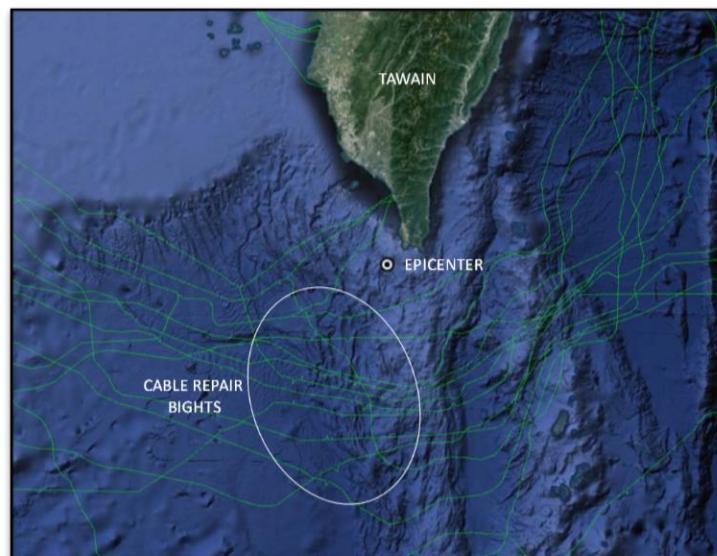


Figure 9-2 Taiwan 2006 Earthquake Cable Breaks

Figure 9-3 shows a timeline plot of the main shock and subsequent aftershocks overlaid with a time-line of observed cable breaks.

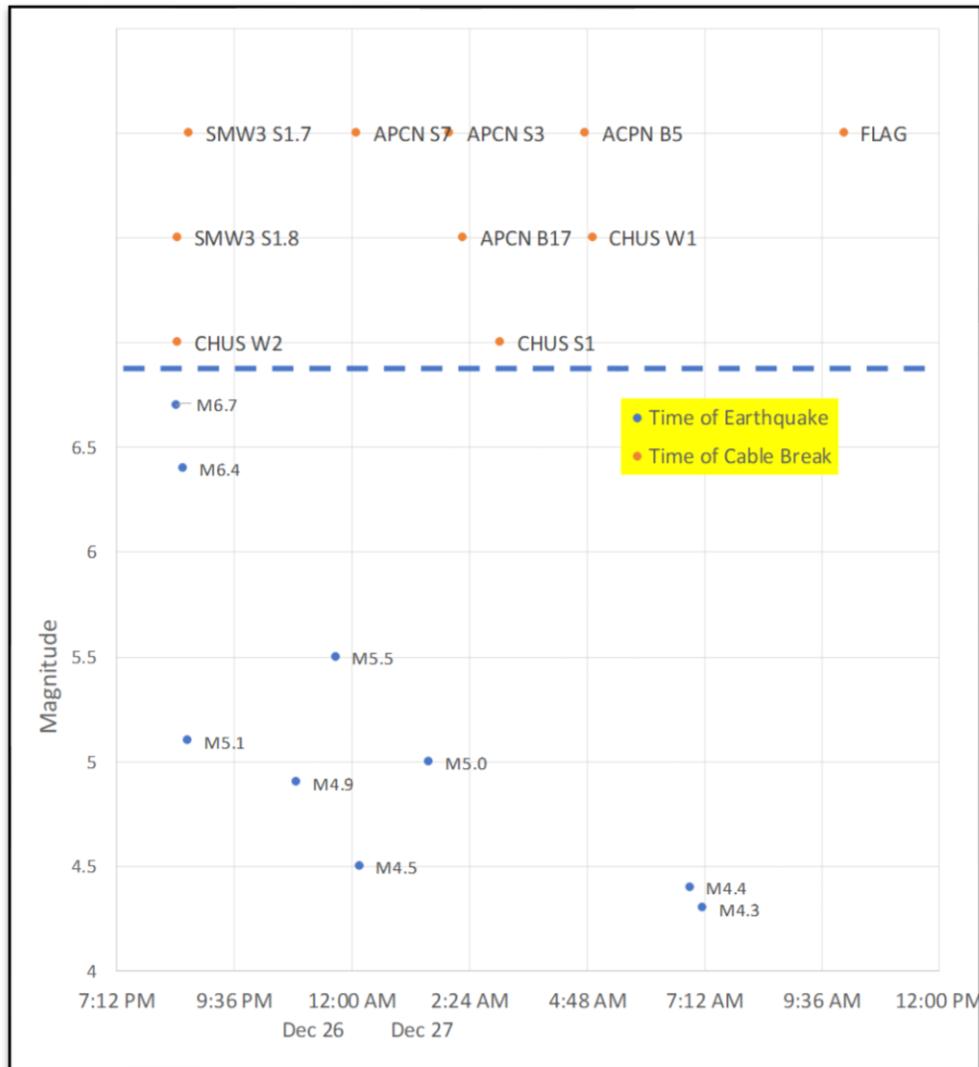


Figure 9-3 Taiwan 2006 Earthquakes and Cable Break Timeline

On March 11 2011 05:46:23 UTC, A magnitude 8.9 earthquake struck off the northeastern coast of Japan (modified to magnitude 9.0 later), at 38.322°N, 142.369°E and 373 km to the northeast of Tokyo. The earthquake, its aftershocks and a tsunami resulted in multiple submarine cable cuts threatening much of the intra-Asia and trans-Pacific telecommunications.

As shown in following figure, about 20 submarine cables land in Japan. APCN-2 and Japan-US CN were first reported to be cut after the earthquake. Kita Ibaraki cable landing station was almost isolated from the submarine networks. As the tsunami spread, Ajigaura cable landing station was hit and isolated, PC-1 and EAC submarine cables were cut. Cables cuts were also reported on China-US and C2C.

Figure 9-4 shows recent plots of submarine cables off the coast of Japan. Numerous repair bights are evident in the updated cable records.

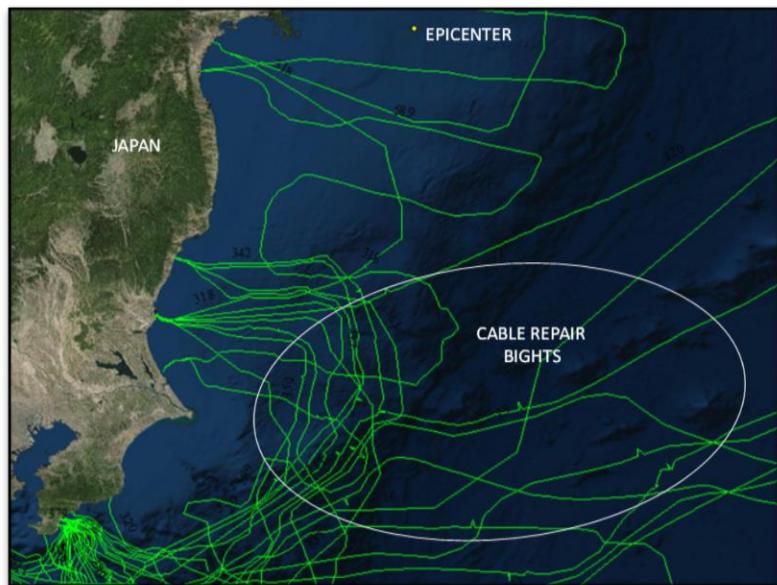


Figure 9-4 Japan 2011 Earthquake Cable Breaks

Large earthquakes can dislodge large volumes of sediment. Areas particularly prone to turbidity currents triggered by earthquakes are submarine canyons and steep slopes covered with unconsolidated sediment, particularly along the edges of the continental shelf.

Such areas cannot be avoided with EWOC cables but the risk of damage by sediment movement has been mitigated by routing the cable perpendicular to the continental shelf and using armor cables to maximum deployment depths to provide maximum abrasion resistance and maximum cable breaking strength. The DTS cable route has also been designed to minimize exposure to sediment flows by routing the cable along the ridges of canyons wherever possible.

10. ROCKY AREA THREATS TO EWOC CABLE

The EWOC cable will be subjected to the risk of abrasion failure wherever there is direct contact with rock exposures and hardbottom along the route. Attempts to minimize cable suspensions along rocky slopes must be managed closely to reduce cable strumming and abrasion at points of contact.

Rock exposure refers to the occurrence of rock at the seabed. Sub-cropping rock refers to rock being close to the seabed but buried by some sediment cover. Rock exposures are a risk for both surface laid and buried cables. Based on Cable Route Surveys and Installation Records from previous projects, rock exposures are expected on the continental shelves offshore of all landings as well as on the slopes leading off the shelves into deep water. The cable route survey will identify the extent and type of rock/coral exposure in all shallow water areas surveyed.

On the continental shelf, rock outcrops and sub-crops are of high concern as they can impede normal plowing operations. They pose a potential risk to a plow and put the cable at additional risk from external aggression in areas where burial is incomplete. Note that the continental

shelves are the areas of maximum risk from fishing and anchoring activity and the presence of rock at or near the seabed does not always preclude these activities. Survey works should identify the extent and type of rock/coral exposure. But locating bedrock horizons within the sedimentary sequence is notoriously difficult by seismic means and the use of CPTs is recommended to help locate these features. Use of adequate cable armoring is recommended in areas where plow burial could be compromised to minimize the chance of chafe or external aggression cable faults.

On continental slopes, very steep slopes and rock outcrops are frequently unavoidable, particularly where the continental slope is deeply gullied. These conditions make plowing hazardous to both the plow equipment and the cable during installation. As a result, cables have to be surface laid. When ascending or descending such slopes, it is best to avoid the floors of the gullies as these could become channels for mass movements during failures.

In deep water, areas of outcrops are mainly associated with seamounts, knolls and ridges, often producing very steep gradients with a potential for cable abrasion, particularly where bottom currents are present.

11. EXISTING CABLES IMPACT ON EWOC CABLE

EWOC cable crossings with existing systems have been avoided wherever possible, however, several crossings must be made to maintain the objectives of the EWOC positioning on the seafloor. Contacts must be made in the future with the owners of these systems, as well as with the owners of any future cables that may still be in planning stages.

There is a possibility that there are uncharted military cables in the EWOC project area. This information is not publicly available, but the pre-survey route should be submitted to the US Navy to ensure that they are no conflicts with any military activities.

Global Marine Cable Database, Nautical Charts and OSI's own databases were used to identify all known existing and proposed cable systems that are to be crossed by the EWOC routes. Details of all cable crossings, both in service and out of service, are presented in the RPL for each segment. It should be noted that cable database positions may be inaccurate due to displacements or unreported cable repairs and recent cable installations. Inaccurate logging of cable positions during the installation may also lead to discrepancies in the positions of existing cables.

Table 11-1 provides the list of existing cables that will be crossed by the EWOC cable system.

Segment	Event	Latitude	Longitude	Water Depth
1	OOS XNG	47°58.510'N	125° 47.380'W	923 m
1	OOS XNG	47°56.818'N	125° 59.588'W	1577
1	PC-1 XNG	47°56.176'N	126° 5.059'W	1638 m
1	OOS XNG	47°28.106'N	126° 26.491'W	2386 m
1	PC-1 XNG	47°16.133'N	126° 11.854'W	2492 m
2	AUFS WEST XNG	46°37.027'N	126° 3.540'W	2625 m
3	TGN Pacific XNG	45°45.989'N	124° 38.720'W	235 m
3	TPE XNG	45°43.275'N	124° 42.689'W	265 m
3	Northstar XNG	45°41.619'N	124° 45.122'W	575 m
3	TGN XNG	45°33.670'N	125° 29.722'W	2440 m
3	North Pacific XNG	45°28.931'N	125° 34.662'W	2517 m
3	Southern Cross/ RSN XNG	45°23.098'N	125° 36.528'W	2583 m
3	TGN XNG	45°11.720'N	125° 19.260'W	1961 m
4	TGN G5 XNG	45° 0.052'N	125° 25.193'W	2684 m
4	RSN S1 XNG	44°58.693'N	125° 33.143'W	2740 m
4	HAWAIKI XNG	44°54.337'N	125° 44.731'W	2820 m
4	TGN G5 XNG	44°17.903'N	125° 30.939'W	2964 m
5	NO CABLE CROSSINGS			
6	NO CABLE CROSSINGS			
7	NO CABLE CROSSINGS			

Table 11-1 Cable Crossings

12. CABLE ENGINEERING RECOMMENDATIONS

Based on the threats described in the previous section, the DTS provides recommendations for cable placement, cable type and slack allocation. Adjustments to these recommendations are expected to some degree upon the completion of a more detailed Desk Top Study and the results of the Cable Route Survey.

12.1. Cable Type Selection

For estimating purposes, three cable types are proposed for use in the EWOC: DA, LWA and SPA. Tables 12.1-1 provides the cables types and proposed maximum deployment depth ratings for each of the cable types proposed to be used in the system.

CABLE TYPE	DEPTHS
DA	0 to 800 m
LWA	800 to 2000 m
SPA	> 2000 m

Table 12.1-1 Cable Types

Table 12.1-2 Provides the Segment Cable Lengths and the Overall System Cable Lengths

CABLE TYPE	CABLE LENGTHS (km)							TOTAL
	S1	S2	S3	S4	S5	S6	S7	
DA	177.139	173.762	162.031	154.220	117.967	115.650	87.921	988.690
LWA	122.599	97.443	78.273	55.168	62.870	54.238	47.733	518.324
SPA	100.400	111.379	72.691	141.367	65.404	100.519	96.436	688.196
TOTAL	400.138	382.584	312.995	350.755	246.241	270.407	232.090	2195.210

Table 12.1-2 Cable Lengths

12.2. Cable Slack Allocation

Slack values included in DTS RPLs developed for this Study are based on cable burial requirements and surface laying requirements. Contingency slack has been built into the DTS Route Position Lists to account for inaccuracies in bathymetry data and potential changes in route lengths based on the Cable Route Survey Results.

Cable Type	Total Surface Slack Value
Buried Cable	0.5%
Surface Laid Cable	3.0%

Table 12.2-1 Cable Slack Allocation

13. CABLE ROUTE DESCRIPTION

13.1. Segment 1 Neah Bay to Pacific Beach

The Segment 1 Cable Route will make a terrestrial connection to Neah Bay. To avoid conflicts with existing cables and marine traffic in the Strait of Juan de Fuca, the designated BMH has been positioned at Makah Bay located approximately 4.5 km southwest of Neah Bay. The BMH has been positioned at $48^{\circ}20.415'N$ $124^{\circ}40.021'W$.

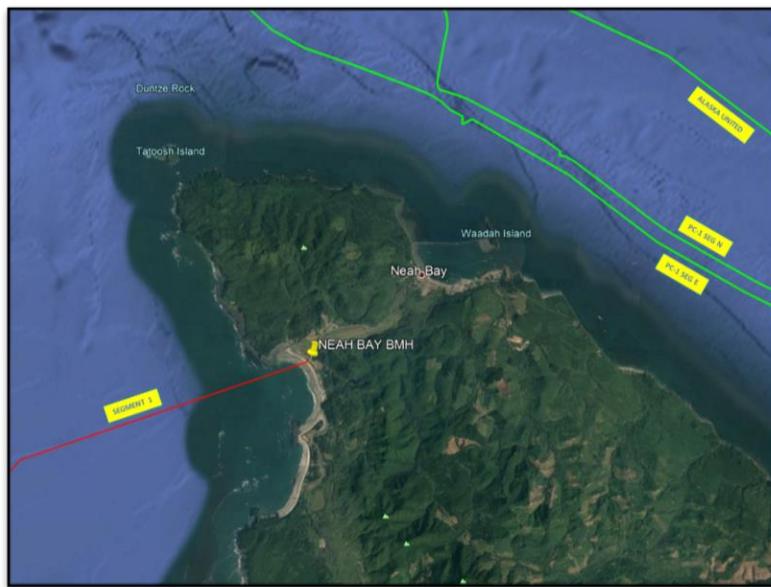


Figure 13.1-1 Segment 1 Cable Landing

The cable route starts inside the NOAA Olympic Coast National Marine Sanctuary (OCNMS) running a south parallel to the Juan de Fuca submarine canyon before turning to the northwest and to cross the canyon. The cable route exits the OCNMS at $48^{\circ}01.917'N$ $125^{\circ}33.361'W$. The total length of cable inside the OCNMS for the northern section of Segment 1 is approximately 92 km.

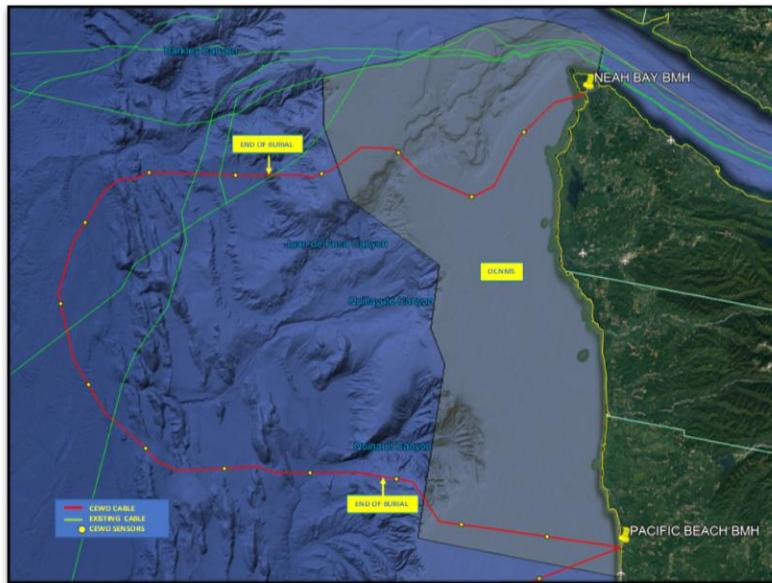


Figure 13.1-2 Segment 1 Cable Route and Sensor Locations

Soon after exiting the OCNMS, the End of Burial position has been set at $47^{\circ}58.443'N$ $125^{\circ}47.947'W$. A total of 111.40 km of cable burial has been proposed for the northern section of Segment 1. The Segment 1 cable crosses PC-1 Segment E at $47^{\circ}56.176'N$ $126^{\circ}5.059'W$ and then continues westerly down the continental slope into deeper water. The cable route then turns south and crosses an Out of Service Cable at $47^{\circ}28.106'N$ $126^{\circ}26.491'W$. The cable route then turns to the southeast and again crosses PC-1 Segment E at $47^{\circ}16.133'N$ $126^{\circ}11.854'W$. Upon reaching the 1000 m water depth contour at $47^{\circ}16.047'N$ $125^{\circ}10.021'W$, cable burial is resumed easterly to the landing site. A total of 77.525 km burial has been established for the southern section of Segment 1. The cable route re-enters the OCNMS at $47^{\circ}14.010'N$ $124^{\circ}58.599'W$. The total length of cable inside the OCNMS for the southern section of Segment 1 is approximately 61 km. The southern section of the Segment 1 cable makes landfall at the Designated Pacific Beach BMH position at $47^{\circ}12.370'N$ $124^{\circ}12.201'W$.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of fifteen (15) Sensors have been positioned along the Segment 1 EWOC Cable. The table below provides positions for the Segment 1 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 1-1	48° 12.745'N	124° 52.467'W	59
SENSOR 1-2	48° 1.312'N	125° 1.433'W	117
SENSOR 1-3	48° 5.774'N	125° 20.123'W	170
SENSOR 1-4	48° 0.193'N	125° 36.565'W	217
SENSOR 1-5	47° 57.242'N	125° 55.996'W	1535
SENSOR 1-6	47° 54.849'N	126° 15.731'W	1832
SENSOR 1-7	47° 45.187'N	126° 27.774'W	2269
SENSOR 1-8	47° 32.067'N	126° 29.277'W	2355
SENSOR 1-9	47° 20.671'N	126° 19.014'W	2442
SENSOR 1-10	47° 12.881'N	126° 3.144'W	2134
SENSOR 1-11	47° 12.360'N	125° 44.585'W	1730
SENSOR 1-12	47° 14.422'N	125° 25.259'W	1734
SENSOR 1-13	47° 16.137'N	125° 5.676'W	757
SENSOR 1-14	47° 11.159'N	124° 49.101'W	142
SENSOR 1-15	47° 11.850'N	124° 29.334'W	58

Table 13.1-1 Segment 1 Sensor Locations

13.2. Segment 2 Pacific Beach to Warrenton

The designated Pacific Beach BMH for the northern section of Segment 2 has been positioned at 47°12.370'N 124° 12.201'W.



Figure 13.2-1 Segment 2 Cable Landing

The cable route starts inside the NOAA Olympic Coast National Marine Sanctuary (OCNMS) initially running southwest along the continental shelf. The cable route exits the OCNMS at 47°07.778'N 124° 23.172'W. The total length of cable inside the OCNMS for the northern section of Segment 1 is approximately 16 km.

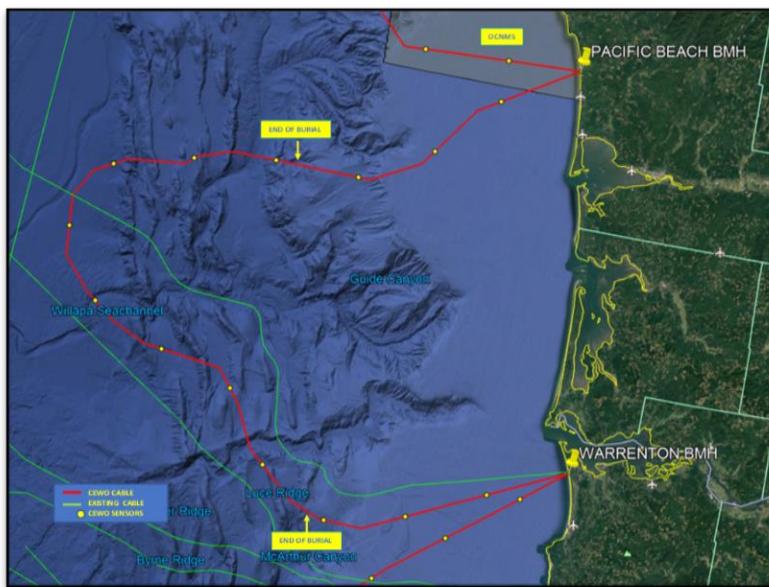


Figure 13.2-2 Segment 2 Cable Route and Sensor Locations

The cable route continues to the southwest and on to the continental slope where the End of Burial position has been set at 46°49.054'N 125°11.580'W. A total of 92.166 km of cable burial has been proposed for the northern section of Segment 2.

The Segment 2 cable continues westerly down the continental slope into deeper water until it turns to the south. The cable route crosses AUFS West at 46°37.027'N 126° 3.540'W and then turns to the southeast where it runs between AUFS West and TGN Pacific Seg G1 towards the Oregon coast. Upon reaching the 1000 m water depth contour at 45°55.630'N 124° 57.480'W, cable burial is resumed easterly to the landing site. A total of 84.338 km burial has been established for the southern section of Segment 2. The southern section of the Segment 2 cable makes landfall at the Designated Warrenton BMH position at 46° 9.007'N 123° 57.729'W. The AUFS West cable also makes landfall at this position.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of fourteen (14) Sensors have been positioned along the Segment 2 EWOC Cable. The table below provides positions for the Segment 2 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 2-1	47° 5.209'N	124° 29.267'W	64
SENSOR 2-2	46°55.388'N	124° 42.311'W	128
SENSOR 2-3	46°48.971'N	124° 58.721'W	623
SENSOR 2-4	46°49.080'N	125° 18.375'W	1302
SENSOR 2-5	46°46.819'N	125° 37.349'W	1848
SENSOR 2-6	46°43.287'N	125° 55.647'W	2616
SENSOR 2-7	46°32.177'N	126° 2.810'W	2638
SENSOR 2-8	46°21.264'N	125° 53.228'W	2606
SENSOR 2-9	46°15.856'N	125° 35.778'W	2253
SENSOR 2-10	46°11.947'N	125° 18.364'W	1697
SENSOR 2-11	46° 0.979'N	125° 7.500'W	1527
SENSOR 2-12	45°54.222'N	124° 51.228'W	735
SENSOR 2-13	45°57.291'N	124° 32.944'W	253
SENSOR 2-14	46° 3.131'N	124° 15.485'W	99

Table 13.2-1 Segment 2 Sensor Locations

13.3. Segment 3 Warrenton to Pacific City

The designated Warrenton BMH for the northern section of Segment 3 has been positioned at 46° 9.007'N 123° 57.729'W. The AUFS West cable also makes landfall at this position.



Figure 13.3-1 Segment 3 Cable Landing

The cable route initially runs southwest along the continental shelf for approximately 68 km where it reaches a series of active cable crossings. The cable route crosses TGN Pacific at 45°45.989'N 124° 38.720'W. It then crosses TPE at 45°43.275'N 124° 42.689'W and then crosses the Northstar cable at 45°41.619'N 124° 45.122'W.

The End of Burial position at the 1000 m water depth contour is located at 45°39.378'N 124° 50.304'W. A total of 88.582 km of cable burial has been proposed for the northern section of Segment 3.

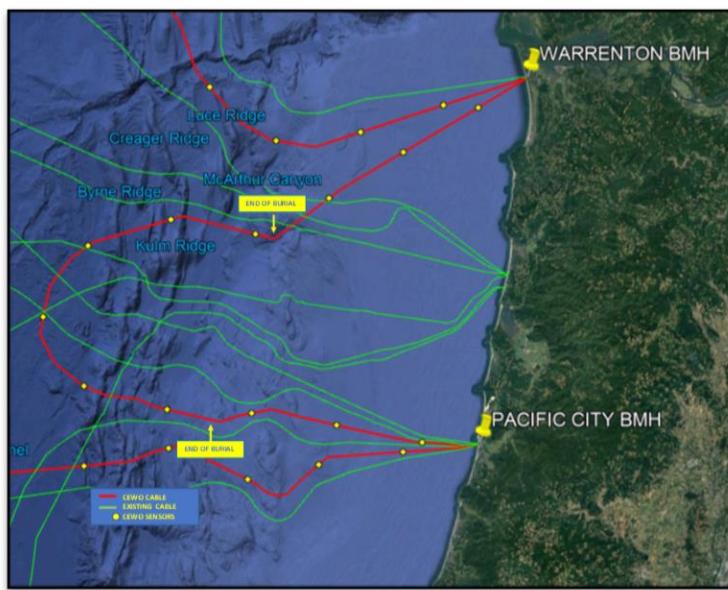


Figure 13.3-2 Segment 3 Cable Route and Sensor Locations

The Segment 3 cable continues westerly down the continental slope into deeper water until it turns to the south. The cable route crosses TGN at 45°33.670'N 125° 29.722'W and it crosses the North Pacific Cable at 45°28.931'N 125° 34.662'W. A triple crossing has been positioned at 45°23.098'N 125° 36.528'W where the Segment 3 cable crosses Southern Cross Segment F and the RSN Segment 5 cable.

The cable route then turns southeast towards the Oregon coast and crosses TGN Segment G5 at 45°11.720'N 125° 19.260'W. Upon reaching the 1000 m water depth contour at 45°10.442'N 124° 59.124'W, cable burial is resumed easterly to the landing site. A total of 81.931 km burial has been established for the southern section of Segment 3.

The southern section of the Segment 3 cable makes landfall at the Designated Pacific City BMH position at 45°12.140'N 123° 58.024'W. The North Pacific, RSN Segment 5 and the RSN Segment 1 cables also make landfall at this position.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of twelve (12) Sensors have been positioned along the Segment 3 EWOC Cable. The table below provides positions for the Segment 3 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 3-1	46° 3.454'N	124° 7.737'W	76
SENSOR 3-2	45°55.117'N	124° 22.961'W	141
SENSOR 3-3	45°46.565'N	124° 37.878'W	222
SENSOR 3-4	45°39.558'N	124° 52.872'W	1198
SENSOR 3-5	45°39.931'N	125° 11.808'W	1848
SENSOR 3-6	45°34.117'N	125° 29.081'W	2433
SENSOR 3-7	45°22.271'N	125° 36.572'W	2589
SENSOR 3-8	45°12.649'N	125° 25.460'W	2607
SENSOR 3-9	45°10.910'N	125° 6.713'W	1573
SENSOR 3-10	45°12.165'N	124° 48.279'W	707
SENSOR 3-11	45°12.120'N	124° 29.512'W	406
SENSOR 3-12	45°11.241'N	124° 10.484'W	131

Table 13.3-1 Segment 3 Sensor Locations

13.4. Segment 4 Pacific City to Florence

The northern section of the Segment 4 cable makes landfall at the designated Pacific City BMH position at 45°12.140'N 123° 58.024'W. The North Pacific, RSN Segment 5, RSN Segment 1 and Hawaiki cables also make landfall at this position

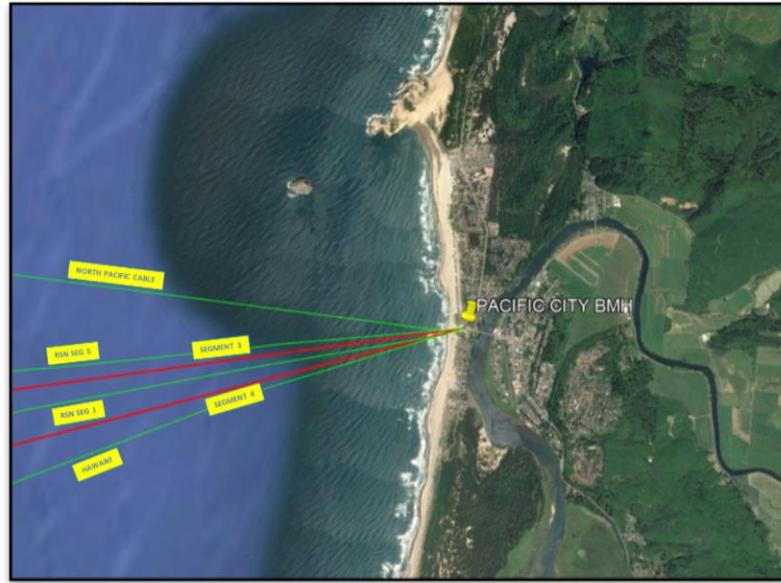


Figure 13.4-1 Segment 4 Cable Landing

Ocean Specialists Inc.

The cable route initially runs southwest along the continental shelf between the RSN Segment 1 and Hawaiki cables. The End of Burial position at the 1000 m water depth contour is located at 45° 4.498'N 124° 58.030'W. A total of 87.546 km of cable burial has been proposed for the northern section of Segment 4.

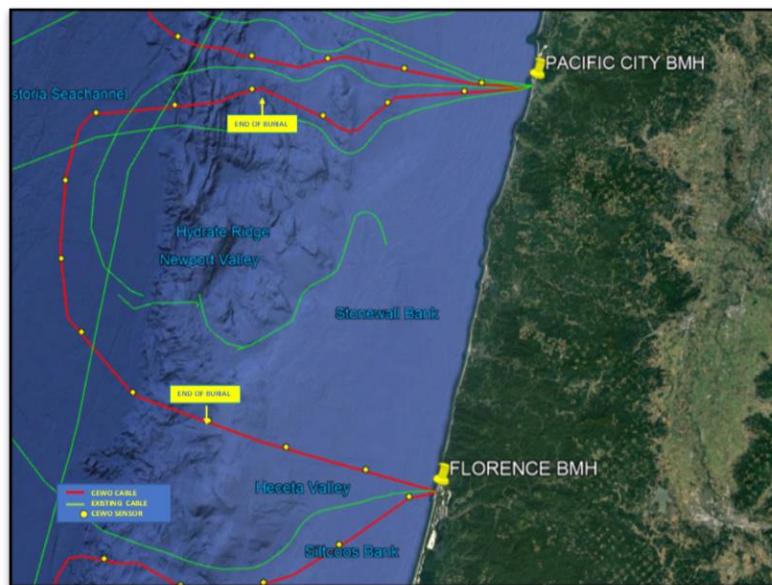


Figure 13.4-2 Segment 4 Cable Route and Sensor Locations

The Segment 4 cable continues westerly down the continental slope into deeper water until it crosses the TGN Segment 5 cable at 45° 0.052'N 125° 25.193'W and then crosses the RSN Segment 1 cable at 44°58.693'N 125° 33.143'W. The cable route turns south and crosses the Hawaiki cable at 44°54.337'N 125° 44.731'W before turning southeast and running towards the Oregon coast. The cable then crosses the TGN Segment 5 cable at 44°17.903'N 125° 30.939'W.

Continuing to the southeast the cable route reaches the 1000 m water depth contour at 44° 8.369'N 125° 1.474'W. Cable burial is resumed easterly to the landing site. A total of 72.774 km of cable burial has been proposed for the southern section of Segment 4.

The southern section of the Segment 4 cable makes landfall at the designated Florence BMH position at 44° 2.098'N 124° 7.956'W. The Akorn Segment 2.2 cable also makes landfall at this position.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of thirteen (13) Sensors have been positioned along the Segment 4 EWOC Cable. The table below provides positions for the Segment 4 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 4-1	45° 9.378'N	124° 14.350'W	168
SENSOR 4-2	45° 5.705'N	124° 32.242'W	331
SENSOR 4-3	45° 1.977'N	124° 47.125'W	590
SENSOR 4-4	45° 5.024'N	125° 5.170'W	1450
SENSOR 4-5	45° 0.439'N	125° 22.920'W	2350
SENSOR 4-6	44° 57.253'N	125° 41.401'W	2786
SENSOR 4-7	44° 44.850'N	125° 45.261'W	2841
SENSOR 4-8	44° 31.538'N	125° 42.349'W	2887
SENSOR 4-9	44° 19.843'N	125° 34.185'W	2948
SENSOR 4-10	44° 11.215'N	125° 19.739'W	2988
SENSOR 4-11	44° 8.363'N	125° 1.436'W	994
SENSOR 4-12	44° 5.847'N	124° 43.034'W	111
SENSOR 4-13	44° 3.949'N	124° 24.493'W	115

Table 13.4-1 Segment 4 Sensor Locations

13.5. Segment 5 Florence to Bandon

The northern section of the Segment 5 cable makes landfall at the designated Florence BMH position at 44° 2.098'N 124° 7.956'W. The Akorn Segment 2.2 cable also makes landfall at this position.



Figure 13.5-1 Segment 5 Cable Landing

The cable route initially runs southwest along the continental shelf paralleling the Akorn Segment 2.2. The End of Burial position at the 1000 m water depth contour is located at 43°42.124'N 124°53.377'W. A total of 73.274km of cable burial has been proposed for the northern section of Segment 5.

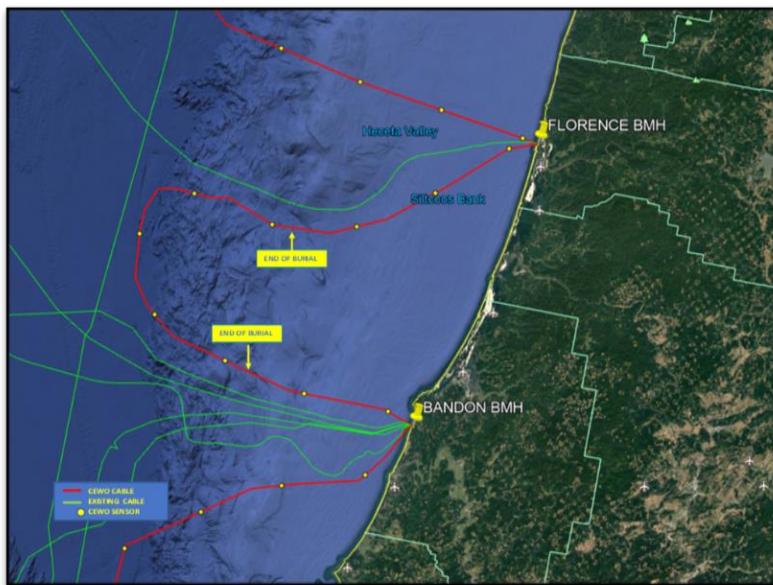


Figure 13.5-2 Segment 5 Cable Route and Sensor Locations

The Segment 5 cable continues westerly down the continental slope into deeper water. Just beyond the 3000 m water depth contour the cable route turns to the south and then to the southeast running towards the Oregon coast. There are no cable crossings along the Segment 5 cable route.

Continuing in an easterly direction, the cable route reaches the 1000 m water depth contour at 43°18.680'N 125° 0.706'W. Cable burial is resumed easterly to the landing site. A total of 52.166 km of cable burial has been proposed for the southern section of Segment 5.

The southern section of the Segment 5 cable makes landfall at the designated Bandon BMH position at 43°15.069'N 124° 23.070'W. The Bandon cable landing is the site for several other major fiber optic submarine cables. China US Segment N, TPC 5 Segment J, TPC 5 Segment T, China US Segment E and Faster Segment 1 all make landfall at the Bandon landing site. Horizontally Directionally Drilled (HDD) pipes serve as conduits to route the cables from the BMH to the ocean floor.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of ten (10) Sensors have been positioned along the Segment 5 EWOC Cable. The table below provides positions for the Segment 5 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 5-1	44° 0.579'N	124° 13.997'W	68
SENSOR 5-2	43°51.584'N	124° 27.905'W	129
SENSOR 5-3	43°44.078'N	124° 43.233'W	509
SENSOR 5-4	43°41.848'N	125° 1.278'W	1318
SENSOR 5-5	43°44.219'N	125° 19.141'W	2184
SENSOR 5-6	43°36.352'N	125° 29.023'W	3062
SENSOR 5-7	43°24.434'N	125° 22.320'W	2859
SENSOR 5-8	43°19.536'N	125° 5.476'W	1237
SENSOR 5-9	43°16.880'N	124° 47.430'W	505
SENSOR 5-10	43°16.649'N	124° 29.005'W	77

Table 13.5-1 Segment 5 Sensor Locations

13.6. Segment 6 Bandon to Crescent City

The northern section of the Segment 6 cable makes landfall at the designated Bandon BMH position at 43°15.069'N 124° 23.070'W. The Bandon cable landing is the site for several other major fiber optic submarine cables. China US Segment N, TPC 5 Segment J, TPC 5 Segment T, China US Segment E and Faster Segment 1 all make landfall at the Bandon landing site. Horizontally Directionally Drilled (HDD) pipes serve as conduits to route the cables from the BMH to the ocean floor.

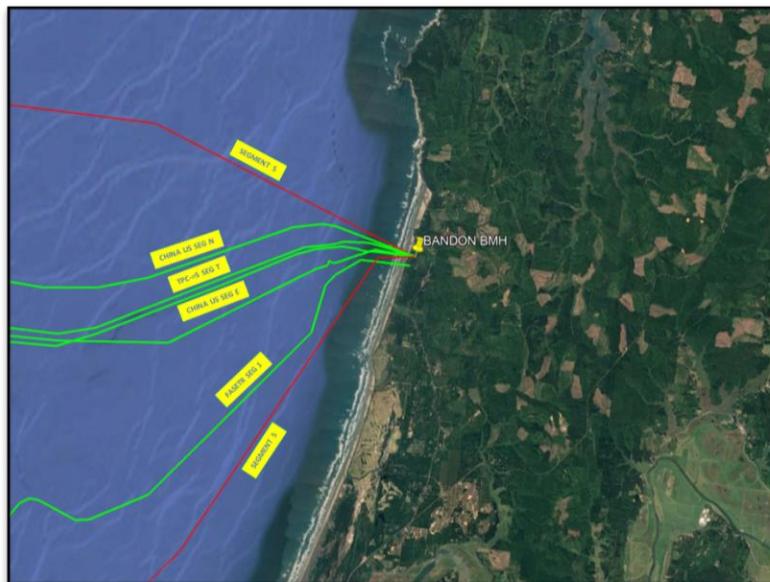


Figure 13.6-1 Segment 6 Cable Landing

Ocean Specialists Inc.

The cable route initially runs southwest along the continental shelf paralleling the Faster Segment 1 cable landing to the coastline. The End of Burial position at the 1000 m water depth contour is located at 42°58.463'N 124° 58.687'W. A total of 61.341 km of cable burial has been proposed for the northern section of Segment 6.

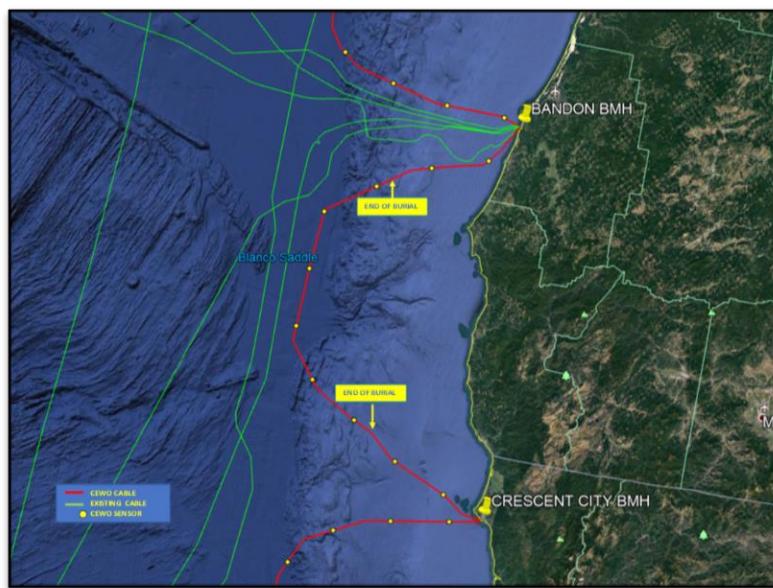


Figure 13.6-2 Segment 6 Cable Route and Sensor Locations

The Segment 6 cable continues westerly down the continental slope into deeper water. Just beyond the 3000 m water depth contour the cable route turns to the south and then to the southeast running towards the California coast. There are no cable crossings along the Segment 6 cable route.

Continuing in an easterly direction, the cable route reaches the 1000 m water depth contour at 42° 0.790'N 124° 53.563'W. Cable burial is resumed easterly to the landing site. A total of 65.675 km of cable burial has been proposed for the southern section of Segment 6.

The southern section of the Segment 6 cable makes landfall at the designated Crescent City BMH position at 41°44.923'N 124° 12.379'W.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of ten (10) Sensors have been positioned along the Segment 6 EWOC Cable. The table below provides positions for the Segment 6 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 6-1	43° 6.207'N	124° 31.219'W	71
SENSOR 6-2	43° 2.053'N	124° 48.366'W	125
SENSOR 6-3	42°55.523'N	125° 4.197'W	1498
SENSOR 6-4	42°47.517'N	125° 18.690'W	3070
SENSOR 6-5	42°34.033'N	125° 19.676'W	3069
SENSOR 6-6	42°20.534'N	125° 20.115'W	3090
SENSOR 6-7	42° 9.167'N	125° 11.870'W	2290
SENSOR 6-8	42° 1.931'N	124° 56.805'W	1033
SENSOR 6-9	41°54.421'N	124° 42.003'W	662
SENSOR 6-10	41°49.047'N	124° 25.429'W	137

Table 13.6-1 Segment 6 Sensor Locations

13.7. Segment 7 Crescent City to Eureka

The southern section of the Segment 7 cable makes landfall at the designated Crescent City BMH position at 41°44.923'N 124° 12.379'W.

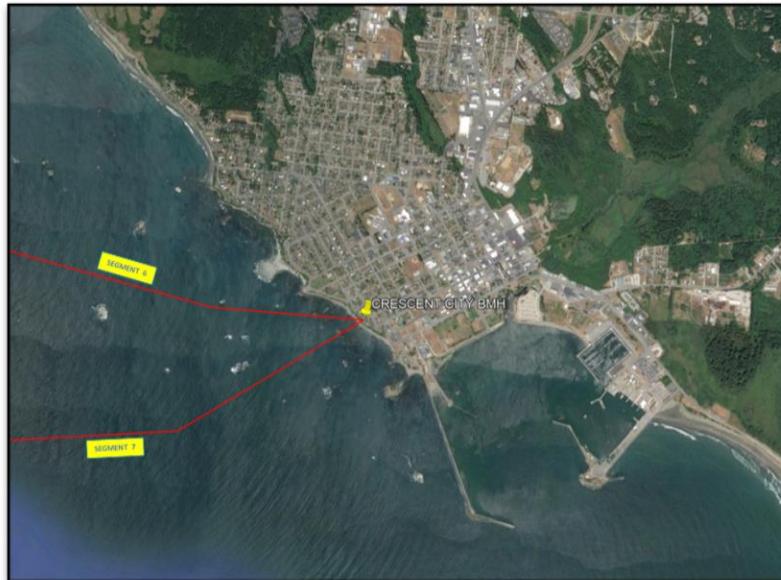


Figure 13.7-1 Segment 7 Cable Landing

The cable route initially runs west along the continental shelf. The End of Burial position at the 1000 m water depth contour is located at 41°36.776'N 124° 54.988'W. A total of 61.910 km of cable burial has been proposed for the northern section of Segment 7.

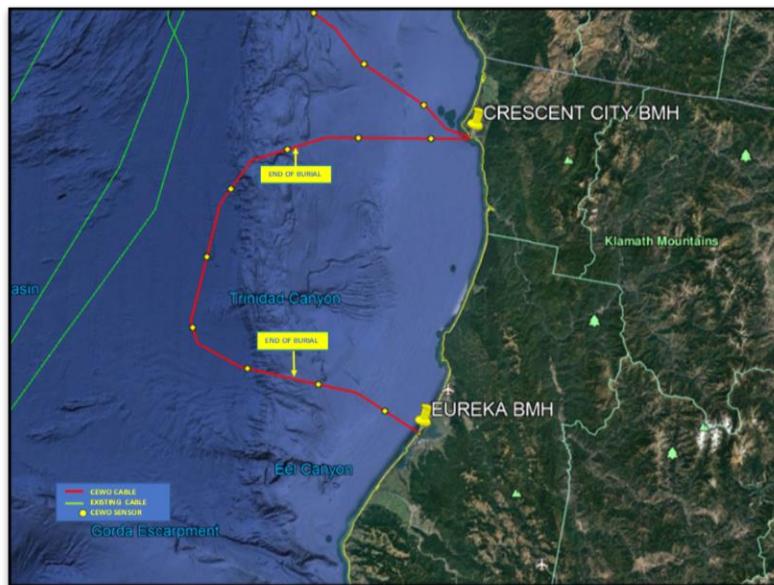


Figure 13.7-2 Segment 7 Cable Route and Sensor Locations

The Segment 7 cable continues westerly down the continental slope into deeper water. Just beyond the 3000 m water depth contour the cable route turns to the south and then to the southeast running towards the California coast. There are no cable crossings along the Segment 7 cable route.

Continuing in a southeasterly direction, the cable route reaches the 1000 m water depth contour at 40°49.774'N 124° 45.546'W. Cable burial is resumed easterly to the landing site. A total of 50.142 km of cable burial has been proposed for the southern section of Segment 7.

The southern section of the Segment 7 cable makes landfall at the designated Eureka BMH position at 40°49.266'N 124° 11.365'W.

Ocean Specialists Inc.

Based on 25 km (route distance) spacing between EWOC Sensors, a total of nine (9) Sensors have been positioned along the Segment 7 EWOC Cable. The table below provides positions for the Segment 7 Sensors.

SENSOR	LATITUDE	LONGITUDE	WATER DEPTH (m)
SENSOR 7-1	41°43.203'N	124° 22.101'W	99
SENSOR 7-2	41°40.779'N	124° 39.829'W	787
SENSOR 7-3	41°36.163'N	124° 56.524'W	1036
SENSOR 7-4	41°26.952'N	125° 8.308'W	3072
SENSOR 7-5	41°13.763'N	125° 10.797'W	3131
SENSOR 7-6	41° 0.415'N	125° 10.768'W	3061
SENSOR 7-7	40°54.971'N	124° 55.603'W	2985
SENSOR 7-8	40°54.628'N	124° 37.804'W	628
SENSOR 7-9	40°52.126'N	124° 20.600'W	92

Table 13.7-1 Segment 7 Sensor Locations

14. ROUTE POSITION LISTS



**Early Warning Offshore Cascadia
Route Position List
Segment 1
Neah Bay to Pacific Beach**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack	Cable Distance		Cable Type
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
001	Neah Bay BMH	48°20.415'N	124° 40.021'W	0				0.000			0.000	
					243.79°	243.79°S	9.550		0.50	9.598		DA
002	AC	48°18.135'N	124° 46.951'W	36				9.550			9.598	
					214.38°	029.41°P	12.100		0.50	12.161		DA
003	SENSOR 1-1	48°12.745'N	124° 52.467'W	59				21.650			21.759	
					214.31°	000.07°P	1.707		0.50	1.716		DA
004	AC	48°11.984'N	124° 53.243'W	67				23.357			23.474	
					196.35°	017.96°P	16.030		0.50	16.110		DA
005	AC	48° 3.683'N	124° 56.875'W	94				39.387			39.584	
					230.63°	034.28°S	7.008		0.50	7.043		DA
006	AC	48° 1.282'N	125° 1.233'W	115				46.395			46.627	
					282.22°	051.59°S	0.255		0.50	0.256		DA
007	SENSOR 1-2	48° 1.312'N	125° 1.433'W	117				46.650			46.883	
					282.22°	000.00°S	15.512		0.50	15.590		DA
008	AC	48° 3.072'N	125° 13.635'W	144				62.162			62.473	
					301.89°	019.68°S	9.488		0.50	9.535		DA
009	SENSOR 1-3	48° 5.774'N	125° 20.123'W	170				71.650			72.008	
					301.81°	000.08°P	1.768		0.50	1.777		DA
010	AC	48° 6.277'N	125° 21.334'W	129				73.419			73.786	
					260.58°	041.23°P	9.465		0.50	9.512		DA
011	AC	48° 5.438'N	125° 28.854'W	131				82.883			83.298	
					220.90°	039.68°P	11.028		0.50	11.083		DA
012	AC	48° 0.937'N	125° 34.661'W	191				93.911			94.380	
					239.79°	018.89°S	2.740		0.50	2.754		DA
013	SENSOR 1-4	48° 0.193'N	125° 36.565'W	217				96.651			97.134	
					239.77°	000.02°P	3.064		0.50	3.079		DA
014	AC	47°59.360'N	125° 38.693'W	496				99.714			100.213	
					268.58°	028.82°S	3.014		0.50	3.030		DA
015	DA/LWA	47°59.320'N	125° 41.115'W	800				102.729			103.243	
					259.14°	009.44°P	7.938		0.50	7.977		LWA
016	OOS XNG	47°58.510'N	125° 47.380'W	923				110.667			111.220	
					260.10°	000.96°S	0.716		0.50	0.719		LWA
017	END OF BURIAL	47°58.443'N	125° 47.947'W	1000				111.382			111.939	



**Early Warning Offshore Cascadia
Route Position List
Segment 1
Neah Bay to Pacific Beach**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		Cable Type	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)		
					256.38°	003.72°P	7.160		0.50	7.196		LWA	
018	AC	47°57.531'N	125° 53.537'W	1503		260.08°	003.70°S	3.108		0.50	3.124		LWA
019	SENSOR 1-5	47°57.242'N	125° 55.996'W	1535		260.05°	000.03°P	4.540		3.00	4.676		LWA
020	OOS XNG	47°56.818'N	125° 59.588'W	1577		260.14°	000.09°S	6.916		3.00	7.124		LWA
021	PC-1 XNG	47°56.176'N	126° 5.059'W	1638		260.09°	000.05°P	13.266		3.00	13.664		LWA
022	AC	47°54.937'N	126° 15.549'W	1828		234.39°	025.70°P	0.279		3.00	0.287		LWA
023	SENSOR 1-6	47°54.849'N	126° 15.731'W	1832		234.39°	000.00°S	3.991		3.00	4.110		LWA
024	AC	47°53.595'N	126° 18.334'W	1870		252.70°	018.31°S	4.897		3.00	5.044		LWA
025	AC	47°52.808'N	126° 22.085'W	1718		222.61°	030.09°P	2.734		3.00	2.816		LWA
026	LWA/SPA	47°51.722'N	126° 23.569'W	2000		222.88°	000.27°S	2.554		158.272		159.979	
027	AC	47°50.712'N	126° 24.962'W	2197		198.94°	023.94°P	10.825		3.00	11.150		SPA
028	SENSOR 1-7	47°45.187'N	126° 27.774'W	2269		198.91°	000.03°P	6.887		3.00	7.094		SPA
029	AC	47°41.670'N	126° 29.557'W	2235		183.52°	015.38°P	15.136		3.00	15.590		SPA
030	AC	47°33.517'N	126° 30.298'W	2349		154.49°	029.03°P	2.977		3.00	3.066		SPA
031	SENSOR 1-8	47°32.067'N	126° 29.277'W	2355		154.50°	000.01°S	8.131		3.00	8.375		SPA
032	OOS XNG	47°28.106'N	126° 26.491'W	2386		154.51°	000.01°S	8.123		3.00	8.367		SPA
033	AC	47°24.149'N	126° 23.712'W	2404		137.43°	017.08°P	8.746		3.00	9.008		SPA
034	SENSOR 1-9	47°20.671'N	126° 19.014'W	2442		137.49°	000.06°S	9.437		3.00	9.720		SPA



**Early Warning Offshore Cascadia
Route Position List
Segment 1
Neah Bay to Pacific Beach**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
035	AC	47°16.915'N	126° 13.956'W	2449				231.088			234.979	
					118.67°	018.81°P	3.021		3.00	3.112		SPA
036	PC-1 XNG	47°16.133'N	126° 11.854'W	2492				234.109			238.091	
					118.17°	000.50°P	11.744		3.00	12.096		SPA
037	AC	47°13.136'N	126° 3.654'W	2179				245.853			250.187	
					126.25°	008.07°S	0.798		3.00	0.822		SPA
038	SENSOR 1-10	47°12.881'N	126° 3.144'W	2134				246.651			251.009	
					126.25°	000.01°S	4.981		3.00	5.130		SPA
039	AC	47°11.291'N	125° 59.964'W	2084				251.631			256.139	
					102.58°	023.67°P	4.117		3.00	4.240		SPA
040	SPA/LWA	47°10.806'N	125° 56.784'W	2000				255.748			260.379	
					102.29°	000.29°P	2.459		3.00	2.533		LWA
041	AC	47°10.523'N	125° 54.882'W	1770				258.207			262.912	
					075.28°	027.02°P	13.444		3.00	13.847		LWA
042	SENSOR 1-11	47°12.360'N	125° 44.585'W	1730				271.651			276.759	
					075.40°	000.13°S	3.739		3.00	3.852		LWA
043	AC	47°12.868'N	125° 41.719'W	1702				275.390			280.611	
					072.48°	002.93°P	5.194		3.00	5.350		LWA
044	AC	47°13.711'N	125° 37.795'W	1622				280.584			285.961	
					096.03°	023.55°S	6.394		3.00	6.586		LWA
045	AC	47°13.347'N	125° 32.758'W	1581				286.978			292.546	
					078.07°	017.96°P	9.672		3.00	9.962		LWA
046	SENSOR 1-12	47°14.422'N	125° 25.259'W	1734				296.650			302.508	
					078.16°	000.09°S	13.894		3.00	14.310		LWA
047	AC	47°15.952'N	125° 14.478'W	1324				310.544			316.819	
					088.19°	010.03°S	5.623		3.00	5.792		LWA
048	END OF BURIAL	47°16.047'N	125° 10.021'W	1000				316.167			322.611	
					088.29°	000.10°S	3.612		0.50	3.630		LWA
049	LWA/DA	47°16.104'N	125° 7.158'W	800				319.780			326.241	
					088.15°	000.14°P	1.871		0.50	1.880		DA
050	SENSOR 1-13	47°16.137'N	125° 5.676'W	757				321.651			328.122	
					088.17°	000.02°S	4.887		0.50	4.911		DA
051	AC	47°16.220'N	125° 1.803'W	638				326.537			333.033	
					135.19°	047.03°S	13.736		0.50	13.805		DA
052	AC	47°10.956'N	124° 54.141'W	170				340.273			346.837	



**Early Warning Offshore Cascadia
Route Position List
Segment 1
Neah Bay to Pacific Beach**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		Cable Type	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)		
					086.59°	048.61°P	6.377		0.50	6.409		DA	
053	SENSOR 1-14	47°11.159'N	124° 49.101'W	142		086.65°	000.06°S	8.956		346.650		353.246	
054	AC	47°11.438'N	124° 42.023'W	108		087.19°	000.54°S	16.045		355.606		362.247	
055	SENSOR 1-15	47°11.850'N	124° 29.334'W	58		087.35°	000.16°S	21.657		371.651		378.372	
056	Pacific City BMH	47°12.370'N	124° 12.201'W	0						393.308		400.137	



Early Warning Offshore Cascadia Route Position List Segment 2 Pacific Beach to Warrenton

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance			
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)		
001	Pacific Beach BMH	47°12.370'N	124° 12.180'W	0				0.000			0.000		
					238.54°	238.54°S	25.350		0.50	25.477		DA	
002	SENSOR 2-1	47° 5.209'N	124° 29.267'W	64		238.33°	000.21°P	7.519		25.350		25.477	
003	AC	47° 3.077'N	124° 34.320'W	79		215.47°	022.87°P	17.482		32.869		33.033	
004	SENSOR 2-2	46°55.388'N	124° 42.311'W	128		215.37°	000.10°P	5.243		50.351		50.603	
005	AC	46°53.080'N	124° 44.700'W	142		241.73°	026.36°S	16.118		55.594		55.872	
006	AC	46°48.950'N	124° 55.860'W	482		270.64°	028.91°S	3.639		71.712		72.071	
007	SENSOR 2-3	46°48.971'N	124° 58.721'W	623		270.60°	000.03°P	14.296		75.351		75.728	
008	DA/LWA	46°49.043'N	125° 9.960'W	800				89.647			90.095		
009	EOB	46°49.054'N	125° 11.580'W	1000		270.54°	000.07°P	2.061		0.50	2.071	LWA	
010	AC	46°49.081'N	125° 14.280'W	1258		270.85°	000.32°S	3.435		91.708		92.166	
011	SENSOR 2-4	46°49.080'N	125° 18.375'W	1302		270.01°	000.84°P	5.208		95.142		95.704	
012	AC	46°49.078'N	125° 21.480'W	2000		269.96°	000.05°P	3.950		100.350		101.068	
013	AC	46°49.078'N	125° 24.660'W	2000		270.09°	000.07°S	4.960		104.300		105.136	
014	AC	46°49.081'N	125° 28.560'W	1804		251.42°	018.67°P	11.278		4.166		LWA	
015	AC	46°47.136'N	125° 36.960'W	1841		220.14°	031.29°P	0.768		5.109		109.302	
016	SENSOR 2-5	46°46.819'N	125° 37.349'W	1848		220.13°	000.00°S	2.669		113.305		114.411	
017	LWA/SPA	46°45.718'N	125° 38.700'W	1851		262.86°	042.72°S	11.937		124.583		126.028	
018	AC	46°44.910'N	125° 48.000'W	2000				139.956		0.791		141.862	
										2.749		129.568	SPA



**Early Warning Offshore Cascadia
Route Position List
Segment 2
Pacific Beach to Warrenton**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		Cable Type	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)		
					262.76°	000.09°P	5.855		3.00	6.030		SPA	
019	AC	46°44.510'N	125° 52.560'W	2402		240.07°	022.70°P	4.539		3.00	4.675		SPA
020	SENSOR 2-6	46°43.287'N	125° 55.647'W	2616		240.03°	000.04°P	6.582		3.00	6.780		SPA
021	AC	46°41.511'N	126° 0.120'W	2612		207.73°	032.30°P	9.383		3.00	9.665		SPA
022	AUFS WEST XNG	46°37.027'N	126° 3.540'W	2625		174.07°	033.66°P	9.035		3.00	9.306		SPA
023	SENSOR 2-7	46°32.177'N	126° 2.810'W	2638		174.08°	000.01°S	8.802		3.00	9.066		SPA
024	AC	46°27.451'N	126° 2.100'W	2600		137.57°	036.51°P	12.772		3.00	13.155		SPA
025	AC	46°22.360'N	125° 55.380'W	2538		126.33°	011.24°P	3.426		3.00	3.529		SPA
026	SENSOR 2-8	46°21.264'N	125° 53.228'W	2606		126.36°	000.03°S	8.431		3.00	8.683		SPA
027	AC	46°18.564'N	125° 47.940'W	2544		113.26°	013.10°P	11.243		3.00	11.581		SPA
028	AC	46°16.163'N	125° 39.900'W	2097		096.09°	017.17°P	5.326		3.00	5.486		SPA
029	SENSOR 2-9	46°15.856'N	125° 35.778'W	2253		096.14°	000.05°S	10.804		3.00	11.128		SPA
030	SPA/LWA	46°15.227'N	125° 27.420'W	2000		096.08°	000.06°P	7.368		3.00	7.589		LWA
031	AC	46°14.804'N	125° 21.720'W	1940		140.79°	044.71°S	6.829		3.00	7.034		LWA
032	SENSOR 2-10	46°11.947'N	125° 18.364'W	1697		140.83°	000.04°S	4.777		3.00	4.920		LWA
033	AC	46° 9.947'N	125° 16.020'W	1577		153.00°	012.18°S	14.151		3.00	14.576		LWA
034	AC	46° 3.139'N	125° 11.040'W	1663		131.20°	021.81°P	6.072		3.00	6.254		LWA
035	SENSOR 2-11	46° 0.979'N	125° 7.500'W	1527		131.24°	000.04°S	5.359		3.00	5.519		LWA



**Early Warning Offshore Cascadia
Route Position List
Segment 2
Pacific Beach to Warrenton**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
036	AC	45°59.072'N	125° 4.380'W	1143				280.710			286.838	
					130.22°	001.02°P	8.329		3.00	8.579		LWA
037	AC	45°56.167'N	124° 59.460'W	1290				289.038			295.417	
					111.21°	019.02°P	2.746		3.00	2.828		LWA
038	EOB	45°55.630'N	124° 57.480'W	1000				291.784			298.245	
					111.77°	000.56°S	0.668		0.50	0.672		LWA
039	LWA/DA	45°55.496'N	124° 57.000'W	800				292.452			298.916	
					111.05°	000.72°P	6.485		0.50	6.518		DA
040	AC	45°54.238'N	124° 52.320'W	730				298.937			305.434	
					091.13°	019.92°P	1.413		0.50	1.420		DA
041	SENSOR 2-12	45°54.222'N	124° 51.228'W	735				300.350			306.854	
					091.14°	000.01°S	11.394		0.50	11.451		DA
042	AC	45°54.094'N	124° 42.420'W	255				311.744			318.305	
					064.14°	027.00°P	13.607		0.50	13.675		DA
043	SENSOR 2-13	45°57.291'N	124° 32.944'W	253				325.351			331.980	
					064.25°	000.11°S	25.000		0.50	25.125		DA
044	SENSOR 2-14	46° 3.131'N	124° 15.485'W	99				350.351			357.105	
					064.46°	000.21°S	25.350		0.50	25.477		DA
045	Warrenton BMH	46° 9.007'N	123° 57.729'W	0				375.701			382.582	



Early Warning Offshore Cascadia Route Position List Segment 3 Warrenton to Pacific City

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)
001	Warrenton BMH	46° 9.007'N	123° 57.732'W	0				0.000			0.000
					231.47°	231.47°S	16.494		0.50	16.576	
002	SENSOR 3-1	46° 3.454'N	124° 7.737'W	76		231.35°	000.12°P	4.248		0.50	4.269
								20.742			20.846
003	AC	46° 2.021'N	124° 10.308'W	84		232.03°	000.68°S	20.752		0.50	20.856
											41.702
004	SENSOR 3-2	45°55.117'N	124° 22.961'W	141		231.88°	000.15°P	20.169		0.50	20.270
											DA
005	AC	45°48.385'N	124° 35.208'W	174		225.77°	006.11°P	4.831		0.50	4.855
											66.826
006	SENSOR 3-3	45°46.565'N	124° 37.878'W	222		225.63°	000.13°P	1.526		0.50	1.534
											DA
007	TGN Pacific XNG	45°45.989'N	124° 38.720'W	235		225.70°	000.07°S	7.196		0.50	7.232
											68.361
008	TPE XNG	45°43.275'N	124° 42.689'W	265				75.216			75.592
						225.84°	000.14°S	4.402		0.50	4.424
009	Northstar XNG	45°41.619'N	124° 45.122'W	575				79.618			80.017
						225.54°	000.30°P	4.123		0.50	4.144
010	DA/LWA	45°40.060'N	124° 47.388'W	800				83.741			84.160
						225.86°	000.32°S	2.129		0.50	2.139
011	AC	45°39.259'N	124° 48.564'W	916				85.870			86.300
						275.54°	049.68°S	2.271		0.50	2.282
012	END OF BURIAL	45°39.378'N	124° 50.304'W	1000				88.141			88.582
						275.74°	000.20°S	3.353		3.00	3.454
013	SENSOR 3-4	45°39.558'N	124° 52.872'W	1198				91.494			92.035
						275.71°	000.03°P	21.555		3.00	22.202
014	AC	45°40.697'N	125° 9.390'W	1242				113.050			114.238
						245.71°	030.00°P	3.445		3.00	3.548
015	SENSOR 3-5	45°39.931'N	125° 11.808'W	1848				116.495			117.786
						245.68°	000.03°P	7.504		3.00	7.729
016	LWA/SPA	45°38.261'N	125° 17.070'W	2000				123.998			125.515
						245.80°	000.11°S	15.839		3.00	16.314
017	AC	45°34.747'N	125° 28.176'W	2436				139.837			141.829
						225.29°	020.51°P	1.657		3.00	1.707
018	SENSOR 3-6	45°34.117'N	125° 29.081'W	2433				141.494			143.536



Early Warning Offshore Cascadia Route Position List Segment 3 Warrenton to Pacific City

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack	Cable Distance		
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
					225.18°	000.11°P	1.176		3.00	1.211		
019	TGN XNG	45°33.670'N	125° 29.722'W	2440		225.29°	000.12°S	4.697		3.00	4.838	
020	AC	45°31.886'N	125° 32.286'W	2472		209.50°	015.80°P	6.288		3.00	6.477	
021	North Pacific XNG	45°28.931'N	125° 34.662'W	2517		210.24°	000.75°S	3.463		3.00	3.567	
022	AC	45°27.316'N	125° 36.000'W	2527		185.04°	025.20°P	7.843		3.00	8.079	
023	Southern Cross/ RSN XNG	45°23.098'N	125° 36.528'W	2583		182.15°	002.89°P	1.533		3.00	1.579	
024	SENSOR 3-7	45°22.271'N	125° 36.572'W	2589		182.15°	000.00°S	4.944		3.00	5.093	
025	AC	45°19.603'N	125° 36.714'W	2612		144.78°	037.37°P	9.064		3.00	9.336	
026	AC	45°15.604'N	125° 32.718'W	2607		121.01°	023.77°P	10.257		3.00	10.564	
027	AC	45°12.748'N	125° 26.004'W	2617		104.37°	016.65°P	0.735		3.00	0.757	
028	SENSOR 3-8	45°12.649'N	125° 25.460'W	2607		104.37°	000.01°S	3.077		3.00	3.169	
029	SPA/LWA	45°12.237'N	125° 23.184'W	2000		104.33°	000.05°P	4.047		3.00	4.168	
030	AC	45°11.695'N	125° 20.190'W	1948		087.83°	016.50°P	1.219		3.00	1.255	
031	TGN XNG	45°11.720'N	125° 19.260'W	1961		087.78°	000.05°P	7.510		3.00	7.735	
032	AC	45°11.875'N	125° 13.530'W	1689		106.03°	018.25°S	5.250		3.00	5.407	
033	AC	45°11.091'N	125° 9.678'W	1614		094.91°	011.13°P	3.898		3.00	4.015	
034	SENSOR 3-9	45°10.910'N	125° 6.713'W	1573		094.94°	000.04°S	9.980		3.00	10.279	
035	END OF BURIAL	45°10.442'N	124° 59.124'W	1000		094.91°	000.03°P	4.040		0.50	4.060	
												LWA



**Early Warning Offshore Cascadia
Route Position List
Segment 3
Warrenton to Pacific City**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		Cable Type
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
036	LWA/DA	45°10.254'N	124° 56.052'W	800				230.515			235.125	
					094.88°	000.03°P	1.759		0.50	1.768		DA
037	AC	45°10.173'N	124° 54.714'W	786				232.274			236.894	
					063.21°	031.67°P	5.476		0.50	5.503		DA
038	AC	45°11.505'N	124° 50.982'W	757				237.750			242.397	
					070.91°	007.70°S	3.745		0.50	3.764		DA
039	SENSOR 3-10	45°12.165'N	124° 48.279'W	707				241.495			246.160	
					070.94°	000.03°S	5.863		0.50	5.892		DA
040	AC	45°13.197'N	124° 44.046'W	570				247.358			252.053	
					097.30°	026.35°S	6.914		0.50	6.948		DA
041	AC	45°12.721'N	124° 38.808'W	397				254.271			259.001	
					095.18°	002.12°P	12.223		0.50	12.284		DA
042	SENSOR 3-11	45°12.120'N	124° 29.512'W	406				266.494			271.285	
					095.29°	000.11°S	1.298		0.50	1.305		DA
043	AC	45°12.055'N	124° 28.525'W	402				267.792			272.590	
					094.76°	000.52°P	13.974		0.50	14.044		DA
044	AC	45°11.420'N	124° 17.893'W	200				281.766			286.633	
					094.01°	000.75°P	7.224		0.50	7.260		DA
045	AC	45°11.145'N	124° 12.391'W	152				288.990			293.893	
					085.91°	008.10°P	2.505		0.50	2.518		DA
046	SENSOR 3-12	45°11.241'N	124° 10.484'W	131				291.495			296.411	
					085.93°	000.02°S	5.373		0.50	5.400		DA
047	AC	45°11.446'N	124° 6.392'W	90				296.868			301.811	
					089.14°	003.21°S	4.779		0.50	4.803		DA
048	AC	45°11.484'N	124° 2.743'W	53				301.647			306.614	
					093.47°	004.33°S	1.275		0.50	1.281		DA
049	AC	45°11.442'N	124° 1.771'W	47				302.922			307.895	
					078.34°	015.13°P	0.537		0.50	0.539		DA
050	AC	45°11.500'N	124° 1.370'W	45				303.459			308.434	
					074.85°	003.49°P	4.540		0.50	4.562		DA
051	Pacific City BMH	45°12.140'N	123° 58.024'W	0				307.998			312.997	



Early Warning Offshore Cascadia Route Position List Segment 4 Pacific City to Florence

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)
001	Pacific City BMH	45°12.140'N	123° 58.024'W	0				0.000			0.000
					248.14°	248.14°S	4.439		0.50	4.461	
002	A/C	45°11.247'N	124° 1.169'W	35		258.75°	010.61°S	17.612		0.50	17.700
						258.59°	000.16°P	21.653		0.50	21.761
003	SENSOR 4-1	45° 9.378'N	124° 14.350'W	168				22.051			22.161
						222.04°	036.55°P	3.346		0.50	3.363
004	AC	45° 7.047'N	124° 30.534'W	350				43.704			43.923
							222.02°	000.02°P	7.390		0.50
005	SENSOR 4-2	45° 5.705'N	124° 32.242'W	331				47.050			47.285
								222.02°	000.02°P	7.390	
006	AC	45° 2.740'N	124° 36.010'W	450				54.440			54.713
								214.89°	007.13°P	4.569	
007	A/C	45° 0.716'N	124° 38.000'W	450				59.010			59.305
								245.08°	030.19°S	3.006	
008	A/C	45° 0.032'N	124° 40.074'W	430				62.016			62.326
								282.83°	037.74°S	3.918	
009	A/C	45° 0.501'N	124° 42.981'W	500				65.933			66.263
								299.96°	017.14°S	4.417	
010	A/C	45° 1.691'N	124° 45.894'W	570				70.350			70.702
								288.18°	011.79°P	1.701	
011	SENSOR 4-3	45° 1.977'N	124° 47.125'W	590				72.051			72.411
								288.16°	000.01°P	9.751	
012	DA/LWA	45° 3.615'N	124° 54.183'W	800				81.802			82.211
								287.98°	000.18°P	5.309	
013	END OF BURIAL	45° 4.498'N	124° 58.030'W	1000				87.110			87.546
								288.04°	000.07°S	6.914	
014	AC	45° 5.653'N	125° 3.041'W	1450				94.025			94.668
								247.38°	040.67°P	3.026	
015	SENSOR 4-4	45° 5.024'N	125° 5.170'W	1450				97.051			97.784
								247.35°	000.03°P	5.022	
016	AC	45° 3.979'N	125° 8.701'W	1480				102.073			102.957



Early Warning Offshore Cascadia Route Position List Segment 4 Pacific City to Florence

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack	Cable Distance	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)
					239.48°	007.87°P	6.522		3.00	6.717	
017	AC	45° 2.190'N	125° 12.979'W	1290		255.90°	016.42°S	9.452		108.594	
						256.53°	000.63°S	4.004		118.046	
018	LWA/SPA	45° 0.943'N	125° 19.957'W	2000					3.00	9.735	
						256.50°	000.03°P	3.071		122.050	
019	SENSOR 4-5	45° 0.439'N	125° 22.920'W	2350					3.00	3.163	
						256.51°	000.01°S	4.998		125.121	
020	TGN G5 XNG	45° 0.052'N	125° 25.193'W	2684					3.00	5.148	
						256.47°	000.04°P	5.750		130.119	
021	AC	44°59.421'N	125° 28.890'W	2743					3.00	5.923	
						256.25°	000.22°P	11.181		135.869	
022	RSN S1 XNG	44°58.693'N	125° 33.143'W	2740					3.00	11.516	
						256.15°	000.10°P	1.672		147.050	
023	SENSOR 4-6	44°57.253'N	125° 41.401'W	2786					3.00	1.722	
						208.88°	047.27°P	5.711		148.722	
024	AC	44°57.037'N	125° 42.635'W	2790					3.00	5.883	
						183.47°	025.41°P	5.625		154.434	
025	HAWAIKI XNG	44°54.337'N	125° 44.731'W	2820					3.00	5.794	
						183.53°	000.05°S	10.029		160.059	
026	A/C	44°51.305'N	125° 44.990'W	2825					3.00	10.330	
						172.40°	011.13°P	1.963		170.088	
027	AC	44°45.901'N	125° 45.457'W	2839					3.00	2.022	
						172.40°	000.00°S	21.876		172.051	
028	SENSOR 4-7	44°44.850'N	125° 45.261'W	2841					3.00	22.532	
						162.03°	010.38°P	3.124		193.926	
029	AC	44°33.142'N	125° 43.077'W	2885					3.00	3.218	
						162.04°	000.01°S	18.192		197.050	
030	SENSOR 4-8	44°31.538'N	125° 42.349'W	2887					3.00	18.737	
						129.70°	032.33°P	6.809		215.242	
031	AC	44°22.193'N	125° 38.126'W	2937					3.00	7.013	
						129.75°	000.05°S	5.616		222.051	
032	SENSOR 4-9	44°19.843'N	125° 34.185'W	2948					3.00	5.785	
						129.65°	000.10°P	19.383		227.667	
033	TGN G5 XNG	44°17.903'N	125° 30.939'W	2964					3.00	19.964	



**Early Warning Offshore Cascadia
Route Position List
Segment 4
Pacific City to Florence**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
034	SENSOR 4-10	44°11.215'N	125° 19.739'W	2988				247.050			252.284	
					129.78°	000.13°S	0.300		3.00	0.309		SPA
035	AC	44°11.111'N	125° 19.567'W	2989			101.90°	027.88°P	7.946		247.350	
									3.00	8.184		252.592
036	SPA/LWA	44°10.224'N	125° 13.733'W	2000			101.80°	000.10°P	16.703		255.296	
									3.00	17.204		260.777
037	END OF BURIAL	44° 8.369'N	125° 1.474'W	1000			101.87°	000.07°S	0.052		271.999	
									0.50	0.052		277.981
038	SENSOR 4-11	44° 8.363'N	125° 1.436'W	994			101.87°	000.00°S	0.709		272.051	
									0.50	0.713		LWA
039	LWA/DA	44° 8.284'N	125° 0.915'W	800			101.81°	000.06°P	17.097		272.760	
									0.50	17.183		278.746
040	AC	44° 6.384'N	124° 48.373'W	106			097.91°	003.89°P	7.194		289.857	
									0.50	7.230		295.928
041	SENSOR 4-12	44° 5.847'N	124° 43.034'W	111					297.051			303.158
							097.98°	000.06°S	25.000		0.50	25.125
042	SENSOR 4-13	44° 3.949'N	124° 24.493'W	115					322.051			328.283
							098.19°	000.21°S	19.943		0.50	20.042
043	AC	44° 2.399'N	124° 9.717'W	35			103.32°	005.13°S	2.417		341.993	
									0.50	2.429		348.326
044	Florence BMH	44° 2.098'N	124° 7.956'W	0					344.411			350.755



Early Warning Offshore Cascadia Route Position List Segment 5 Florence to Bandon

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)
001	Florence BMH	44° 2.098'N	124° 7.956'W	0				0.000			0.000
					250.82°	250.82°S	8.548		0.50	8.591	
002	SENSOR 5-1	44° 0.579'N	124° 13.997'W	68		250.75°	000.07°P	0.234		8.548	
									0.50	0.235	8.591
003	AC	44° 0.538'N	124° 14.162'W	70		227.60°	023.15°P	21.562		8.782	
									0.50	21.670	8.826
004	AC	43°52.676'N	124° 26.049'W	119		230.90°	003.30°S	3.205		30.344	
									0.50	3.221	30.495
005	SENSOR 5-2	43°51.584'N	124° 27.905'W	129		230.88°	000.02°P	16.059		33.549	
									0.50	16.139	33.716
006	AC	43°46.106'N	124° 37.189'W	304		245.19°	014.31°S	8.941		49.607	
									0.50	8.986	49.855
007	SENSOR 5-3	43°44.078'N	124° 43.233'W	509		245.12°	000.07°P	7.827		58.548	
									0.50	7.866	58.841
008	AC	43°42.298'N	124° 48.519'W	663				66.376			66.708
						266.84°	021.71°S	4.003		0.50	4.023
009	DA/LWA	43°42.178'N	124° 51.494'W	800				70.378			70.730
						267.76°	000.93°S	2.531		0.50	2.544
010	END OF BURIAL	43°42.124'N	124° 53.377'W	1000				72.909			73.274
						266.99°	000.78°P	10.502		3.00	10.818
011	AC	43°41.822'N	125° 1.183'W	1312				83.412			84.091
						290.49°	023.51°S	0.137		3.00	0.141
012	SENSOR 5-4	43°41.848'N	125° 1.278'W	1318				83.549			84.232
						290.49°	000.00°S	14.733		3.00	15.175
013	AC	43°44.625'N	125° 11.558'W	1583				98.282			99.407
						260.35°	030.14°P	5.710		3.00	5.881
014	AC	43°44.107'N	125° 15.751'W	1779				103.991			105.288
						272.61°	012.26°S	3.291		3.00	3.390
015	LWA/SPA	43°44.187'N	125° 18.200'W	2000				107.283			108.679
						272.68°	000.08°S	1.266		3.00	1.304
016	SENSOR 5-5	43°44.219'N	125° 19.141'W	2184				108.549			109.983
						272.67°	000.01°P	6.960		3.00	7.169
017	AC	43°44.393'N	125° 24.320'W	3000				115.509			117.152
						250.86°	021.81°P	3.984		3.00	4.104
018	AC	43°43.687'N	125° 27.123'W	3061				119.493			121.255



**Early Warning Offshore Cascadia
Route Position List
Segment 5
Florence to Bandon**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack	Cable Distance		Cable Type	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)		
					201.56°	049.30°P	6.544		3.00	6.740		SPA	
019	AC	43°40.400'N	125° 28.912'W	3064		182.85°	018.71°P	6.067		3.00	6.249		SPA
020	AC	43°37.128'N	125° 29.136'W	3063		173.98°	008.87°P	1.445		3.00	1.488		SPA
021	SENSOR 5-6	43°36.352'N	125° 29.023'W	3062		173.98°	000.00°S	12.714		3.00	13.096		SPA
022	AC	43°29.523'N	125° 28.035'W	3055		145.37°	028.61°P	8.925		3.00	9.193		SPA
023	AC	43°25.556'N	125° 24.277'W	3064		128.17°	017.20°P	3.361		3.00	3.462		SPA
024	SENSOR 5-7	43°24.434'N	125° 22.320'W	2859		128.20°	000.02°S	8.210		3.00	8.456		SPA
025	AC	43°21.691'N	125° 17.544'W	2227		103.75°	024.44°P	4.022		3.00	4.143		SPA
026	SPA/LWA	43°21.174'N	125° 14.653'W	2000		103.68°	000.07°P	12.767		3.00	13.150		LWA
027	SENSOR 5-8	43°19.536'N	125° 5.476'W	1237		103.79°	000.10°S	6.642		3.00	6.841		LWA
028	END OF BURIAL	43°18.680'N	125° 0.706'W	1000		103.74°	000.05°P	4.905		0.50	4.930		LWA
029	LWA/DA	43°18.050'N	124° 57.182'W	800		103.71°	000.03°P	9.146		0.50	9.192		DA
030	AC	43°16.876'N	124° 50.614'W	462		089.88°	013.83°P	4.307		0.50	4.329		DA
031	SENSOR 5-9	43°16.880'N	124° 47.430'W	505		089.92°	000.04°S	23.772		0.50	23.891		DA
032	AC	43°16.876'N	124° 29.858'W	83		109.98°	020.06°S	1.227		0.50	1.233		DA
033	SENSOR 5-10	43°16.649'N	124° 29.005'W	77		109.99°	000.01°S	8.548		0.50	8.591		DA
034	Bandon BMH	43°15.069'N	124° 23.070'W	0					242.096			246.238	



Early Warning Offshore Cascadia Route Position List Segment 6 Bandon to Crescent City

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)
001	Bandon BMH	43°15.069'N	124° 23.070'W	0				0.000			0.000
					261.92°	261.92°S	1.241		0.50	1.247	
002	AC	43°14.975'N	124° 23.978'W	12				1.241			1.247
					206.73°	055.19°P	11.552		0.50	11.610	
003	AC	43° 9.402'N	124° 27.810'W	39				12.793			12.857
					218.03°	011.30°S	7.506		0.50	7.544	
004	SENSOR 6-1	43° 6.207'N	124° 31.219'W	71				20.299			20.400
					217.99°	000.04°P	2.562		0.50	2.575	
005	AC	43° 5.117'N	124° 32.381'W	87				22.861			22.975
					256.19°	038.20°S	16.423		0.50	16.505	
006	AC	43° 2.990'N	124° 44.125'W	192				39.283			39.480
					253.27°	002.92°P	6.015		0.50	6.045	
007	SENSOR 6-2	43° 2.053'N	124° 48.366'W	125				45.298			45.525
					253.22°	000.05°P	8.731		0.50	8.774	
008	AC	43° 0.689'N	124° 54.518'W	481				54.029			54.299
					233.98°	019.25°P	4.914		0.50	4.939	
009	DA/LWA	42°59.128'N	124° 57.442'W	800				58.943			59.238
					233.98°	000.01°S	2.092		0.50	2.103	
010	END OF BURIAL	42°58.463'N	124° 58.687'W	1000				61.036			61.341
					234.03°	000.05°S	9.263		3.00	9.541	
011	SENSOR 6-3	42°55.523'N	125° 4.197'W	1498				70.299			70.882
					233.97°	000.06°P	4.864		3.00	5.010	
012	AC	42°53.977'N	125° 7.086'W	1651				75.162			75.891
					234.83°	000.85°S	2.251		3.00	2.319	
013	LWA/SPA	42°53.276'N	125° 8.438'W	2000				77.414			78.210
					234.89°	000.06°S	17.029		3.00	17.540	
014	AC	42°47.978'N	125° 18.655'W	3072				94.443			95.750
					183.18°	051.70°P	0.856		3.00	0.882	
015	SENSOR 6-4	42°47.517'N	125° 18.690'W	3070				95.299			96.632
					183.18°	000.00°S	23.773		3.00	24.487	
016	AC	42°34.696'N	125° 19.654'W	3068				119.072			121.118



**Early Warning Offshore Cascadia
Route Position List
Segment 6
Bandon to Crescent City**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack	Cable Distance		Cable Type	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)		
					181.38°	001.80°P	1.227		3.00	1.264		SPA	
017	SENSOR 6-5	42°34.033'N	125° 19.676'W	3069		181.38°	000.00°S	25.000		3.00	25.750		SPA
018	SENSOR 6-6	42°20.534'N	125° 20.115'W	3090		181.38°	000.00°S	6.305		3.00	6.494		SPA
019	AC	42°17.129'N	125° 20.226'W	3096		142.00°	039.38°P	18.694		3.00	19.255		SPA
020	SENSOR 6-7	42° 9.167'N	125° 11.870'W	2290		142.09°	000.09°S	1.760		3.00	1.813		SPA
021	AC	42° 8.417'N	125° 11.085'W	2321		139.66°	002.43°P	2.945		3.00	3.034		SPA
022	SPA/LWA	42° 7.204'N	125° 9.702'W	2000		119.09°	020.57°P	18.224		3.00	18.771		LWA
023	AC	42° 2.408'N	124° 58.162'W	1057		115.24°	003.85°P	2.070		3.00	2.132		LWA
024	SENSOR 6-8	42° 1.931'N	124° 56.805'W	1033		115.25°	000.02°S	4.949		3.00	5.098		LWA
025	END OF BURIAL	42° 0.790'N	124° 53.563'W	1000		115.23°	000.02°P	4.324		200.247		204.729	
026	AC	41°59.793'N	124° 50.730'W	923		131.83°	016.60°S	4.894		0.50	4.346		LWA
027	LWA/DA	41°58.030'N	124° 48.091'W	800		131.96°	000.13°S	8.756		209.465		213.993	
028	AC	41°54.865'N	124° 43.382'W	680		113.34°	018.62°P	2.077		0.50	8.800		DA
029	SENSOR 6-9	41°54.421'N	124° 42.003'W	662		113.36°	000.02°S	25.000		0.50	20.087		DA
030	SENSOR 6-10	41°49.047'N	124° 25.429'W	137		113.54°	000.18°S	1.094		0.50	25.125		DA
031	AC	41°48.811'N	124° 24.705'W	121		127.14°	013.60°S	9.997		0.50	10.047		DA
032	AC	41°45.548'N	124° 18.956'W	41		098.53°	028.62°P	8.055		0.50	8.095		DA
033	AC	41°44.900'N	124° 13.209'W	2		087.90°	010.63°P	1.152		0.50	1.158		DA



**Early Warning Offshore Cascadia
Route Position List
Segment 6
Bandon to Crescent City**

Issue: 2
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance	
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)
034	Crescent City BMH	41°44.923'N	124° 12.379'W	0				265.596			270.404



Early Warning Offshore Cascadia Route Position List Segment 7 Crescent City to Eureka

Issue: 7
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
001	Crescent City BMH	41°44.923'N	124° 12.379'W	0				0.000			0.000	
					231.75°	231.75°S	1.594		0.50	1.602		DA
002	AC	41°44.390'N	124° 13.282'W	9				1.594			1.602	
					259.86°	028.11°S	12.425		0.50	12.487		DA
003	SENSOR 7-1	41°43.203'N	124° 22.101'W	99				14.019			14.089	
					259.76°	000.10°P	25.000		0.50	25.125		DA
004	SENSOR 7-2	41°40.779'N	124° 39.829'W	787				39.019			39.214	
					259.57°	000.20°P	0.959		0.50	0.964		DA
005	DA/LWA	41°40.686'N	124° 40.509'W	800				39.978			40.178	
					259.73°	000.17°S	10.092		0.50	10.143		LWA
006	AC	41°39.710'N	124° 47.663'W	869				50.070			50.321	
					241.94°	017.79°P	11.532		0.50	11.589		LWA
007	END OF BURIAL	41°36.776'N	124° 54.988'W	1000				61.602			61.910	
					242.04°	000.10°S	2.417		3.00	2.490		LWA
008	SENSOR 7-3	41°36.163'N	124° 56.524'W	1036				64.019			64.399	
					242.02°	000.02°P	13.033		3.00	13.424		LWA
009	AC	41°32.855'N	125° 4.801'W	1906				77.052			77.824	
					203.92°	038.10°P	1.256		3.00	1.294		LWA
010	LWA/SPA	41°32.234'N	125° 5.167'W	2000				78.309			79.118	
					204.10°	000.18°S	10.710		3.00	11.031		SPA
011	SENSOR 7-4	41°26.952'N	125° 8.308'W	3072				89.019			90.149	
					204.07°	000.03°P	6.564		3.00	6.761		SPA
012	AC	41°23.714'N	125° 10.228'W	3110				95.582			96.910	
					182.47°	021.60°P	18.436		3.00	18.989		SPA
013	SENSOR 7-5	41°13.763'N	125° 10.797'W	3131				114.018			115.899	
					182.46°	000.01°P	0.086		3.00	0.089		SPA
014	AC	41°13.717'N	125° 10.800'W	3131				114.105			115.988	
					182.52°	000.06°S	22.756		3.00	23.439		SPA
015	AC	41° 1.434'N	125° 11.514'W	3070				136.861			139.427	
					151.01°	031.51°P	2.157		3.00	2.222		SPA
016	SENSOR 7-6	41° 0.415'N	125° 10.768'W	3061				139.018			141.649	
					151.02°	000.01°S	5.699		3.00	5.870		SPA
017	AC	40°57.721'N	125° 8.800'W	3043				144.717			147.519	
					107.54°	043.48°P	16.613		3.00	17.112		SPA
018	AC	40°55.007'N	124° 57.517'W	2976				161.331			164.631	

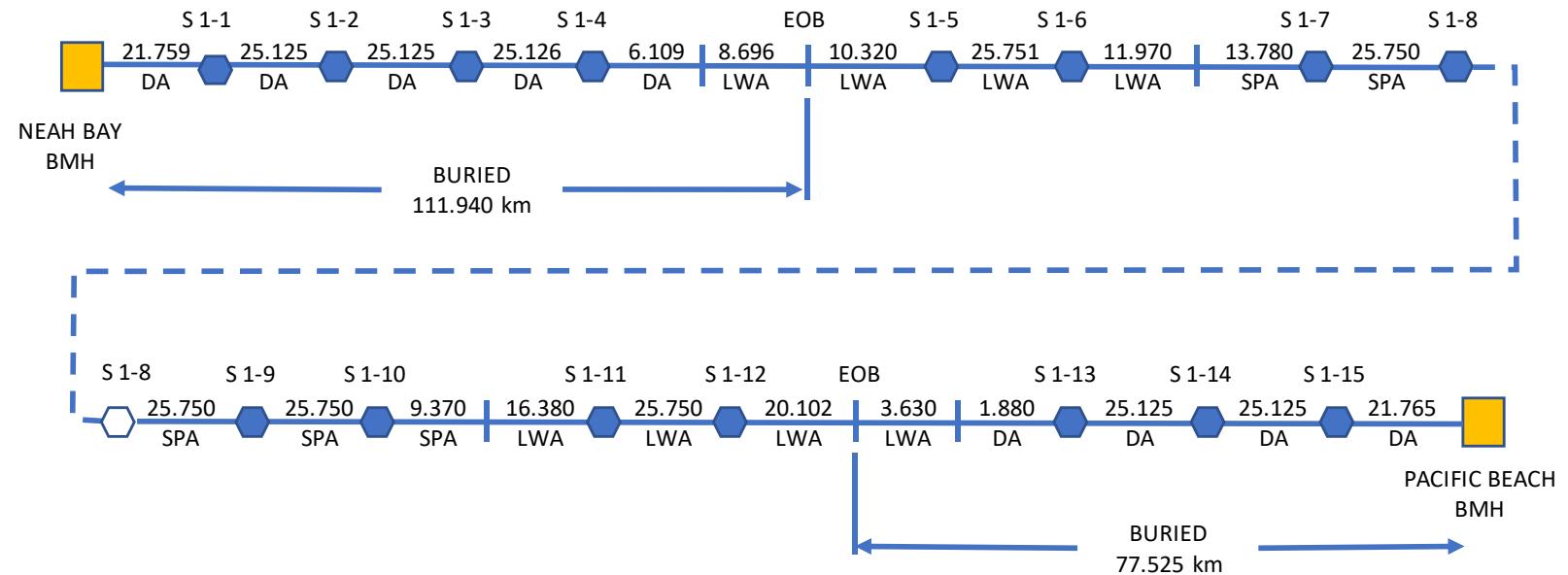


Early Warning Offshore Cascadia
Route Position List
Segment 7
Crescent City to Eureka

Issue: 7
Date: November 13, 2018

Pos	Event	Latitude	Longitude	Water Depth (m)	Course Heading	Course Change	Route Distance		Slack (%)	Cable Distance		Cable Type
							Incremental (km)	Cumulative (km)		Incremental (km)	Cumulative (km)	
					091.42°	016.11°P	2.688		3.00	2.769		SPA
019	SENSOR 7-7	40°54.971'N	124° 55.603'W	2985				164.019			167.399	
					091.45°	000.02°S	7.917		3.00	8.154		SPA
020	SPA/LWA	40°54.860'N	124° 49.966'W	2000				171.936			175.554	
					091.45°	000.01°S	6.208		3.00	6.394		LWA
021	END OF BURIAL	40°54.774'N	124° 45.546'W	1000				178.144			181.948	
					091.49°	000.04°S	2.387		0.50	2.399		LWA
022	LWA/DA	40°54.740'N	124° 43.847'W	800				180.531			184.347	
					091.37°	000.12°P	8.488		0.50	8.530		DA
023	SENSOR 7-8	40°54.628'N	124° 37.804'W	628				189.019			192.878	
					091.44°	000.07°S	13.636		0.50	13.704		DA
024	AC	40°54.436'N	124° 28.096'W	392				202.655			206.582	
					112.06°	020.62°S	11.364		0.50	11.421		DA
025	SENSOR 7-9	40°52.126'N	124° 20.600'W	92				214.019			218.002	
					112.14°	000.08°S	14.018		0.50	14.088		DA
026	Eureka BMH	40°49.266'N	124° 11.365'W	0				228.037			232.091	

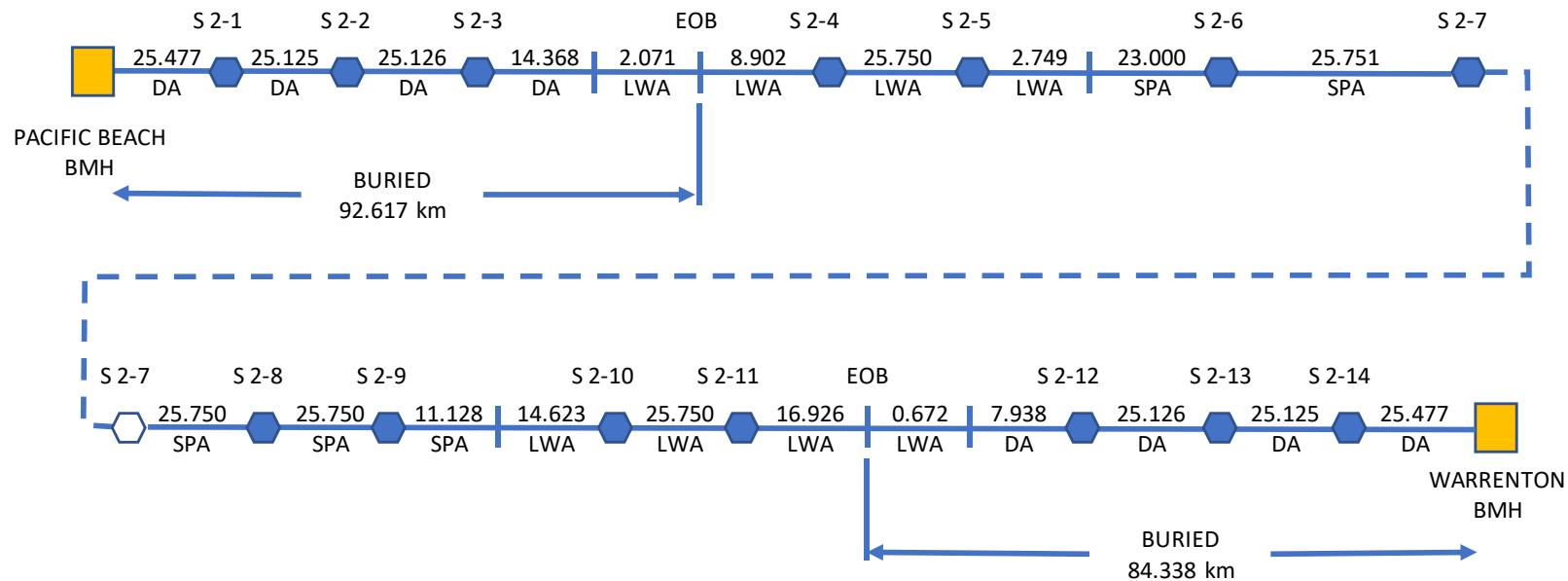
15. STRAIGHT LINE DIAGRAMS



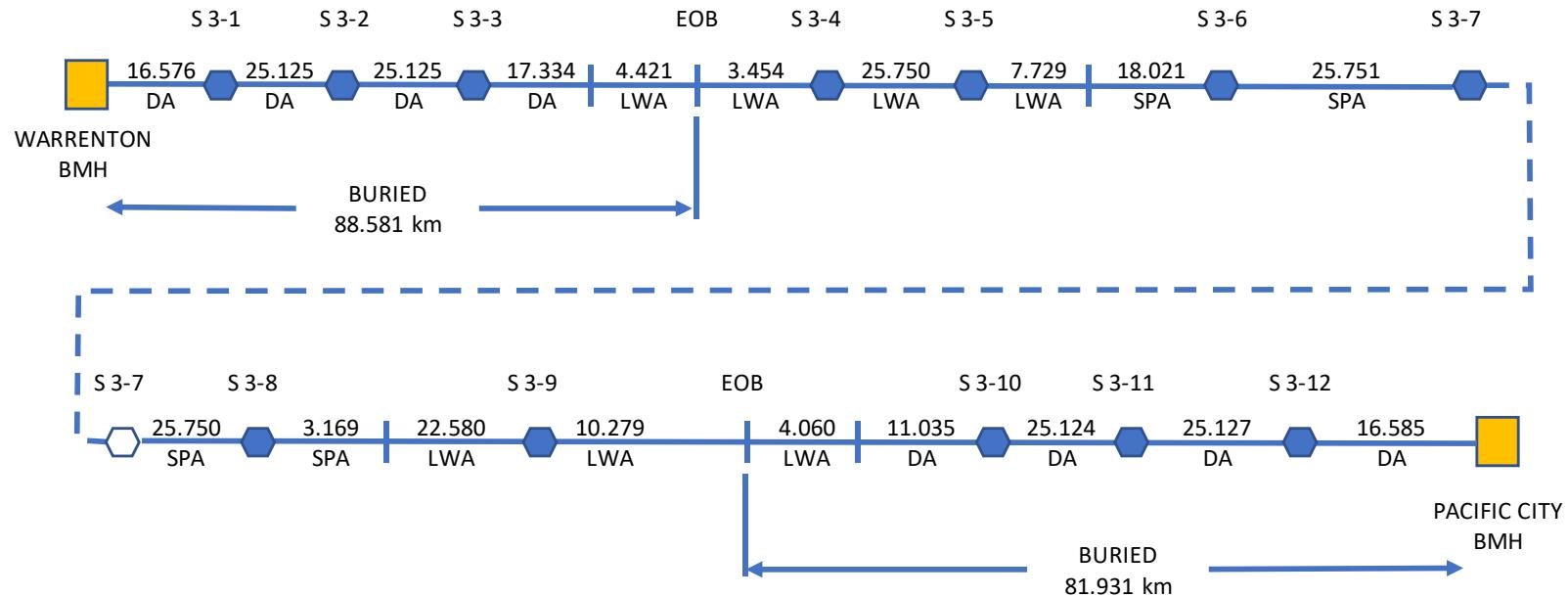
CABLE SUMMARY	
CABLE TYPE	LENGTH
DA	177.139 km
LWA	122.599 km
SPA	100.400 km
TOTAL CABLE	400.138 km



STRAIGHT LINE DIAGRAM		
SEGMENT 1		
NEAH BAY to PACIFIC BEACH		
Issue	Date	Page
2	13 November 2018	1 of 1



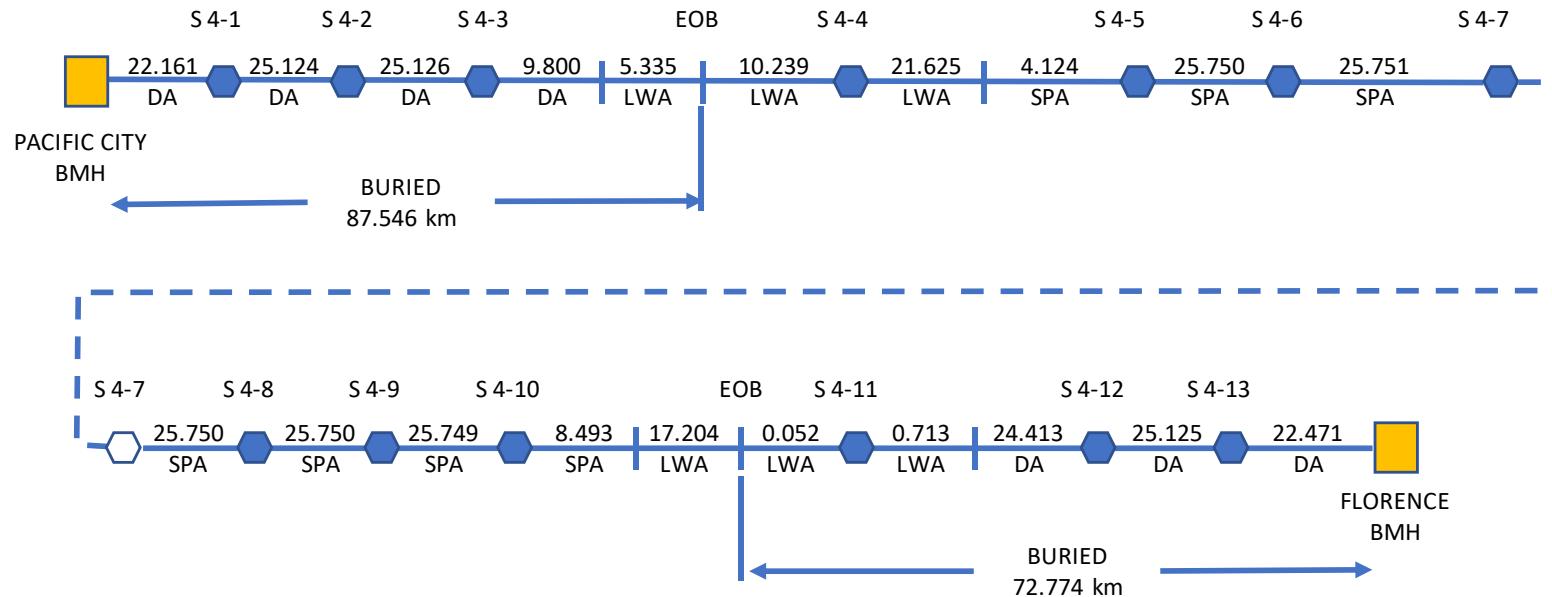
CABLE SUMMARY		EARLY WARNING OFFSHORE CASCADIA 	STRAIGHT LINE DIAGRAM		
CABLE TYPE	LENGTH		SEGMENT 2		
DA	173.762 km		PACIFIC BEACH to WARRENTON		
LWA	97.443 km				
SPA	111.379 km				
TOTAL CABLE	382.584 km		Issue	Date	Page
		2	13 November 2018	1 of 1	



CABLE SUMMARY	
CABLE TYPE	LENGTH
DA	162.031 km
to LWA	78.273 km
SPA	72.691 km
TOTAL CABLE	312.995 km



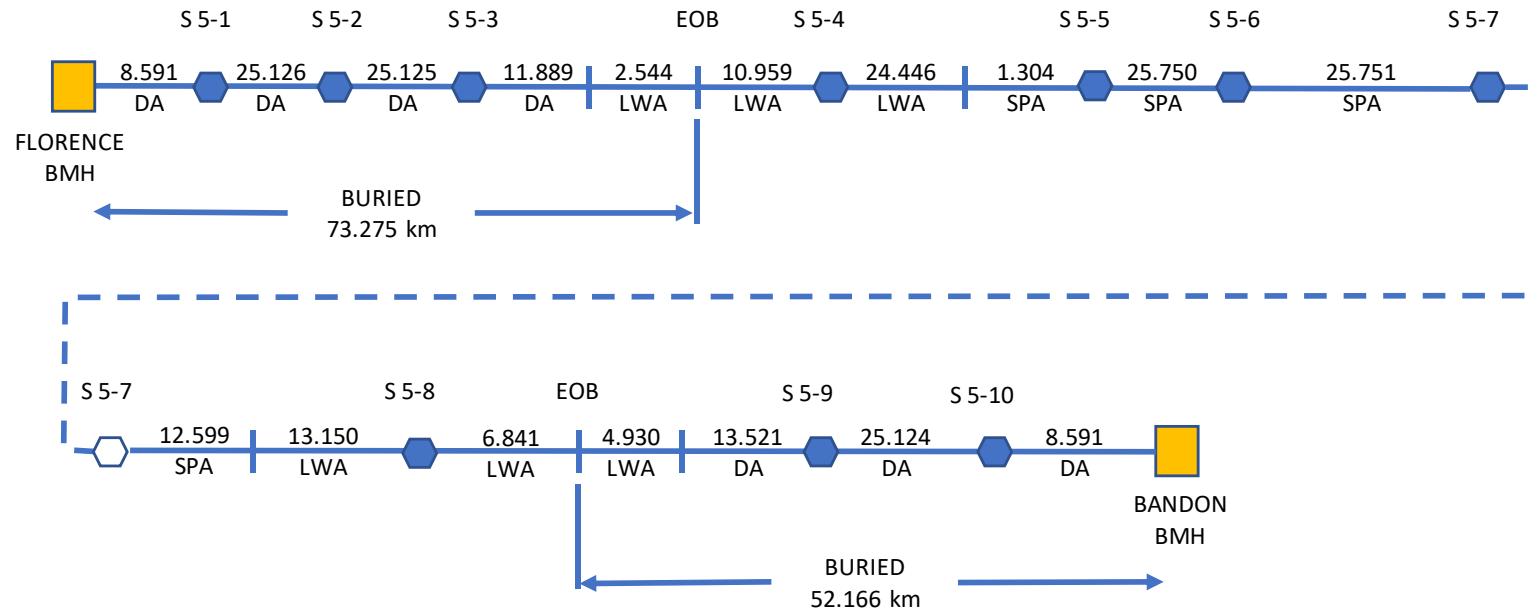
STRAIGHT LINE DIAGRAM		
SEGMENT 3		
WARRENTON to PACIFIC CITY		
Issue	Date	Page
2	13 November 2018	1 of 1



CABLE SUMMARY	
CABLE TYPE	LENGTH
DA	154.220 km
LWA	55.168 km
SPA	141.367 km
TOTAL CABLE	350.755 km



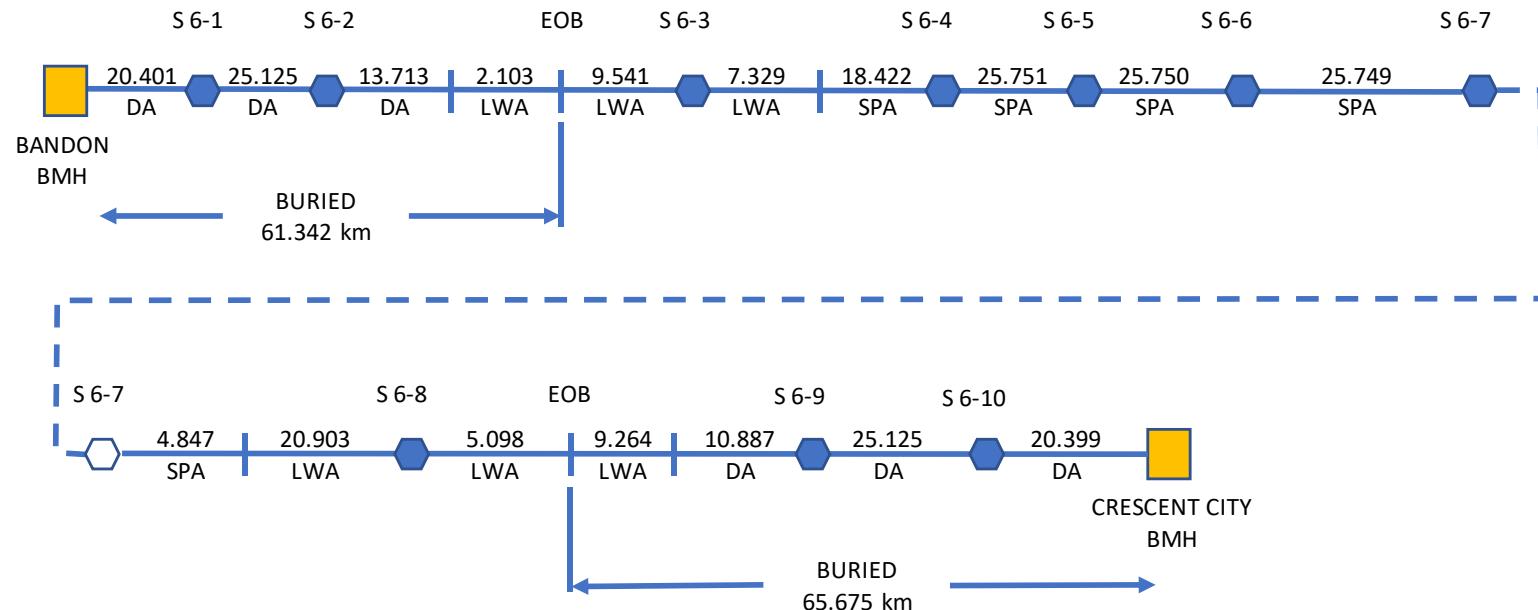
STRAIGHT LINE DIAGRAM		
SEGMENT 4		
PACIFIC CITY to FLORENCE		
Issue	Date	Page
2	13 November 2018	1 of 1



CABLE SUMMARY	
CABLE TYPE	LENGTH
DA	117.967 km
LWA	62.870 km
SPA	65.404 km
TOTAL CABLE	246.241 km



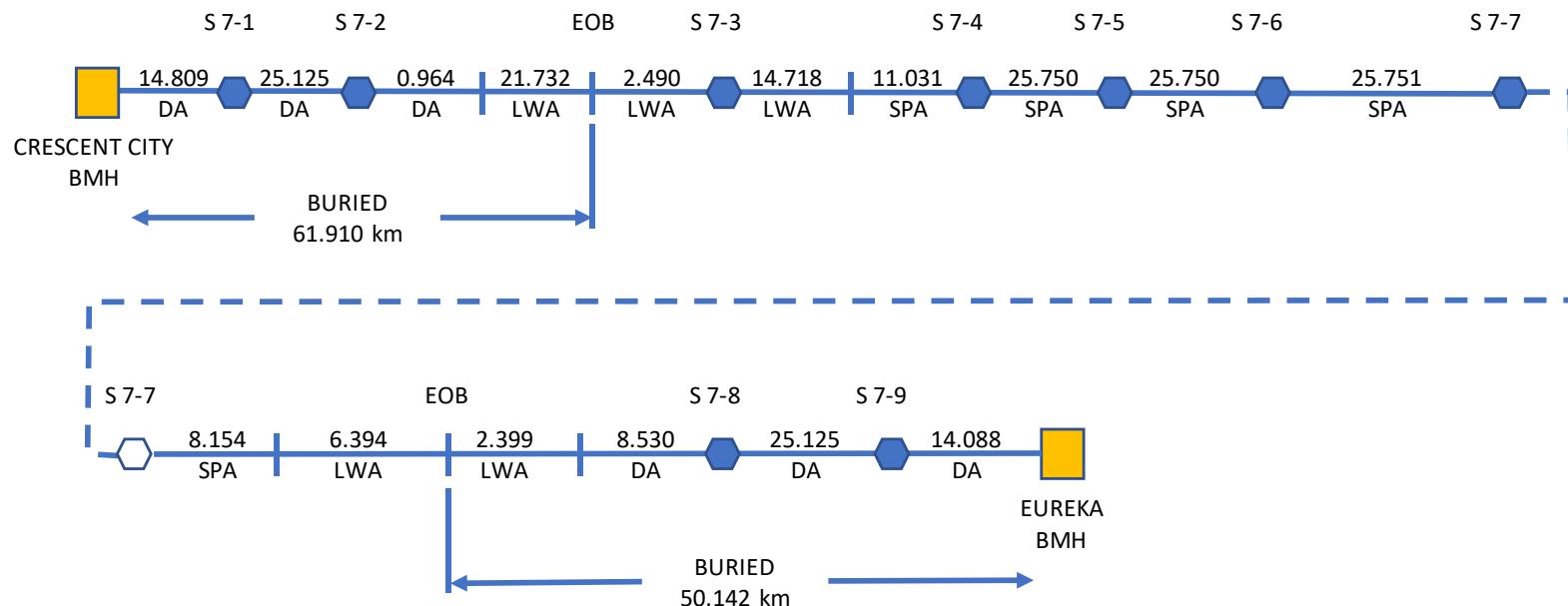
STRAIGHT LINE DIAGRAM		
SEGMENT 5		
FLORENCE to BANDON		
Issue	Date	Page
2	13 November 2018	1 of 1



CABLE SUMMARY	
CABLE TYPE	LENGTH
DA	115.650 km
LWA	54.238 km
SPA	100.519 km
TOTAL CABLE	270.407 km



STRAIGHT LINE DIAGRAM		
SEGMENT 6		
BANDON to CRESCENT CITY		
Issue	Date	Page
2	13 November 2018	1 of 1



CABLE SUMMARY	
CABLE TYPE	LENGTH
DA	87.921 km
LWA	47.733 km
SPA	96.436 km
TOTAL CABLE	232.090 km



STRAIGHT LINE DIAGRAM		
SEGMENT 7		
CRESCENT CITY to EUREKA		
Issue	Date	Page
2	13 November 2018	1 of 1

16. CHARTS

Headquarters:
8502 SW Kansas Avenue
Stuart, Florida 34997
+1 772-219-2037



Early Warning
Offshore Seismic
Proposed Cable Route
System Overview



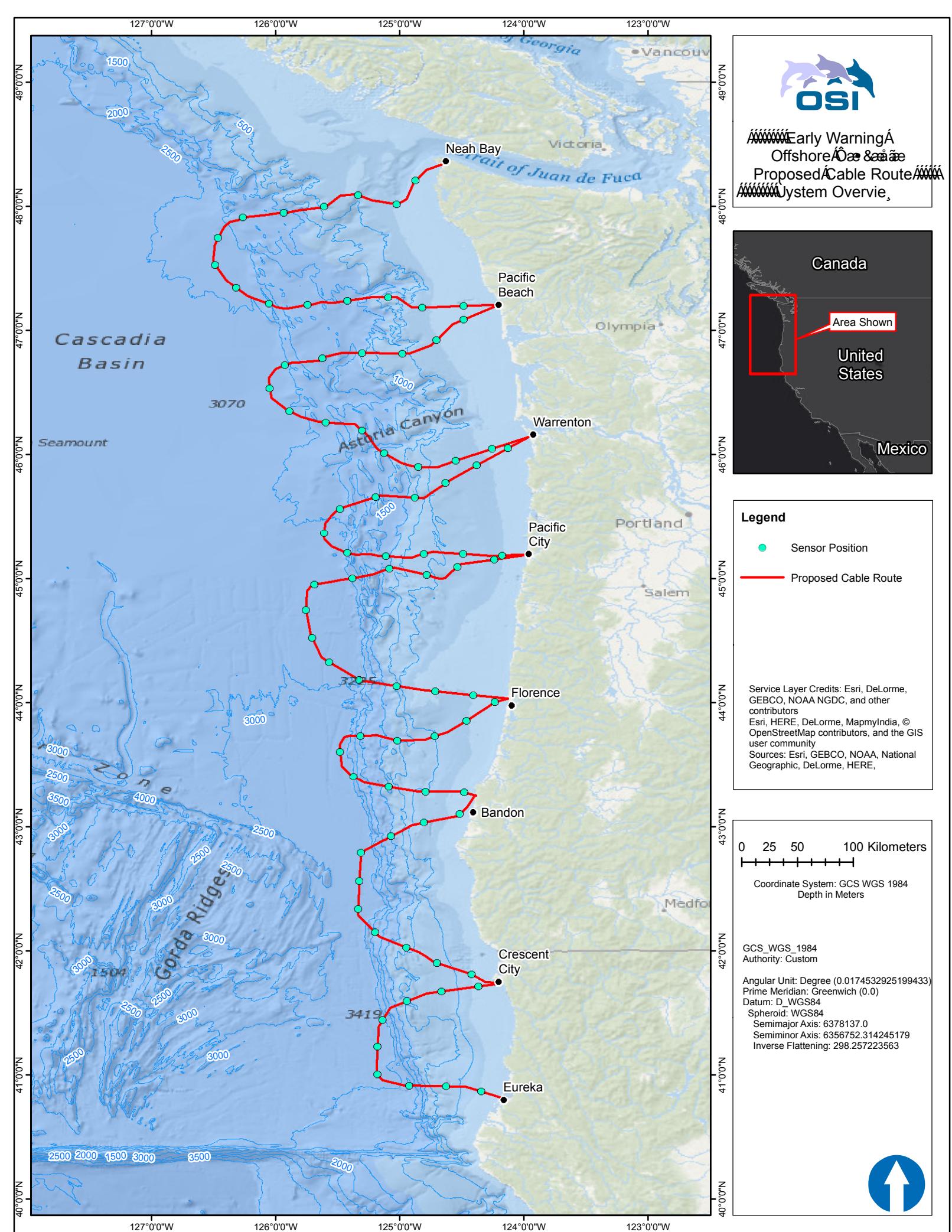
Legend

- Sensor Position (Green Circle)
- Proposed Cable Route (Red Line)

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Coordinate System: GCS WGS 1984
Depth in Meters

GCS_WGS_1984
Authority: Custom
Angular Unit: Degree (0.0174532925199433)
Prime Meridian: Greenwich (0.0)
Datum: D_WGS84
Spheroid: WGS84
Semimajor Axis: 6378137.0
Semiminor Axis: 6356752.314245179
Inverse Flattening: 298.257223563





Early Warning
Offshore Cascadia
Proposed Cable Route
Segment 1



Legend

- Sensor Position
- Proposed Cable Route
- - - Existing Cable

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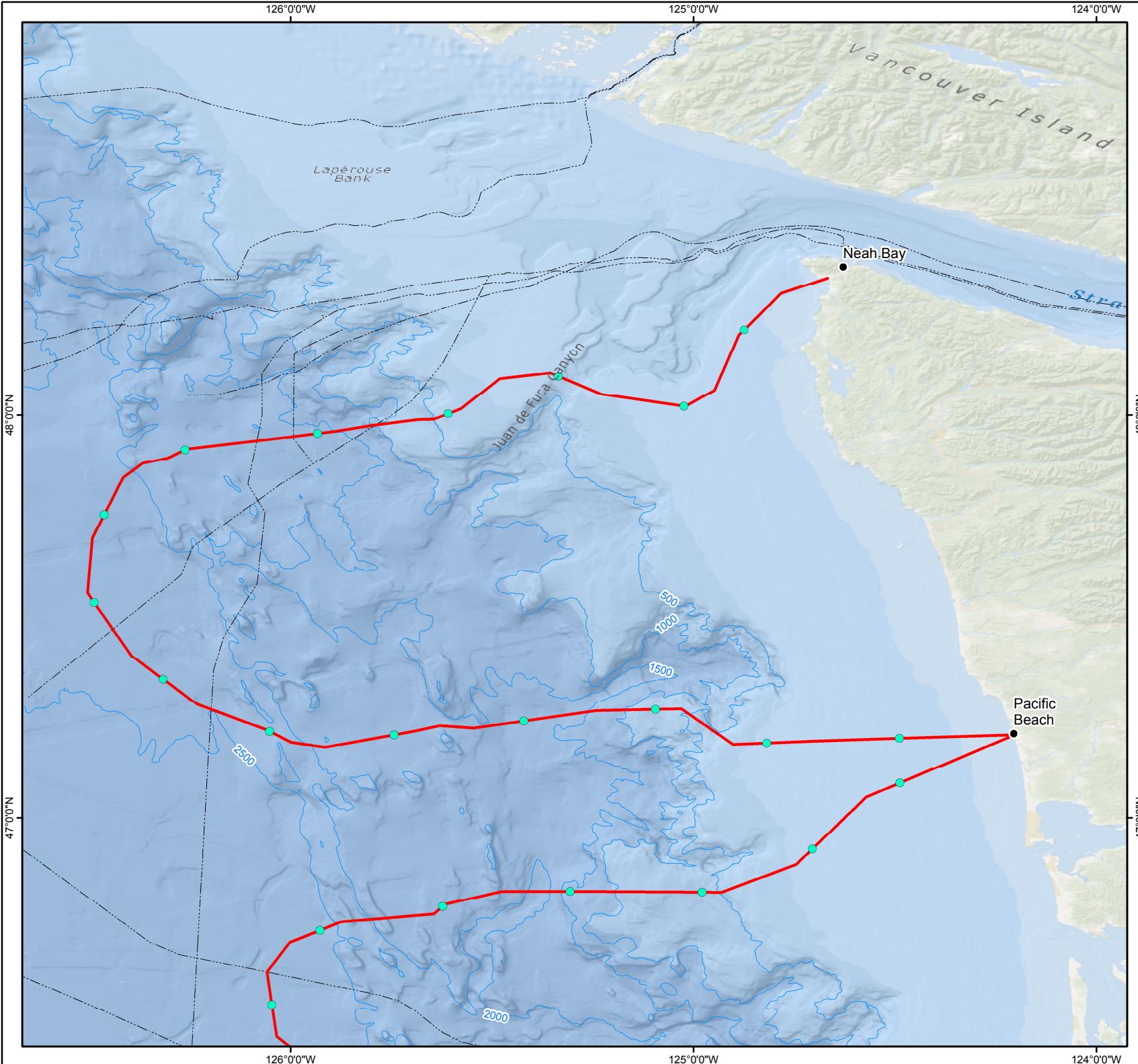
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Coordinate System: GCS WGS 1984
Depth in Meters

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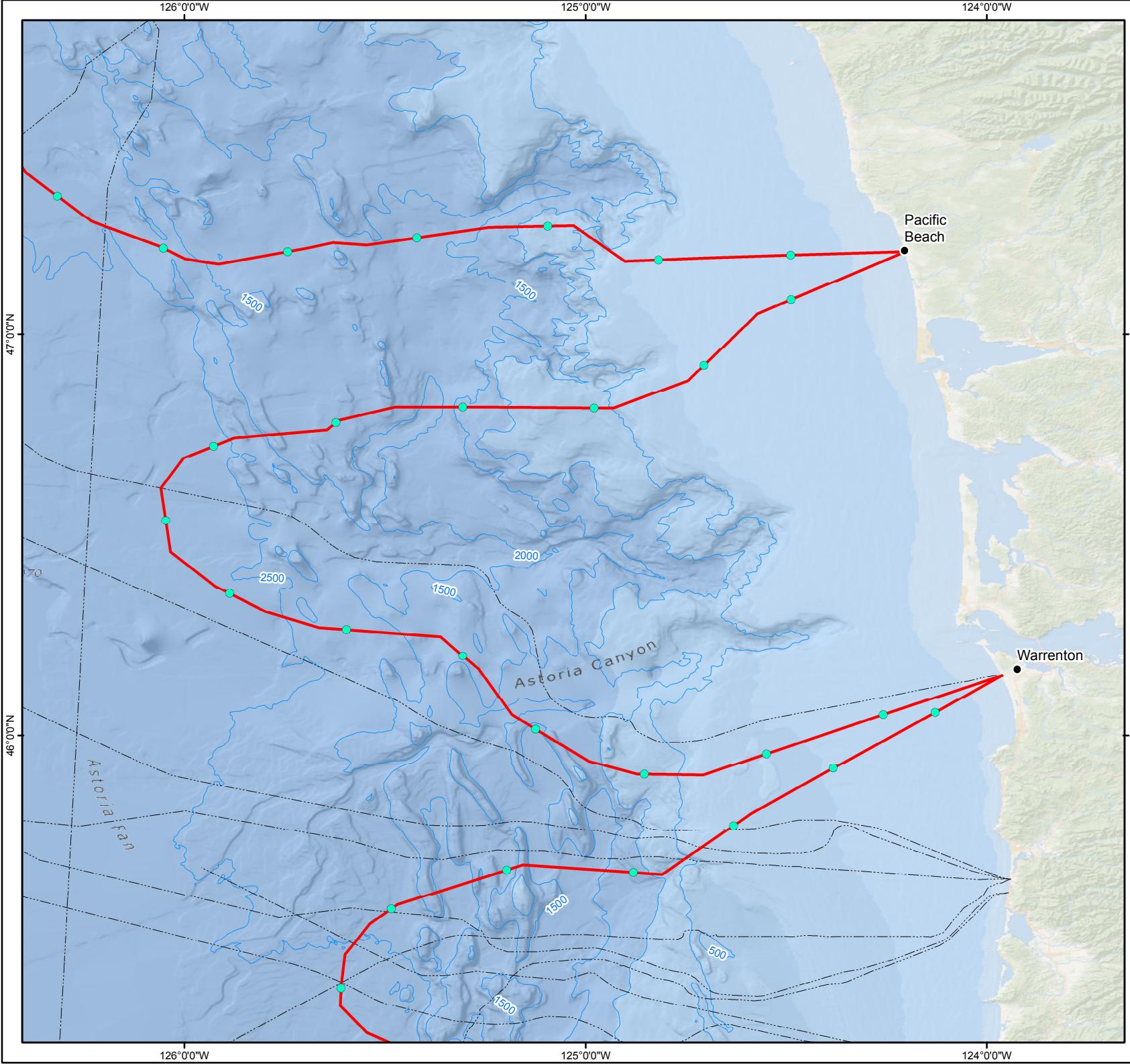
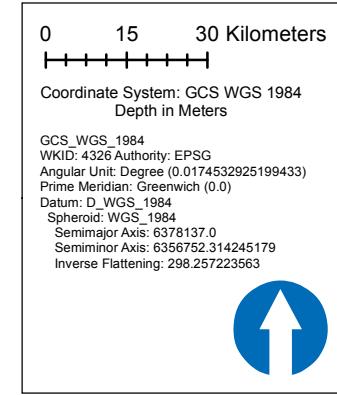
Early Warning
Offshore Cascadia
Proposed Cable Route
Segment 2



Legend

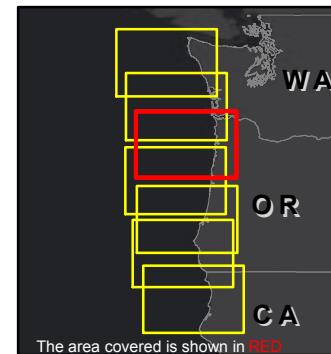
- Sensor Position (Green Circle)
- Proposed Cable Route (Red Line)
- Existing Cable (Dashed Line)

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Early Warning
Offshore Cascadia
Proposed Cable Route
Segment 3

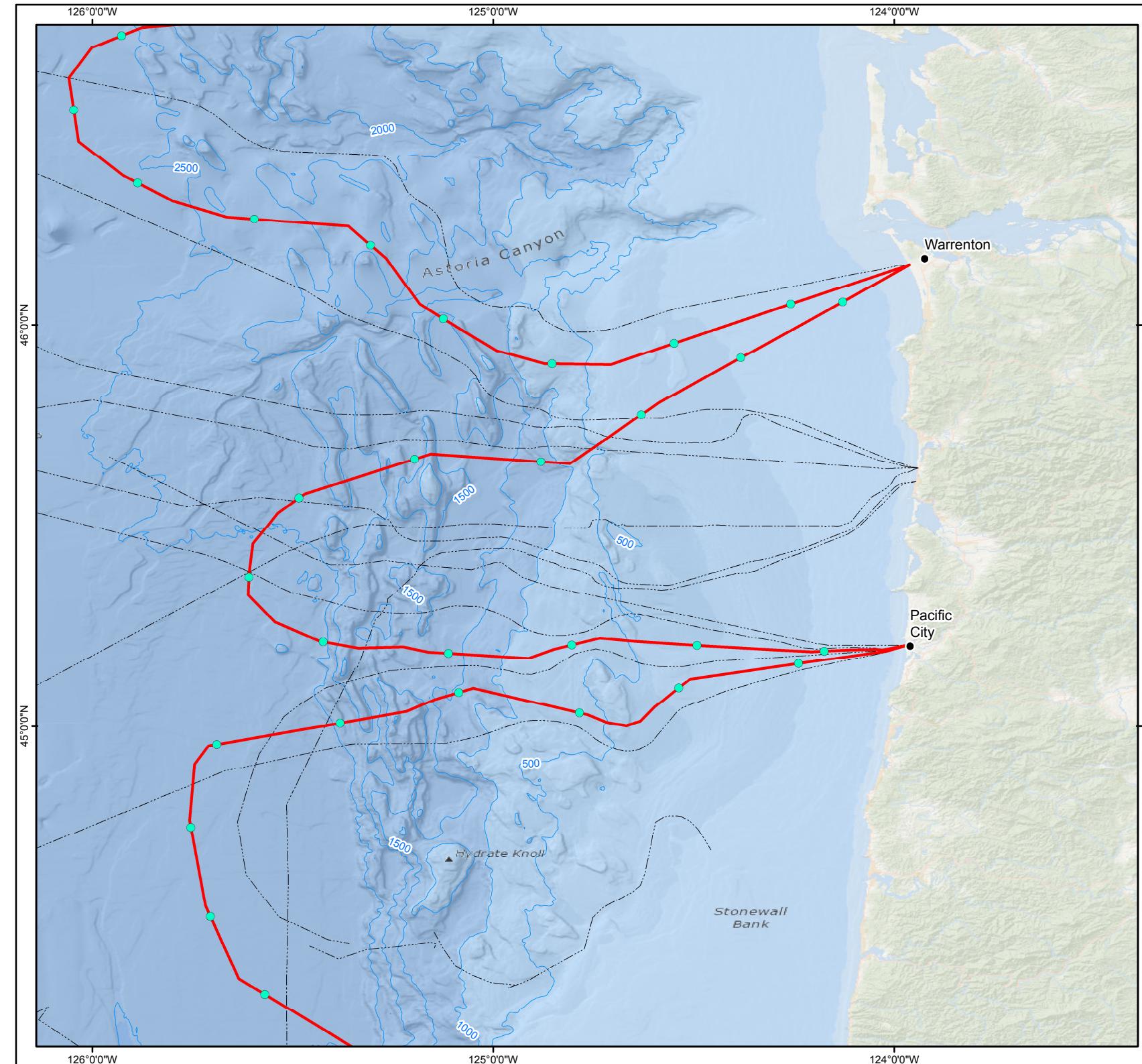


- Legend**
- Sensor Position
 - Proposed Cable Route
 - - - Existing Cable

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0 15 30 Kilometers
Coordinate System: GCS WGS 1984
Depth in Meters

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Angular Unit: Degree (0.0174532925199433)
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Inverse Flattening: 298.257223563





Early Warning
Offshore Cascadia
Proposed Cable Route
Segment 4

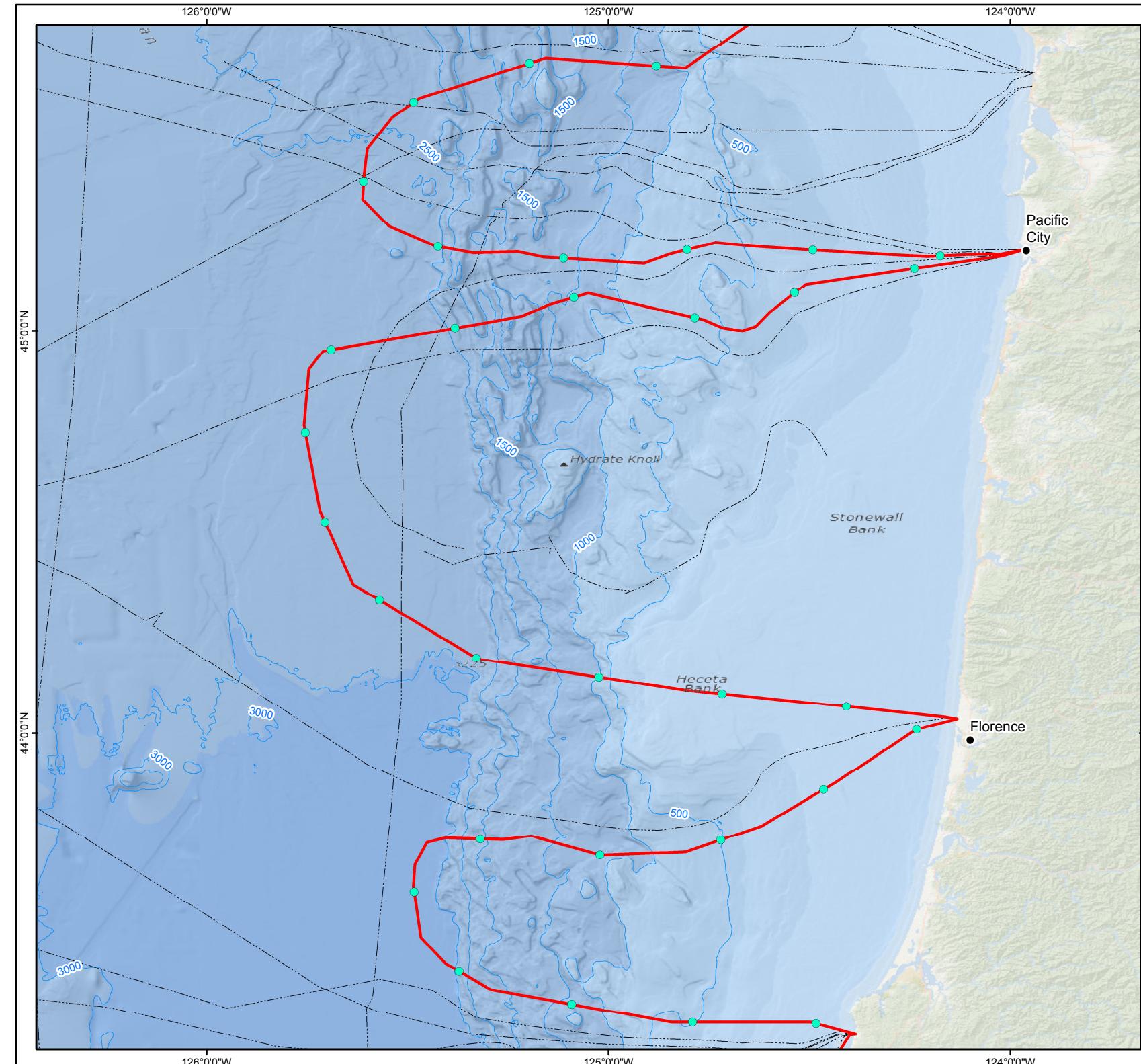


- Legend**
- Sensor Position (Green dot)
 - Proposed Cable Route (Red line)
 - Existing Cable (Dashed line)

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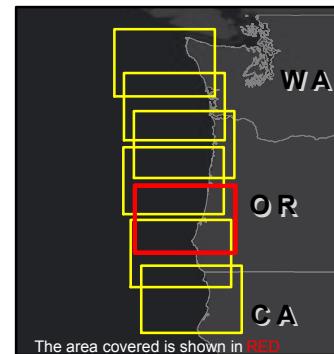
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Depth in Meters

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Datum: D_WGS_1984
Spheroid: WGS_1984
Semimajor Axis: 6378137.0
Semiminor Axis: 6356752.314245179
Inverse Flattening: 298.257223563





Early Warning
Offshore Cascadia
Proposed Cable Route
Segment 5

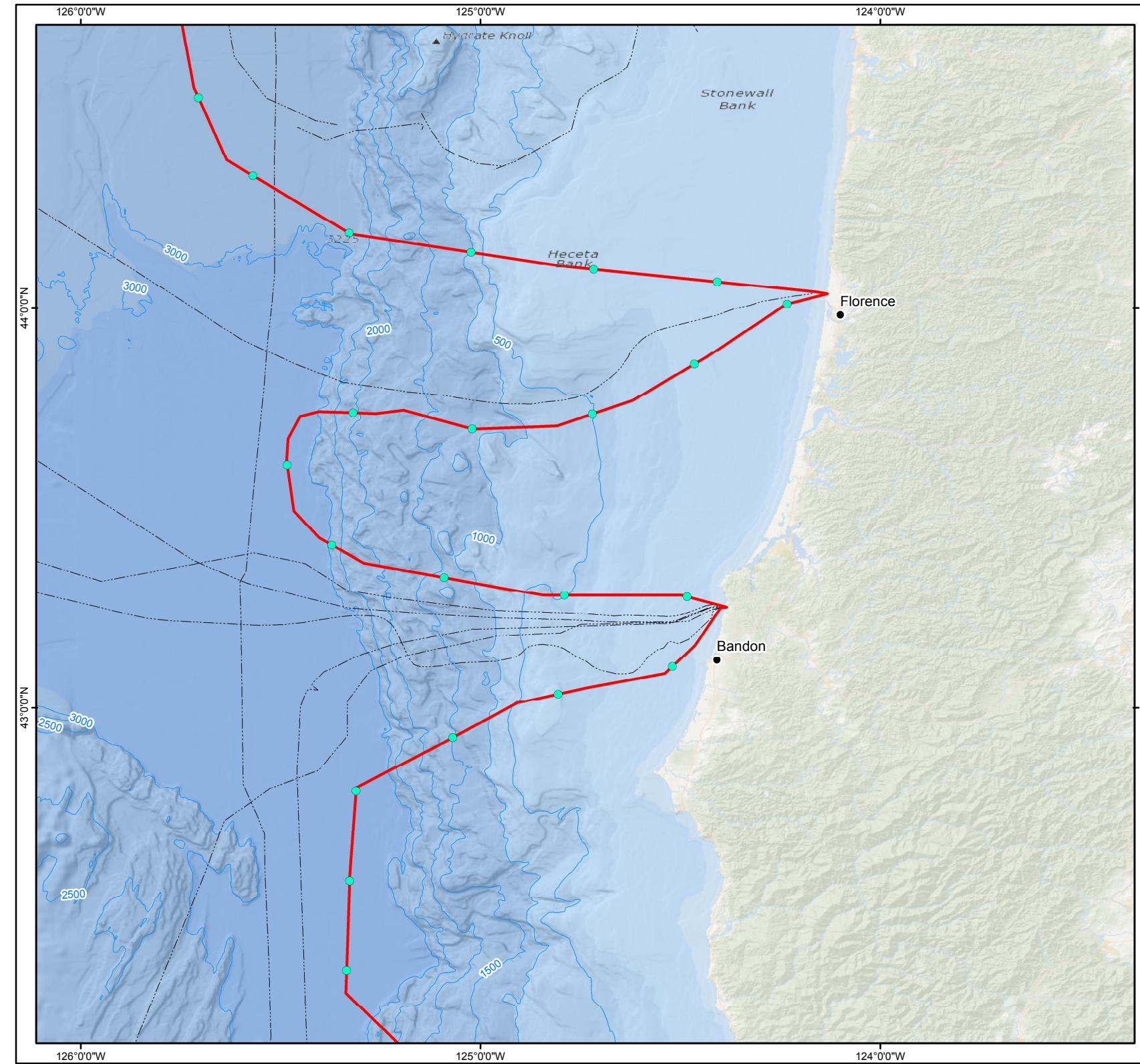


- Legend**
- Sensor Position
 - Proposed Cable Route
 - - - Existing Cable

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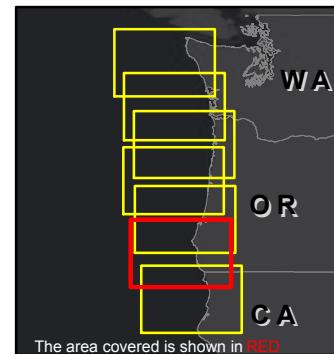
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Depth in Meters

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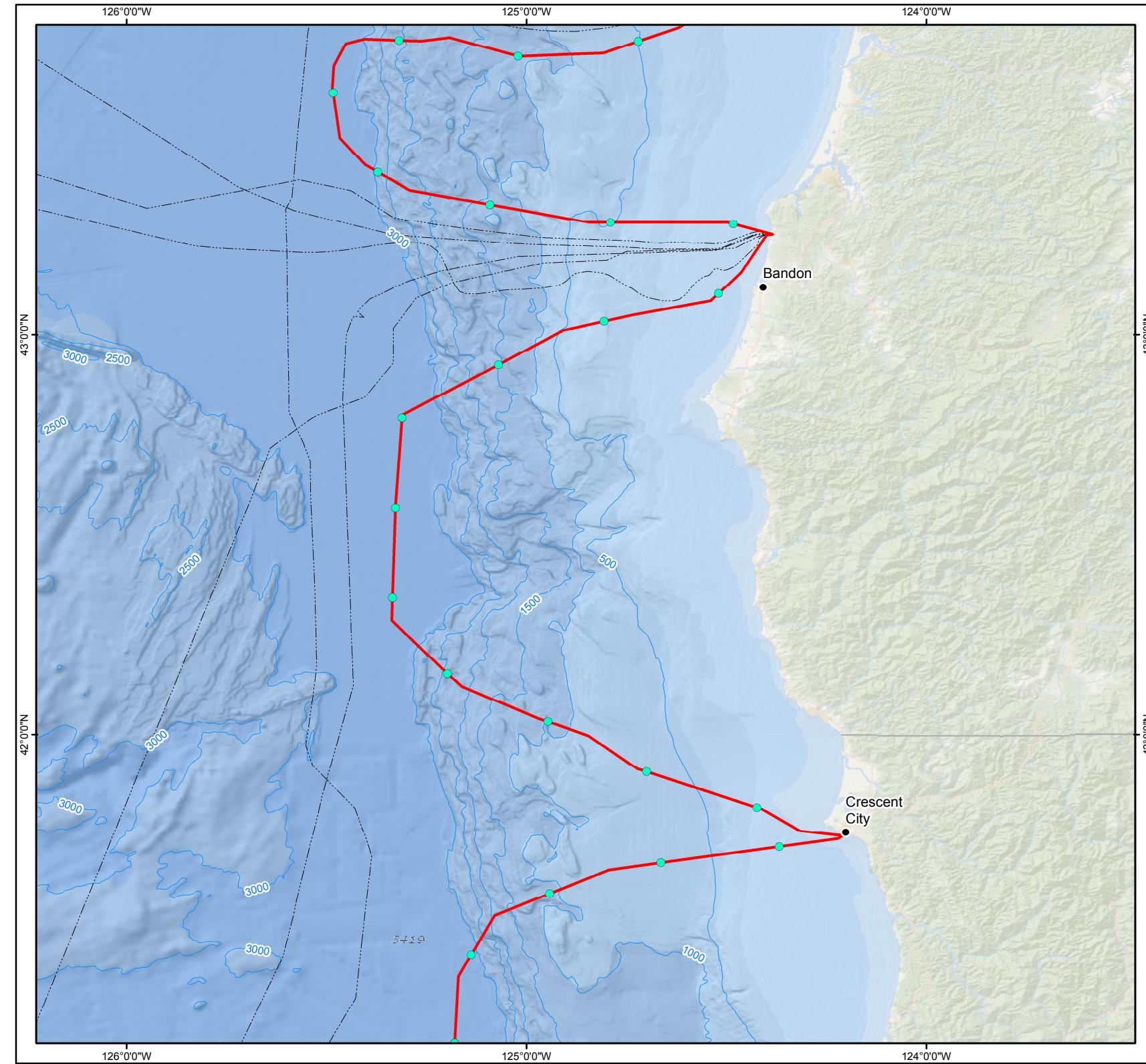
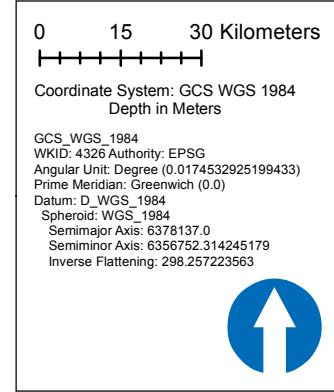
Early Warning
Offshore Cascadia
Proposed Cable Route
Segment 6

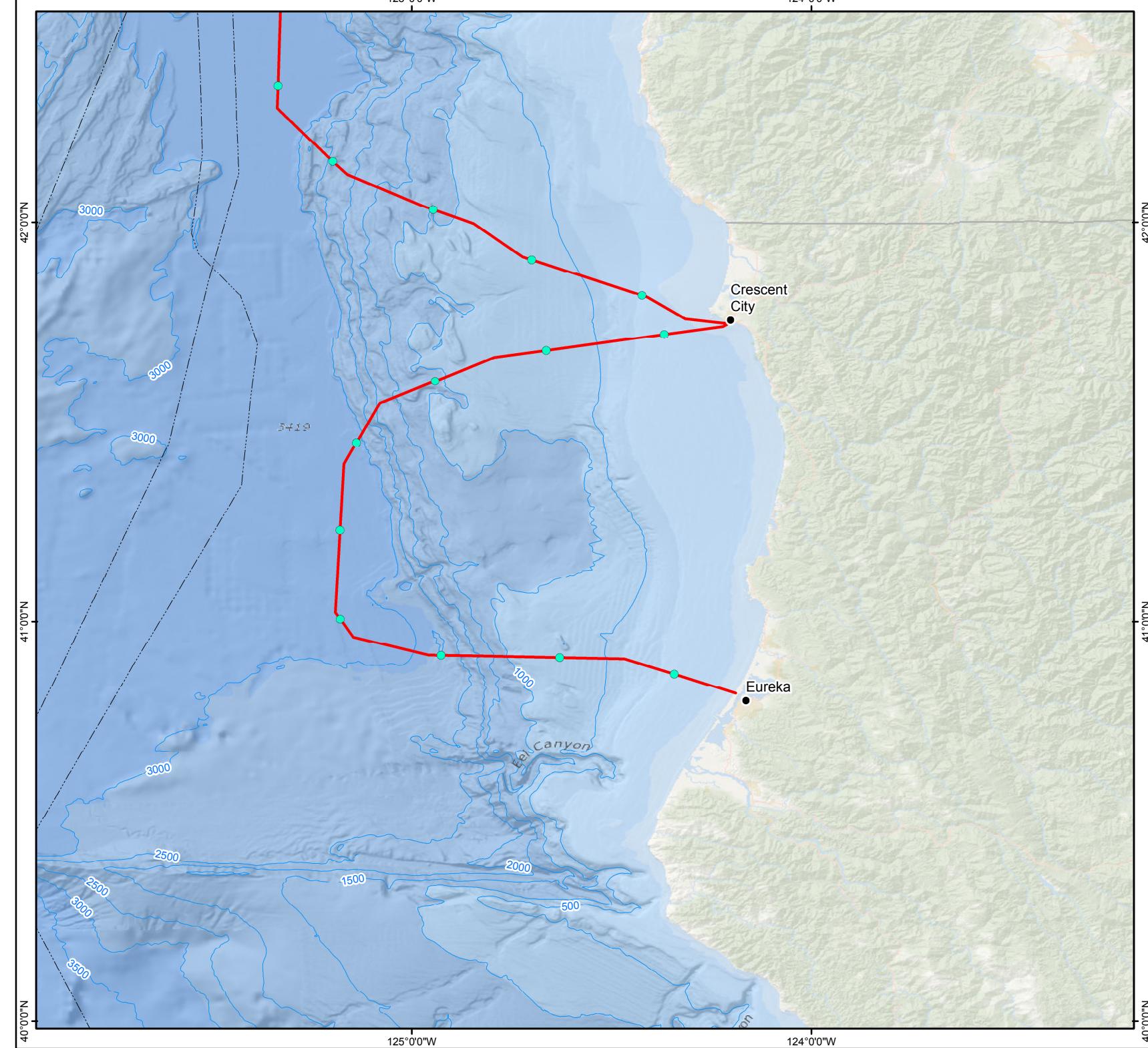


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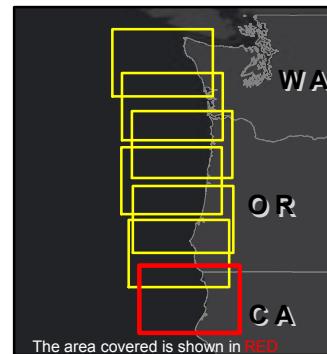
- Sensor Position
- Proposed Cable Route
- - - Existing Cable

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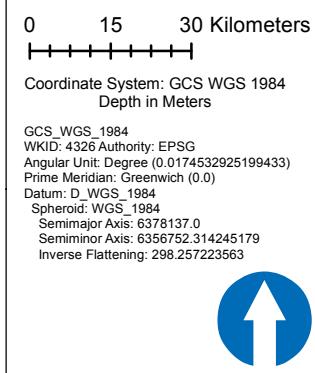
Early Warning Offshore Cascadia Proposed Cable Route Segment 7



Legend

- Sensor Position
 - Proposed Cable Route
 - - - Existing Cable

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ICPC PRESS RELEASE – 21 March 2007
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Insights into Submarine Geohazards from Breaks in Subsea Telecommunication Cables
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Robert C. Beckman
Tara M. Davenport

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